ARCHITECTURAL DESIGN INTERVENTIONS TOWARD IMPROVEMENT OF CONSTRUCTION HEALTH, SAFETY, AND ERGONOMICS IN SOUTH AFRICA

BY

CRAIG COLIN GOLDSWAIN

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Promoter: Professor John Julian Smallwood

DECLARATION

I, Craig Colin Goldswain with student number 8607249, hereby declare that the thesis for the degree of Doctor of Philosophy in Construction Management is my own work, and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another university or for another qualification.

CRAIG COLIN GOLDSWAIN

DEDICATION

This research is dedicated to the improvement of architectural design in South Africa relative to construction health, safety, and ergonomics. The aim is to empower architectural designers to practice healthier, safer, and more ergonomic design through enhanced tertiary architectural education programmes and through continuous professional development training. Ultimately this dedication is to a healthier, safer, more ergonomic South African construction industry.

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ABSTRACT

The construction industry produces a high rate of accident statistics. Constructors are exposed to a range of construction hazards and risks which manifest themselves in accidents and lead to a high incidence of illnesses, injuries and fatalities. Despite evidence that up to 50% of construction accidents can be avoided through mitigation of hazards and risks in the design phase of construction projects, architectural designers do not adequately engage in designing for construction health, safety, and ergonomics.

The research localises the problem in the context of South Africa and sets out to develop an architectural design oriented model toward a reduction of construction hazards and risks, which can be engendered through optimisation of tertiary architectural education and through continuing professional development (CPD) programmes. The ultimate aim is to realise a paradigm shift in architectural design relative to construction health, safety, and ergonomics as architectural designers in South Africa still view it as the constructor’s responsibility.

The research intertwined a range of secondary data with four provisional studies undertaken in the Eastern Cape Province considered representative of South Africa. This involved both quantitative and qualitative methodologies and were directed at architectural designers registered with the South African Council for the Architectural Profession (SACAP). The provisional studies were published in international conference proceedings and served to gradually provide local insight, and ultimately provided a line of structured questions for use in the main study.

The main study was positioned in the action research (AR) paradigm and used focus group (FG) methodology to solicit a vast richness of qualitative data from SACAP registered architectural designers who participated in the FG proceedings. Synthesis of data with literature and the provisional studies gave rise to a provisional model comprising six main model components and a range of sub-components. The provisional model was validated and refined while simultaneously testing the research hypotheses by means of questionnaires directed at the SACAP registered FG participants.

The evolved model includes a core model embedded in a greater process model, and implementation and use of the core model relies on appropriate knowledge of architectural designers. It is ultimately recommended that tertiary architectural education institutions and those involved in architectural CPD programmes take 'upstream design ownership' and use the model as a basis for designing and implementing appropriate tertiary architectural programmes and architectural CPD offerings.

Ultimately the model is not considered as a complete means to an end, and further investigation is needed in order to design and implement the recommended programmes. Only then can we begin to realise a paradigm shift in architectural thinking and practice.

Keywords: architectural designers, construction health, safety, and ergonomics, model.

CONTENTS

CONTENTS OF THE STUDY

Chapter one provides an introduction to the study. This includes a general introduction to provide the setting, followed by the statement of the problem, the sub-problems, the hypotheses, the delimitations, the definition of the terms, the abbreviations, the assumptions, the importance of the study, and the aims and objectives of the study.

Chapter two provides a review of relevant literature in support of the study. This includes local and international research, research papers, books, journals, electronic sources, and international models considered relevant to the topic.

Chapter three demonstrates the methodological considerations used in the study. This includes the use of a range of quantitative and qualitative provisional studies, and leads on to the AR paradigm involving FG methodology for the purpose of data gathering. It also includes combined quantitative and quantitative questionnaires directed at the FG participants in order to validate the provisional model as presented in chapter six.

Chapter four discusses the range of quantitative and qualitative provisional studies. These assisted in understanding elements of the review of the literature within the context of South Africa and served to provide direction to the main study and to provide basis for the line of structured questioning used to extract data from the research FGs.

Chapter five outlines the FG gatherings and processes, and demonstrates the vast amount of data gathered through the AR paradigm making use of research FGs. The data is presented in terms of ‘themes’ arising from the data.

Chapter six interprets and synthesises appropriate literature, the provisional studies, and the data emanating from the research FGs, merges and integrates the themes into model components, and gradually evolves a graphic provisional model which comprises a ‘core model’ embedded in a greater ‘process model’.

Chapter seven is dedicated to the validation and refinement of the model. It demonstrates the validation data obtained from the FG participants through the use of a questionnaire integrating quantitative and qualitative methodologies, which was administered together with an explanation and the provisional model. The chapter summarises and presents a refined graphical model.

Chapter eight tests the findings of the research relative to the hypotheses and incorporates feedback from the research FG participants as a measure of their perceptions. It draws on the validation questionnaire, which included statements relative to the research hypotheses.

Chapter nine draws conclusions from the study and makes recommendations for future requirements toward including the model in tertiary architectural programmes and continuous professional development courses – ultimately toward a paradigm shift in architectural thinking in South Africa.

The References section follows Chapter 9. A comprehensive list of references relative to the sources used in support of the study is included in line with those references made within the text.

A range of appendices follows the References, which includes the published conference papers resulting from the provisional studies, and the model validation documentation.

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LIST OF DIAGRAMS

1. THE PROBLEM AND ITS SETTING

1.1 FOREWORD

While the majority of construction designers strive toward ‘beauty’[1] in order to satisfy clients, as inferred by De Botton (2007) in his book ‘The Architecture of Happiness’, the risks, in terms of health, safety, and ergonomics, to the constructors is often insufficiently considered by designers.

This research positions itself within the construction industry of the Republic of South Africa, which, as worldwide, can be considered to be a people based industry and is largely dependent on labour. The exposure to health, safety, and ergonomic hazards and risks is enormous and often gives rise to illness, injury, and death, resulting in one of the most dangerous industries in South Africa and worldwide.

Throughout this thesis, for purposes of brevity, construction health, safety, and ergonomics will be referred to as construction H&S, as construction ergonomics is really a construction health and safety matter.

Accidents do not simply happen. Haslam *et al*. (2005, 402) reference Kletz (2001) suggesting a “... systematic nature of safety failures and wide reaching contributory factors”, which, inter alia, include issues surrounding design, in terms of choice of material and equipment and the design situation in which they are used, thus supporting Reason (1995), as suggested by Haslam *et al*. (2005), who contend poor design and planning decisions lead to ‘active failures’.

Hinze (2005) actively promotes the need for a paradigm shift from simply monitoring H&S performance to proactively improving it through continuous operational improvement. Proactively, design should be “... reviewed to ensure it can be constructed safe(l)y, as well as meet cost, schedule, and quality goals.” (Toole and Gambatese, 2006)

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[1] ‘Beauty’ is expressed here as meaning not only beautiful looking buildings, but is inclusive of form and function as well as the psychological ‘happiness’ of building occupants.

Maghsoudi *et al*. (2013) review a range of current design practices from different perspectives and recognise four quality attributes as constituting ‘design value’. These include economic values, environmental values, functional values, and impact values with a range of sub-categories. Relevant to this study, they note H&S as being a functional value.

The question arises as to whether the construction hazards and risks giving rise to the main causes of construction accidents can actually be attributed to design? Behm (2006), in analysing 450 construction accident reports, suggests that one third (151 cases) of the hazards leading to the accidents “... could have been eliminated or reduced if design-for-safety measures had been implemented...”, while the HSE (2003), in a detailed construction accident study, suggest that up to 50 of 100 cases could have mitigated the risks through alternative design.

Despite the South African Construction Regulations being promulgated in 2003, and due for amendment in 2014 in terms of Section 43 of the OH&S Act (Republic of South Africa, 2003; Geminiani *et al*., 2005), which ensure a multi-stakeholder responsibility for construction H&S, designers in South Africa are not committed to designing for construction H&S and do not adequately conduct hazard identification and risk assessments (HIRAs) during the design process, mostly due to inadequate designing for construction H&S education at tertiary education institutions (Goldswain & Smallwood, 2009).

What follows, overviews the traditional approach to construction H&S and the cost implications involved, legislation and professional ethics, H&S by design, risk management through effective planning, and the appropriateness of design education. It then considers the way forward, and entertains the ‘opening formalities’ of the thesis.

1.2 TRADITION AND COST

Mroszczyk (2005), Schneider (2006), and Smallwood (2006a) concur with respect to the hazards and risks to which constructors are exposed. By tradition, the responsibility for construction H&S is left to contractors and other site personnel, and entails all on-site activities undertaken between design and handover of a structure (Mroszczyk, 2005). The interrelationship of cost, quality, and schedule are traditionally used as a measure of project success, which does little to mitigate construction hazards and risks (Schneider, 2006; Smallwood, 2006a).

Compounded, these result in environmental damage, lead to reduced productivity, sacrifice quality, extend the duration of projects, and ultimately increase construction costs (Smallwood, 2006a) – all counteractive in terms of economics. While the aforementioned project parameters are all management concerns, the cost of accidents inflate that of construction and are ultimately borne by the client (cidb, 2009). Such costs can be expressed as a percentage of construction value completed nationally, and comprise the direct and indirect costs. Direct costs include accident related medical costs and consequential compensation to sufferers through workmen's compensation insurance, while indirect costs include: "... reduced productivity; ... clean up costs; replacement costs; stand-by costs; costs of overtime; administrative costs; replacement worker orientation; costs resulting from delays; supervision costs; costs related to rescheduling; transportation, and wages paid while the injured is idle." (cidb, 2009)

Relative to South Africa, it is estimated that direct costs contribute 27% and indirect costs contribute 73%, and that this ultimately relates to 2%, approximately R 3.5 billion per annum, of construction value in South Africa (cidb, 2009). Additional planning and implementation costs for construction H&S systems are estimated to be up to 3% of project costs, suggesting that the total transferred to the client could amount to 5% of construction value.

It is suggested that the total cost of accidents in the USA amounts to 6.5% of construction costs, and approximately 8.5% of tender price in the UK (cidb, 2009). Ultimately, better planning and fewer accidents will reduce construction costs. Construction H&S needs to "... be seen as an enabler and as the catalyst for enhanced performance relative to cost, the environment, productivity, quality, and schedule." (cidb, 2009)

1.3 LEGISLATION AND PROFESSIONAL ETHICS

The Constitution of the Republic of South Africa (1996) makes provision for 'human dignity' and the 'rights' of the citizens of the country, and everyone has the right to "an environment that is not harmful to their health or well-being."

Occupational health and safety (OHS) in South Africa is legislated by the OH&S Act No. 85 (Republic of South Africa, 1993), and serves toward the protection of workers. The South African Construction Regulations were promulgated on 18 July 2003 and serve as a sub-section to the OH&S Act (Republic of South Africa, 2003, Geminiani *et al*., 2005).

Smallwood and Haupt (2005) contend that the South African Construction Regulations strive to ensure a multi-stakeholder responsibility for construction H&S. Clients, designers and quantity surveyors, as well as the principal contractor must all accept responsibility for construction H&S. Their roles are not all elaborated here, however designers are required to, *inter alia*, provide the client with relevant design information which has an effect on cost, inform the contractor of likely construction risks, provide a geo-science technical report, advise on methods and sequence of construction, and modify the design where construction risks are apparent (Republic of South Africa, 2003). With regard to professional ethics and legislation The Architectural Professions Act, No. 44 of 2000 (Republic of South Africa, 2000) provides a code of conduct ensuring that all architectural designers are registered with the SACAP, which expects all registered persons to competently carry out their duties with integrity (SACAP, 2008), a case for construction H&S itself.

1.4 RISK MANAGEMENT THROUGH EFFECTIVE PLANNING

Cameron *et al*. (2005) promote effective planning as being essential if projects are to be completed according to schedule and budget and without the negative experiences arising from construction risks (Cameron *et al*., 2005). Two international models used to facilitate effective project planning, including planning for construction H&S, are the United Kingdom's Gateway model (HSE, 2004a) and the Australian CHAIR model (WorkCover NSW, 2001).

The Gateway model relies on good people management as opposed to paperwork management and moves ownership of construction H&S risks upstream in a "... structured, systematic, logical, rigorous and transparent ..." (HSE, 2004a, x) manner and offers a means of assessing designers' and contractors' work, which includes performance assessments at given intervals throughout the mentioned phases. It warrants a multi-stakeholder approach and includes 'support tools', which aim at improving general project planning and integrating construction H&S planning, and the project team is required to sign-off all items prior to confidently progressing (HSE, 2004a). This is not elaborated here, but is included in the review of the literature.

The Construction Hazard Assessment Implication Review (CHAIR), which is an Australian 'tool' or model aimed at promoting a multi-stakeholder approach toward a reduction of construction H&S risks linked to design. The focus of CHAIR, and the choice of the name 'CHAIR', is to give designers the "... opportunity to sit down, pause and reflect on possible problems" – a time for 'brainstorming' (WorkCover NSW, 2001), and recognises that design involves the need to combine construction H&S with, for example, "... operability, aesthetics and economics ..." (WorkCover NSW, 2001) congruent with the influence of a multi-stakeholder approach. Three specific phases exist in the CHAIR process, which are not elaborated here, but are also included in the review of the literature. The thinking of the CHAIR is included in the 'principles of safe design' (Australian Safety and Compensation Council, 2006), being 'persons in control, 'product lifecycle', 'systematic risk management', 'safe design knowledge and capability', and 'information transfer', as well as the 'hierarchy of control' model (Australian Safety and Compensation Council, 2006) inclusive of 'elimination', 'substitution', 'isolation', 'administration', and as a last resort, 'personal protective equipment (PPE)'.

Numerous recommendations toward improved design for H&S, generally in the form of 'lists' have been drawn up, expanded upon and disseminated by researchers and authors such as Gambatese (1997), Weinstein (2005), and Behm (2005). These are not elaborated here, but are included in the review of the literature.

1.5 THE APPROPRIATENESS OF DESIGN EDUCATION

Cowley *et al*. (2000, 11) advocate The Consultancy Company (1997) suggesting "... that architects lack experience in construction and maintenance and so have a poor appreciation of the hazards of their designs". Hecker (2005), as advocated by Toole and Gambatese (2008), suggests that people with relevant construction H&S education will be in a position to make the most appropriate design decisions, however maintains that construction designers generally have insufficient knowledge of the processes required to actively mitigate risk through design.

Toole and Gambatese (2006) further suggest that a strong emphasis on 'designing for constructability' needs to be included in design education. Schulte *et al*. (2008) consider Prevention through Design (PtD) and claim that education can be enhanced through expansion of curricula and by stimulating professional accreditation. Similarly, Smallwood (2006) declares construction H&S education inappropriate, and encourages optimisation of design programmes at tertiary level. Engaging CPD courses will raise awareness and subsequently change perceptions of designers (Smallwood, 2006a).

1.6 THE WAY FORWARD

The earlier inclusions, despite legislation, provide evidence to suggest that the traditional means of managing construction H&S excludes the design realm, and exacerbates construction risk. It also suggests that effective management and appropriate design can mitigate construction hazards and risks, and that appropriate design education and training can prepare designers to address the issues at hand.

It is suggested that sufficient evidence exists to support the need for this study, and while design may include a range of professions, this study focuses specifically on architectural design, and the means by which architectural designers can mitigate construction H&S hazards and risks. What follows entertains the 'opening formalities' of the thesis.

1.7 THE STATEMENT OF THE PROBLEM

The purpose of this research is to investigate issues pertaining to health, safety, and ergonomics within the construction industry, in order to develop an architectural design oriented model toward a reduction of construction hazards and risks in South Africa, which can be engendered through optimum design related programmes at tertiary education institutions and through CPD courses. The ultimate aim is to realise a paradigm shift in architectural design relative to construction health, safety, and ergonomics as architectural designers in South Africa still view it as the constructor's problem.

1.8 THE SUB-PROBLEMS

With reference to construction health, safety and ergonomics, the sub-problems are:

1.8.1 Construction work is hazardous and constructors are placed at risk;

1.8.2 Constructors become ill, and experience the onset of terminal diseases;

1.8.3 Constructors are injured, including fatal occurrences;

1.8.4 Constructors experience WMSDs;

1.8.5 Design dictates construction and leads to hazardous work being undertaken by constructors, and

1.8.6 Designers lack health, safety and ergonomic related design skills.

1.9 THE HYPOTHESES

With reference to construction health, safety and ergonomics, the hypotheses are:

1.9.1 Construction work generates hazards, which could be mitigated by improved design, causing constructors to be placed at risk;

1.9.2 Exposure to specific construction processes and materials, which could be mitigated by improved design, causes illness, some terminal;

1.9.3 Exposure to specific construction hazards, which could be mitigated by improved design, can lead to injuries and fatalities;

1.9.4 Exposure to specific construction work, which could be mitigated by improved design, can lead to workplace musculoskeletal disorders (WMSDs);

1.9.5 Improved design can reduce the exposure of constructors to hazardous work, and

1.9.6 Design education is inadequate in terms of construction health, safety and ergonomics.

1.10 THE DELIMITATIONS

This study:

- will be limited to the design of structures / buildings as opposed to motor vehicles, which are notorious for accidents in the construction industry, but only those occurring on construction sites will serve toward the focus of this study, as opposed to accidents on public roads and highways;

- will not consider the cost of construction relative to the study;

- will not attempt to develop the design related education and training programmes, however may provide some insight into possible programmes;

- will be limited to architectural designers, who are professionally registered with SACAP, in the two larger regions of the Eastern Cape Province, South Africa, namely the Buffalo City and Nelson Mandela metropolitan regions, and

- where necessary will engage, but will not focus on, related professions.

1.11 THE DEFINITION OF TERMS

In the context of this study, unless elsewhere justified:

- 'Constructor(s)' "include construction firms, contractors, and subcontractors responsible for building a project and employing construction workers." (Behm, 2006);
- 'Designing for safety' is the "consideration of construction site safety in the preparation of plans and specifications for construction projects." (Behm, 2006);
- 'Designing for construction safety' is "the deliberate consideration of construction site safety in the design phase of a construction project, with the goal of reducing inherent risk to construction workers." (Toole *et al*., 2006);
- 'Design Professional(s)' "includes architects, designers, and design engineers responsible for a project's design." (Behm, 2006);
- 'Hazard' "is a condition or event with the potential to cause harm." (European Federation of Engineering Consultancy Associations (EFCA) and the Architects' Council of Europe (ACE), 2006);
- 'Risk' is "the probability that harm from a particular hazard will occur combined with the likely severity of the harm" (EFCA & ACE, 2006), and
- 'Disabling injury' is "an injury that leaves a worker temporarily or permanently disabled." (Behm, 2006)

1.12 THE ABBREVIATIONS

The following abbreviations are included in the thesis:

ACE	Architects' Council of Europe
AR	Action Research

CAD	Computer Aided Design
cidb	Construction Industry Development Board
CPD	Continuous professional development
CP	Critical path
CPM	Critical Path Method
DA	Document analysis
DfH&S	Designing for (construction) health and safety
EFCA	European Federation of Engineering Consultancy Association
EME	Established market economy
FEMA	Federated Employers' Mutual Assurance Company Limited
FG	Focus group
GDP	Gross domestic product
H&S	Health and safety, inclusive of construction ergonomics
HAVS	Hand-arm vibration syndrome
HCS	Hazardous chemical substance
HSE	The Health and Safety Executive
MVA	Motor vehicle accident
NBR	National Building Regulations
OHS	Occupational health and safety
PPE	Personal protective equipment
RSI	Repetitive strain injury

SACAP	South African Council for the Architectural Profession
SANS	South African National Standards (SANS 10400 is relevant)
SHE	Safety, health, and environment
UK	United Kingdom
USA	United States of America
VO	Variation order
WBS	Work breakdown structures
WMSD	Work-related Musculoskeletal Disorder

1.13 THE ASSUMPTIONS

It is assumed that:

- current trends are not directed at conceptual design, but rather at the management of health, safety, and ergonomic risks 'inherited' from the design team, and

- construction accidents will continue to occur, but mitigation of construction hazards and risks through appropriate architectural design will lead to a reduction of construction accidents.

1.14 THE IMPORTANCE OF THE STUDY

Given the appalling statistics and the causes of accidents referred to in the review of the literature to follow, as expounded, *inter alia*, by the cidb (2009) report, created by the hazards and risks to which constructors are exposed, the ultimate aim of this study is thus to realise a paradigm shift relative to construction H&S as architectural designers in South Africa still view it as the constructor's problem.

In order to achieve this, the study seeks to develop a design oriented model suitable for use by architectural designers to proactively contribute toward the reduction of construction hazards and risks, which lead to 'active failures' in the construction industry. It is anticipated that such a model can be incorporated into tertiary education design programmes and CPD courses.

Any reduction of health, safety, and ergonomic hazards and risks through design will save lives, reduce illness and injury, save on direct and indirect costs, improve quality, reduce legal encounters, improve labour relations, improve public relations and improve the image of the construction industry at large.

1.15 THE AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to realise a paradigm shift in architectural design in South Africa, relative to construction H&S. The objectives of the study are therefore to:

- conduct a review of relevant literature;
- comprehend the extent and worth of relevant extant models and lists of remedies;
- consider the relevance of the above-mentioned within the context of South Africa;
- develop a model which would encourage architectural designers in South Africa to engage in designing for construction H&S, and
- validate the model through SACAP registered architectural designers

2. THE REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

A review of related literature seeks to assist researchers to place their chosen topic or research problem in perspective relevant to the existing body of knowledge learned from those who have already 'journeyed into the unknown' and have recorded their findings (Leedy and Ormrod, 2010). In order to place this research in perspective, a range of local and international sources including books, journal articles, theses, conference papers, reports and online sources were utilised toward gathering secondary data. More information presides in Chapter 3 'The research paradigm and methodology'.

The literature builds an understanding of construction H&S within the local and international arena, and further promotes the importance and need for this study in the context of South Africa.

A sad appreciation of the hazards and risks to which construction workers are exposed is demonstrated in the early sections of the review. The devastating statistics relative to the South African and international construction industries depict a high incidence of illness, injury, and death. The causes of construction accidents define how such illness, injury, and death occurs, and the exposed construction hazards and risks are really an accident waiting to happen.

While numerous avenues for mitigating construction hazards and risks have been explored, designing for construction H&S is probably least explored, especially in the context of South Africa. Designing for construction H&S exemplifies the need and opportunities, while literature on construction technologies, processes and programming, HIRAs, design recommendations, and the regulatory design framework in South Africa provides a succinct backdrop. Some international approaches and models are worthy of exploration, and the CDM regulations, the United Kingdom's (UK's) Gateway model and the Australian CHAIR model are considered.

Ultimately, the review of related literature provided insight for this research to continue.

2.2 OVERVIEW OF RELEVANT STATISTICS

2.2.1 Foreword

This section provides an overview of statistical data relevant to H&S, within the construction industry of South Africa, and relies heavily on the outdated, but most recent 'Report on the 1999 Statistics' (Compensation Commissioner, 1999).

In terms of the Compensation for Occupational Injuries and Diseases (COID) Act, it is compulsory that all employers in the construction sector are registered with either the Compensation Commissioner, within the Department of Labour (DoL), or with Federated Employers Mutual Assurance (FEMA), and that any injuries or occupational diseases are reported within 7 or 14 days of occurrence respectively.

The statistics gathered by FEMA (2008) are included in the statistics presented in the COID report, however differences in format and interpretation thereof are problematic. Apart from statistics not being regularly updated and made available, problems include gross under-reporting, as well as the situation whereby statistics provided by FEMA (2008) and the COID report include construction related motor vehicle accidents (MVAs), while the DoL does not include these as they are reported to the South African Police Services (SAPS) (cidb, 2009).

The sections which follow, present an overview of relevant South African statistics followed by international trends in order to understand the relativity thereof.

2.2.2 Relevant South African statistics

The South African construction industry is dangerous. The COID report of 1999 suggests that of the 24 industries listed, Building and Construction ranks ninth in terms of accident frequency rate, fifth in terms of accident severity rate, and third in terms of fatality rates. Although outdated, an example extracted from the tables suggests 14 418 medical aid injuries, 4 587 temporary total disablements, 315 permanent disablements, and 137 fatalities in a single year.

A brief analysis of ‘unsafe mechanical or physical condition’ suggests that improper guarded agencies, defects of agencies and hazardous arrangements attributes to a reasonable amount of identifiable statistics. A perusal of the statistics relating to ‘unsafe acts’ brings human attitude and behaviour to the forefront of accident statistics – a case for industrial psychology, inclusive of the need for a paradigm shift in architectural thinking.

The cidb (2009) report exposes more recent statistics and suggests that according to the DoL, over the period 2004/05 to 2007/08, fatalities increased to approximately 160, while temporary and permanent disablements totalled approximately 400. Table 1 was originally sourced from the DoL and extracted from the cidb (2009) report.

Table 1: Construction accidents excluding motor vehicle related accidents

Category	**Period**			
	2004/05	**2005/06**	**2006/07**	**2007/08**
Fatal	54	81	79	162
Non-Fatal	159	250	245	396
Non-casualty*	11	7	10	20
Total	224	338	334	578

* Based on invalid claims

FEMA, who insure approximately half of the industry’s workforce, recorded the number of fatalities for 2006 as a total of 74, similar to the 79 recorded by the DoL, and a total of 60 fatalities for 2007, as opposed to the 162 recorded by the DoL (cidb, 2009).

The question arises as to whether such statistics relate to international trends?

2.2.3 International statistical trends

Weitz and Luxenberg (2010) claim that in the US Construction Industry, which experiences more fatalities than any other industry, 1 204 fatalities in 2007 was reduced to 969 in 2008. The Bureau of Labour Statistics (Bureau of Labour Statistics – US Department of Labour) (2007) states that in 2007, fatalities for the entire US totalled 1

172. Similarly for 2008, the Bureau of Labour Statistics – US Department of Labour (2008) infers 966 fatalities.

Penny (2007) infers approximately 2.2 million construction workers in the UK and that there have been 2 800 fatalities in the last 25 years. There has however been a reduction of fatalities of approximately 36% between 1999/00 and 2005/06, and 2004/05 and 2005/06 saw 69 and 59 fatalities respectively. At the time, according to Penny (2007), the lowest rate for fatalities of 3.0 per 100 000 construction workers in the UK was an all-time record, not too far off the EU average of 2.5 for 2006 (HSE, 2010a).

The Health and Safety Executive (HSE, 2010b) also reports good progress, in graph format, in the reduction of construction industry rates in the UK, with fatality rates reduced by approximately 36% between 1999/00 and 2005/06, as suggested by Penny (2007).

However, not mentioned by Penny was a dramatic increase of approximately 26% of construction fatalities from 1999/00 to 2000/01 (HSE, 2010b). Hence, not that it necessarily should be, if the reduction in construction fatalities is calculated from 2000/01 to 2005/06, it approximates to 62%. The rate of major injuries from 1999/00 to 2005/06 reduced by approximately 22% and the rate for minor injuries (over 3 day rate) was reduced by approximately 32% during the same time period (HSE, 2010b).

Pritchard (2009) refers to the Labour Department statistics for 2007 with 19 fatalities and 3 042 accidents within the construction industry of Hong Kong.

Innes (2009) considers New South Wales, Australia, which experienced 193 construction industry fatalities between 1980 and 1986. More recently, Safe Work Australia (2010) released statistics for 2007 to 2008. The construction industry is rated as one of five industries with incidence rates exceeding the national average, with claims for the top five industries ranging between 21.6 and 24.4 claims per 1 000 employees, yet all industries showed a reduction in claims from 2002/03 to 2006/07, with a reduction of 22% for the construction industry (Safe Work Australia, 2010, vii-viii). A brief analysis of the Australian situation suggests that the construction industry had 14 410 serious claims of a total of 88 865 for all seventeen industries, equating to 11% with an incidence rate of 21.6, and a frequency rate, which is the serious claims per million hours worked, of 10.7. There were 37 compensated fatalities recorded for the 2007/08 period. This figure represents a reduction of fatalities from 2002/03 (48), 2003/04 (51), 2004/05 (47), 2005/06 (45), and 2006/07 (53).

Much of the above demonstrates the statistics purely in terms of numerical value. In order to understand the South African scenario relative to international economies, fatality rates and accident rates calculated per 100 000 workers are demonstrated in Table 2, extracted from the cidb (2009) report.

Table 2: Accidents by Region

Region	**Fatality Rate per 100 000 workers**	**Accident Rate per 100 000 workers**
Established Market Economies (EME)	4.2	3 240
Former Socialistic Economies (FSE)	12.9	9 864
Other Asia and Islands (OA) (excluding China and India)	21.5	16 434
Sub-Saharan Africa (SSA) (including South Africa)	21.0	16 012
Latin America & the Caribbean (LAC)	17.2	13 192
Middle Eastern Crescent (MEC)	18.6	14 218
Singapore	9.8	7 452
South Africa	19.2	14 626

It is evident that developed countries with established market economies (EMEs) have a far lower accident and fatality rate than those economies consisting mainly of developing countries, inclusive of South Africa. The correlation between accidents, inclusive of fatalities, and level of development, using approximate gross domestic product (GDP) per capita, is strong. This is no reason to become complacent, but should motivate toward improvement (cidb, 2009).

2.2.4 Summary

The construction industry, both locally and internationally, remains dangerous and presents hazards and risks, which ultimately give rise to a very high number of medical aid claims, temporary disablements, permanent disablements and fatalities. It may be that some, or many, of these hazards and risks have the potential of being reduced or eliminated through designing for construction H&S.

The statistics presented raise the question of 'what causes construction accidents' and more specifically, if an attempt is made to mitigate construction accidents through design, 'what type of accidents are contributing to the demonstrated statistics'?

2.3 THE CAUSES OF CONSTRUCTION ACCIDENTS

2.3.1 Foreword

Accidents do not simply happen. Haslam *et al*. (2005) reference Kletz (2001) suggesting a "... systematic nature of safety failures and wide reaching contributory factors." Accidents are multi-causal in nature with the coincidence of a number of factors resulting in an incident. There are two main types of factors which are influenced by a range of attributes.

Firstly, 'proximal factors' occurring in the immediate environment on site, include the attitude, ability, awareness, health and fatigue status of workers generally affected by the successes of industrial psychology in the form of communication, motivation and training, and current health status of individuals, and site hazards created in the absence of suitable planning, management, and supervision, leading to an absence of H&S culture.

Secondly, 'distal factors', which are those linked or attached to, such as issues surrounding design, in terms of choice of material and equipment and the design situation in which they are used, thus supporting Reason (1995), as suggested by Haslam *et al*. (2005), who offer poor design and planning decisions leading to 'active failures' (HSE, 2003; Gibb *et al*., 2006).

Similarly, these factors can be grouped as worker factors, site factors and material / equipment factors, which "... are a result of originating influences, such as permanent works design, project management, construction processes, safety culture and risk management ..." (HSE, 2003, 58), which are affected by client requirements, economic climate and the educational ambit of the people involved (HSE, 2003; Gibb *et al*., 2006).

The specific 'causes of accidents' will contribute more directly towards this study being the distal factor of 'permanent works design'.

2.3.2 Focus on accident causes by statistics

This section touches on data relevant to South Africa, followed by some related international trends, in order to establish common patterns of what causes accidents, while reserving the link to design for later.

Relative to South Africa, Table 1 indicated a total of 376 fatalities and 1 050 non-fatal accidents, with only 48 non-casualty accidents, all excluding related motor vehicle accidents (MVAs).

The COID report claims that for 2006 and 2007 respectively the category of 'motor vehicle accidents' had a total of 1 508 claims and 55 fatalities. 'Falls onto different levels' had a total of 2 651 claims and 28 fatalities, and 'struck by' with a total of 8 505 claims and 27 fatalities. These far exceed 'inhalation, absorption, ingestion', which follows with a total of 279 claims and seven fatalities for 2006 and 2007 respectively.

Further analysis of the FEMA statistics, according to the cidb (2009) report reveals that the dominating causes of injuries were struck by (44%), falls onto different levels (14%) and striking against (10%); the dominating causes of fatalities were MVAs (47%), struck by (17%) and falls on to different levels (17%); penetrating wounds (30%) and superficial wounds (31%) predominated in terms of the nature of injuries sustained; multiple injuries caused 47% of fatalities; injuries to hands (24%), head and neck (19%), and legs (16%) were common anatomic regions involved; and in terms of agency, automobiles (10%) and hand tools (6%) dominated as causes of injuries.

Internationally, Weitz and Luxenberg (2010) claim that in the US Construction Industry, which experiences more fatalities than any other industry, the 1 204 fatalities in 2007 were reduced to 969 cases in 2008. The most frequent events causing fatalities were falls (33%), transportation (20%), contacts with objects or equipment (19%), and exposure to harmful substances (17%).

The Bureau of Labour Statistics (Bureau of Labour Statistics – US Department of Labour) (2007) reports that in 2007 fatalities for the entire US totalled 1 172 of which the main causes were falls (35.6%), transportation incidents (22.7%), contact with objects and equipment (20%), exposure to harmful substances or environments (15.6%), assaults and violent acts (2.9%), and fires and explosions (2.8%).

Similarly, for 2008 the Bureau of Labour Statistics – US Department of Labour (2008) reports 966 fatalities of which the main causes of injuries were falls (32%), transportation incidents (23.7%), contact with objects and equipment (23%), exposure to harmful substances or environments (13.9%), and assaults and violent acts tying fifth with fires and explosions (3.3%).

Haslam *et al*. (2005) suggest that in Great Britain for 2002/03 the construction industry was responsible for 31% of industrial deaths, of which the majority (46%) were as a result of falls from height and 15% as a result of being struck by moving vehicles, while major injuries were caused most commonly by falls from height (31%), slips, trips and falls on same level (25%), and struck by moving/falling object (17%).

Penny (2007) refers to the 2005/06 year in the UK during which there were 59 fatalities. Of these, the main causes were 24 falls from height (41%) and eight cases where workers were hit by moving vehicles (14%).

The HSE (2010b) reports the predominating causes of accidents in the UK over the years as falls from height, struck by moving, including flying / falling objects, slips, trips or falls on the same level, and injured while handling, lifting or carrying. Recent trends (2005/06) show a reduction in falls from height and to some extent struck by moving including flying / falling objects, however a rise in manual handling injuries and slips and trips has led to the latter being the number one cause of injuries for 2005/06, while struck by moving vehicle remains constant (HSE, 2010b).

Innes (2009) writing for the SafetyLine Institute cites one state in Australia, New South Wales, which experienced 193 construction industry fatalities between 1980 and 1986, and identifies the main causes of these as gravitational energy (47.0%), machine energy (20.7%), electrical energy (17.6%), heart and health (4.1%), oxygen deprivation (4.1%), explosion (3.1%), self-energy / thrown from (1%), high velocity particles (1%), heat / burns (0.5%), and non-specific (0.5%).

More recently, Safe Work Australia (2010) released statistics for 2007/08. Body stressing, considered to include lifting, carrying, handling and putting down, among others, caused 34 % of serious claims, followed by falls, trips and slips (26%), falls from height (13%) and falls on same level (12%). A breakdown of 'falls from heights' suggests that 26% of serious claims emanate from 'roofing services' and 32% from 'painting and decorating services', while the majority of serious claims for 'body stressing' in 'concrete services' was double the overall rate with 70%, while 'bricklaying services' and 'tiling and carpeting services' tied at 43% followed by 'glazing services' with 42% (Safe Work Australia, 2010).

2.3.3 Summary

While common patterns are evident, the variety in categories, naming of categories and overlaps can therefore create confusion.

The main cause of fatalities in the USA and the UK is recorded firstly as 'falls' and / or 'falls from heights', while the term 'gravitational energy' as used in the earlier Australian example insinuates the same.

These are followed, secondly, by fatalities involving transportation and / or motor vehicles, which may reflect, or at least include, the 'machine energy' in the Australian example, and thirdly by 'struck by' / 'hit by' objects and equipment and / or moving vehicles. In South Africa, construction related MVAs are the dominating cause of fatalities, followed by the equally rated ‘struck by’ and ‘falls onto different levels’.

The fourth main cause of fatalities in the USA and South Africa respectively, but not mentioned in the other examples, namely ‘exposure to harmful substances or environments’ and / or ‘inhalation, absorption, ingestion’. Similar trends prevail as the main cause of injuries over the years and across the various countries.

The more recent Australian example (Safe Work Australia, 2010) brings ‘body stressing’, considered to include lifting, carrying, handling and putting down, *inter alia*, to the fore – a case for construction ergonomics.

Internationally, and in order, the main causes of accidents appear to be ‘falls onto different levels’, ‘MVAs’, ‘struck by’, ‘inhalation, absorption and ingestion’, and ‘WMSDs or body stressing’ (cidb, 2009).

The question arises as to how the hazards and risks which engender these dominant causes of accidents can be mitigated through appropriate design? These are exposed in what follows, and the identification of hazards and undertaking of risk assessments is included in the later ‘design’ section.

2.4 CONSTRUCTION HAZARDS AND RISKS

2.4.1 Foreword

If construction hazards and risks are to be mitigated through design, it may be expedient to include the meaning of ‘hazards’ and the meaning of ‘risk’ – after all, these lead to construction accidents. A ‘hazard’ “is a condition or event with the potential to cause harm.” (European Federation of Engineering Consultancy Associations (EFCA) and the Architects’ Council of Europe (ACE), 2006), and a ‘risk’ is “the probability that harm from a particular hazard will occur combined with the likely severity of the harm.” (EFCA & ACE, 2006)

If the main causes of construction accidents are the five broad categories suggested earlier, these must then be considered in terms of construction health, safety, and ergonomics hazards and risks. It is evident from the outset that inhalation, absorption, and ingestion can be considered integral of construction health hazards and risks; falls onto different levels, MVAs, and struck by are integral of construction safety hazards and risks; WMSDs or 'body stressing' are integral of construction ergonomics hazards and risks, and these notwithstanding any interrelationship between categories.

The question arises as to whether the construction risks giving rise to the main causes of construction accidents, can actually be attributed to design? Toole and Gambatese (2006) suggest that reducing such risks can be achieved during the design process by conducting reviews of the design at various stages, while Behm (2006), in analysing 450 construction accident reports, suggests that one third (151 cases) of the hazards leading to the accidents "... could have been eliminated or reduced if design-for-safety measures had been implemented...", while the HSE (2003) in a detailed construction accident study, suggest that up to 50 of 100 cases could have mitigated the risks through alternative design.

What follows entertains separate overviews on construction health hazards and risks, construction safety hazards and risks, and construction ergonomics hazards and risks.

2.4.2 Construction health hazards and risks

Hazardous chemical substances (HCSs) can enter the human body through inhalation, absorption through the skin, and ingestion.

Inhalation refers to the breathing in of airborne contaminants such as dusts, fumes, vapours, mists, and gasses resulting in eye irritation, respiratory tract problems and subtle damage to organs. Dusts are caused by handling and the processing of construction materials. Coughing and sneezing may be an early warning of irritants being inhaled, however very fine dust particles can still reach the lungs leading to pneumoconiosis (lung disease caused by inhaling mineral or metallic dust over a long period), asbestosis (inflammation of the lungs caused by prolonged inhalation of asbestos fibers), or lung cancers. Inhalation of solvents can result in respiratory problems and central nervous system damage, while complex fumes given off by welding processes can lead to metal-fume fever (Deacon, 2003; Smallwood, 2001; Occupational Safety and Health Council, 2004; cidb, 2009).

Absorption refers to HCSs being absorbed through the skin. Some examples are the use of solvents which can cause dermatitis, working with concrete, which can cause allergic contact dermatitis as a result of alkaline and abrasive properties, and handling of bitumen and similar products can lead to dermatitis and acne related skin disease (Deacon, 2003; Smallwood, 2001; Occupational Safety and Health Council, 2004; Bureau of Labour Statistics – US Department of Labour, 2007; Bureau of Labour Statistics – US Department of Labour, 2008 Weitz and Luxenberg, 2010).

Ingestion refers to the swallowing of HCSs, occasionally erroneously, but more often through carelessness, for example, the handling of products containing HCSs and eating without washing of hands (Deacon, 2003; Smallwood and Deacon, 2001; Occupational Safety and Health Council, 2004; Bureau of Labour Statistics – US Department of Labour, 2007; Bureau of Labour Statistics – US Department of Labour, 2008).

Cowley *et al*. (2000) advocate Bender and Hadley (1994) suggesting that hazardous material risks should be managed through all stages of development, use, recycling and waste management, and further suggest that more pressure be applied on manufacturers of hazardous chemicals to improve hazard information on packaging, thus making 'upstream target groups', being designers, more aware of the risks presented through the use of specific products.

2.4.3 Construction safety hazards and risks

MVAs occurring on construction sites are considered relevant to this study, as opposed to accidents occurring on public roadways, which require an alternative approach. In terms of design, the design of access routes, warning signs, and a general awareness of vehicular movement on site will serve toward mitigation of related risks. While reverse beepers and other vehicular attributes remain important, these should be focussed on by vehicle designers and suppliers, and be maintained in an operational condition by construction firms, construction managers, site managers and personnel.

'Falls onto different levels' are often caused by tripping, often as a result of poor housekeeping, falling from and collapsing of scaffolding and support work, falling from ladders, hoists and platforms, falling during demolition, falling into open excavations, falling off buildings and roof structures, and falling through openings. Many of these falls can be considered due to design and scheduling insufficiencies and due to a lack of, or inappropriate, barricading, and prevention efforts (Behm, 2006; cidb, 2009; HSE, 2003; Bureau of Labour Statistics – US Department of Labour, 2008; Innes, 2009; Weitz and Luxenberg, 2010; HSE 2010b).

'Struck by' accidents are often caused by falling materials, plant, equipment, structures, people and collisions, impact or failure with respect of motor vehicles and could occur during construction, maintenances or demolition. Other risks include exposure to electrical hazards leading to electrical shock, contact with moving parts of machinery and vehicles, fire and explosion related hazards, excavation collapses, and working in confined spaces (Behm, 2006; cidb, 2009; HSE, 2003; Bureau of Labour Statistics – US Department of Labour, 2008; Innes, 2009; Deacon and Smallwood, 2010; Weitz and Luxenberg, 2010; HSE 2010b).

Cowley *et al*. (2000, 11) advocate The Consultancy Company (1997) suggesting that if hazards are assessed it is usually too late to intervene, and further advocate Gambatese *et al*. (1997) who claim that designers are "... often given legal advice not to address construction safety, to avoid legal liability." Hazard assessments need to be timeous and legal concerns addressed.

2.4.4 Construction ergonomics hazards and risks

Smallwood (2007) cites La Dou (1994) claiming that ergonomics "… is an applied science concerned with people's characteristics that need to be considered in designing and arranging things that they use in order that people and things will interact most effectively and safely." The Construction Regulations (Republic of South Africa, 2003) definition proposes that ergonomics is "… the application of scientific information concerning humans to the design of objects, systems, and the environment."

Smallwood (2007) also cites Schneider and Susi (1994) and Gibbons and Hecker (1999) suggesting that relative to construction, ergonomics poses significant problems and the range of construction tasks adversely affect construction workers.

Construction ergonomic problems include repetitive movements, climbing and descending, handling heavy materials, bending or twisting the back, working in awkward positions, reaching overhead, vibrating tools and equipment, repetitive strain injuries (RSIs), exposure to noise, use of body force, handling heavy or inconveniently sized materials, handling heavy equipment, working in cramped positions, reaching away from the body, working in hot conditions, staying in the same position for long periods, working in humid conditions, working in wet conditions, working in cold conditions, and working while hurt or injured (WorkCover NSW, 2001; Smallwood, 2006b; Smallwood, 2007; cidb, 2009; Deacon and Smallwood, 2010; Safe Work Australia, 2010; HSE 2010b).

Predominating causes of ergonomic related injuries in South Africa include repetitive movements, climbing and descending, handling of heavy materials, use of body force, exposure to noise, and bending or twisting of the back (Smallwood, 2006b).

The construction trades, generally give rise to a range of ergonomic problems, however concreting, reinforcing, formwork and structural steelwork predominate followed by masonry, roofing, building fabric, plumbing and drainage, electrical, floor finishes, suspended ceilings, painting and decorating, and paving and other external work (Smallwood, 2006b).

In the context of South Africa, it is suggested that construction ergonomics can be improved through a range of aspects including design, a degree of mechanisation, and a multi-stakeholder approach (Smallwood, 2006b), and also by focusing on the format of materials, the amount of work required on construction projects, the requirements set out in the details and specifications, the general design, and the procurement system adopted (Smallwood, 2007).

Smallwood (2007) further professes that architectural designers do consider ergonomics during the design process, however this leans more toward the end user than it does toward constructors, and suggests that contributions can be enhanced through the inclusion of construction ergonomics in architectural education and training.

2.4.5 Summary

In terms of the five earlier mentioned accident categories, the main causes of construction accidents were addressed in more detail in separate categories, namely construction health, construction safety, and construction ergonomics.

It is suggested that construction health hazards and risks can be mitigated through improved choice of materials and finishes, based on informed decisions and available information. It proposes that construction safety hazards and risks can be mitigated if designers consider construction safety during the design process. It also implies that construction ergonomics hazards and risks can be mitigated if designers consider construction ergonomics during the design process, and proposes enhanced architectural education and training as a medium for improvement.

If construction H&S hazards and risks can be mitigated through improved design, the question arises as to whether and how designers, more specifically architectural designers, can actually undertake the task of designing for construction H&S?

2.5 DESIGNING FOR CONSTRUCTION H&S

2.5.1 Foreword

This section addresses the question of whether and how architectural designers can undertake the task of designing for construction H&S.

It broadly includes ‘H&S by design’ while pondering whether this is achievable. It considers the need for designers to have a good understanding of construction technologies, processes, and programming, and the need for architectural designers to be able to conduct HIRAs which are considered critical toward designing for construction H&S, and provides a range of design recommendations and touches on the purpose of some.

It anticipates that designers need a sound knowledge of the aforementioned mechanisms if they are going to engage in designing for construction H&S, but is not considered all-encompassing, as further aspects are included in the later review of the literature.

2.5.2 H&S by design

Numerous researchers and authors contend that between one third and half of construction accidents can be mitigated through the design process, which can be enhanced by conducting construction H&S reviews at the various stages of design (Toole *et al*., 2006; Toole and Gambatese, 2006; Behm, 2006; HSE, 2003).

Behm and Culvenor (2011) consider the thought processes of designers as key to the protection of construction workers, and Hinze (2005) suggests that designers are well positioned to combat construction hazards and risks, but what exactly is 'designing for construction H&S'? A range of terminologies, acronyms and definitions have been used to describe designing for construction H&S. Some examples of these include the following.

Toole *et al*. (2006) who define designing for construction safety (DfCS) "... as the deliberate consideration of construction site safety in the design phase of a construction project, with the goal of reducing inherent risk to construction workers."

Behm (2006) who claims that 'Designing for safety' is the "consideration of construction site safety in the preparation of plans and specifications for construction projects."

Hinze (2005) and Toole and Gambatese (2006) recognise the traditional approach and concur that a proactive approach is necessary. Toole and Gambatese (2006) insist that "… design is reviewed to ensure it can be constructed safe(l)y, as well as meet cost, schedule and quality goals", and refer to this process as 'constructability'. Toole *et al*.

(2006) further suggest that construction expertise and related decisions be incorporated into the design process as part of the constructability review. Ultimately, "... designers should make appropriate design decisions which not only consider cost, quality and schedule, but must be all inclusive in terms of mitigating construction health, safety, and ergonomic risks." (Goldswain and Smallwood, 2009)

The question is the extent to which design professionals can be expected to design for construction H&S, and how they can approach the issue at hand? Hetherington (1995) suggests that design professionals "… will only be expected to take into account those risks which can reasonably be foreseen at the time at which the design was prepared" and should aim toward "… avoiding and combating H&S risks inherent in the construction process." (Hetherington, 1995) He further suggests that construction H&S can be addressed through design interventions during the 'concept stage', 'design evolution' and the 'detailed specifications', and that designers should provide information along with their designs to ensure that potential risks and associated issues are identified.

It is suggested that designing for construction H&S can occur through reviewing design at specific intervals. International approaches such as the Gateway model (HSE, 2004a) and the Australian CHAIR model (WorkCover NSW, 2001) provide much insight into reviews and processes. This is addressed later in the review of the literature.

Also included later is the notion that design education inadequately prepares designers to engage the process (Smallwood, 2006; Toole and Gambatese, 2006).

Given the aforementioned statistics and the causes of accidents, as well as the range of construction hazards and risks which give rise to and exacerbate the causes of accidents, it becomes essential for designers to have a good understanding of 'construction technologies, processes, and programming', and be able to undertake HIRAs as part of the design process. These are included in the two sections to follow.

2.5.3 Construction technologies, processes, and programming

The range of technologies, processes, and programming related to construction are ubiquitous, and diverse. It is impossible and not the intention to expose or discuss the seemingly endless range of possibilities here. This section is better focussed on the need for designers, or better still architectural designers, to have a comprehensive understanding of these.

Construction technology is involved in all aspects of construction, whether in the form and assembly of complete structures, or in the production of elements, components or subcomponents. The use and type of technology influences construction performance and the ability to achieve the range of strategic objectives (Chang and Lee, 2004). It becomes essential for all stakeholders, including architectural designers, to recognise the design and construction relationship, what Hendrickson (2008) perceives as an 'integrated system', while Chang and Lee (2004) raise concern that most studies address construction management issues and ignore the construction technology realm. The real issue is "… the implementation of a design envisioned by architects and engineers … performed with a variety of precedence and other relationships among different tasks." (Hendrickson, 2008)

Hendrickson (2008) suggests that the planning and design of any facility should consider the entire project life-cycle, and include:

- Nearly every facility is custom designed and constructed, and often requires a long time to complete;
- Both the design and construction of a facility must satisfy the conditions peculiar to a specific site;
- Because each project is site specific, its execution is influenced by natural, social and other locational conditions such as weather, labo(u)r supply, and local building codes;
- Since the service life of a facility is long, the anticipation of future requirements is inherently difficult, and

- Because of technological complexity and market demands, changes of design plans during construction are not uncommon.

While designers and contractors seem willing to introduce time and cost saving techniques into construction, designs should be reviewed to optimise constructability to minimise negative impact (Toole and Gambatese, 2006; Hendrickson, 2008).

With innovation and technology comes change and depending on the type of facility required, the designers' capabilities relative to computational methods or new materials presented, and newly introduced modernised equipment or construction methods (Hendrickson, 2008). Integrated into design and technology is 'method' which involves both tactic and strategy. Decisions regarding the best or ideal sequence of operations are then made, and should be integrated into the design process rather that leaving all decisions up to the production team or contractor (Hendrickson, 2008). It is also important that all people involved are not only competent, but are sufficiently motivated to ensure project success (Lester, 2007).

As far as the sequence of operations is concerned, up front planning is traditionally undertaken by construction planners or managers. While the fundamental criteria of cost, quality, and schedule, or more broadly 'performance' as Lester (2007) puts it, are seen as motivators, scheduling, often in the form of work breakdown structures (WBS) in order to understand what happens in which project phases, network or precedent diagrams, and bar charts are considered the most fundamental tools to achieve optimum sequencing and timing of construction activities, while considering cost and resources, and serve to demonstrate the interrelationship of activities. Smart scheduling is considered key to successful project management and can negate bottlenecks and hold-ups, and ensure lead times to facilitate timely ordering and delivery of construction materials. More recently, computerised network grids can readily be used without converting them to bar charts (Hendrickson, 2008; Lester, 2007).

Key or critical activities and their lead times, start dates, durations, completion dates, and their interrelationships with other critical activities can be produced manually or more recently using computer software programmes. Node calculations are performed based on dates and durations in order to establish the critical path of construction activities – the

Critical Path Method (CPM). Less critical activities generally have lesser durations or spaced duration giving them flexibility in terms of activity start and completion dates. These are generally referred to as floats or float activities and can be adjusted between earliest start and latest start dates, and subsequently earliest finish and latest finish dates. The physical work performed on site can be measured against the pre-determined programme in order to monitor progress and expenditure. The nature, timing, and interrelationships of construction activities are thus grounded in the work undertaken by construction managers – that of scheduling (Hendrickson, 2008; Lester, 2007).

Ultimately this may assist the traditional measures of project success being cost, quality, and schedule, but more inclusion in terms of designing for construction H&S is necessary (Smallwood, 2006). Cameron *et al*. (2005) maintain that project success should arise without construction site risks presenting negative experiences.

The HSE (2004b) promotes alternative or further planning and assessment of construction activities and projects in order to deal with a range of H&S issues. The HSE (2004b) incorporates networks and refers to them as 'influence networks' and encourage the technique toward understanding of organisational and human factors relative to the H&S of workers. As they incorporate critical factors and paths, they can be effectively used to identify hazards and risks and therefore assist in control planning. They also indicate relationships between activities, drawing attention to changes in operations which exacerbate hazards and risks.

The 'influence network' (HSE, 2004b) includes a hierarchy of influences with causal connotations. It includes the following:

- 'Direct performance influences' which directly influence the likelihood of accidents and applies to site personnel actually carrying out the work;

- 'Organisational influences' influence the direct performance influences and applies to the level of organisation on site and site management, and the designers who directly influence the work to be undertaken;

- ‘Policy level influences’ whereby decision makers expectations affect risk and demonstrate the expectations and arrangements pertaining to the organisation, and applies to clients and contracting companies as well as the supply chain, and

- ‘Environmental level influences’ covering political, regulatory, market and social issues which impact on the aforementioned policies.

The HSE (2004b) considers a process which can be adapted to suit specifically identified hazards and risks. This is outlined here, but more detail can be located in the HSE document. The basic steps are as follows:

- Define the problems and the complete setting in which it resides;

- Collect and analyse all data relevant to the problem and its setting;

- Assemble a group of experts including those involved;

- Use the experts in a structured workshop situation;

- Adequately review and define each influence;

- Apply a scale of best practice (0 to 10) to each influence;

- Seek expert agreement relevant to the issues and record it;

- For influences above the ‘environmental level’ agree to weightings such as high, medium, or low risk and record the basis for the weightings;

- For influences above the ‘policy level’ agree to weightings such as high, medium, or low risk and record the basis for the weightings;

- For influences above the ‘organisational level’ agree to weightings such as high, medium, or low risk and record the basis for the weightings;

- For influences relative to the ‘direct performance influences’ agree to weightings such as high, medium, or low risk and record the basis for the weightings;

- Quantify the influence network to obtain a ‘network index’ to understand current risk level;

- Use the outcomes to identify critical influences throughout the network path and define appropriate risk controls;

- Assess the likely effects of the risk controls for all individual influences, and

- Re-evaluate the potential effect on overall risk level comparing alternative risk control options.

The HSE (2004b) claims that the workshop to achieve this could last a day, with an additional day being required to adequately develop the risk controls.

The report engages a range of identified concern areas relative to construction H&S to test the influence networks. These are not deliberated here. The identified ‘health issues’ where they include ergonomics’ issues includes hand-arm vibration syndrome, cement dermatitis, and musculoskeletal problems, whereas the ‘safety issues’ include falls from height, construction plant, road works, and goods delivery (HSE, 2004b).

This section did not focus on the endless range of construction technologies available, but pondered the impact of architectural designers on the use and application of construction technologies, processes, and programming. If architectural designers had an enhanced understanding of these they would be better equipped toward designing for construction H&S. Surely this would also enhance their ability to undertake HIRAs as discussed in the section to follow.

2.5.4 Hazard identification and risk assessments (HIRAs)

Following on the earlier definitions of hazards and risks, according to WorkSafe Victoria (2005), ‘hazard identification’ encompasses the identification of specific situations whereby people may be exposed to harm, and ‘risk assessment’ involves the likelihood of harm occurring and early assessment thereof, while risk control involves the mechanisms applied to mitigate such hazards and risks. WorkSafe Victoria (2005) also simplify the terminology – ‘find it’, ‘assess it’, and ‘fix it’.

Gangolells *et al*. (2010) promote the need for proactive hazard identification and the need for appropriate elimination thereof and, although considering residential buildings, provide a quantitative method of evaluating construction safety through risk analysis. Toward achieving this, they identified a broad range of main processes such as earthworks, foundations, structures, and more, and reduce these to a total of 219 stages and activities. Their aim was to identify the range of construction risks related to these processes and then undertake an assessment of the risks. This involved the calculation of the significance of risks through considering the probability of risks and the severity of the consequences. Risks are also relevant to exposure, which is the direct relationship of time to the volume of required work (Gangolells *et al*., 2010).

Although discussing pipeline construction, Pipe Line Safety (2000) demonstrate a risk matrix whereby identified hazards can be assessed in terms of ‘probability of occurrence’ and ‘severity of consequence’, and includes a numeric points system within the matrix cells. They suggest that the tool can be used to undertake risk assessments which should be done ‘between project personnel and the contractor …’ They further suggest that issues be incorporated into appropriate training ‘to ensure that all persons are aware of the potential hazards and the mitigation measures to be implemented’, while the basis for hazard identification can stem from experienced staff, historical data pertaining to similar projects, and specialists. Table 3 below is included for demonstration purposes.

Table 3: Assessment matrix for quantifying risk

Potential Severity	**Probability of Occurrence**			
	Frequent	**Occasional**	**Remote**	**Unlikely**
Catastrophic	Extreme Risk (9)	Extreme Risk (8)	High Risk (7)	High Risk (6)
Critical	Extreme Risk (8)	High Risk (7)	Medium Risk (5)	Medium Risk (5)
Moderate	High Risk (7)	Medium Risk (5)	Medium Risk (4)	Low Risk (3)
Minor	Medium Risk (4)	Low Risk (3)	Low Risk (2)	Low Risk (1)

In order to understand the table, the severity and probability parameters are defined by Pipe Line Safety (2000) in the table which follows:

Table 4: Hazard assessment matrix in order to quantify risk

Potential Severity	**Probability of Occurrence**
How severe could an event be if no preventative measures are implemented?	What is the potential reoccurrence if existing hazards and conditions are not corrected?
Catastrophic Fatality or permanent disabling injury Loss of greater than (financial value) Legislative – facility closure	Frequent Occurs repeatedly during the X month(s)/year Project / operational life cycle. More than once per month / year. Example: lifting sling failure
Critical Lost time injury. Threat to public Loss of less than (financial value) Legislative – fines and charges	Occasional Will likely occur, once during duration of project, or once every X years. Example – a moderate size product spill
Moderate Modified work or medical treatment Loss of less than (financial value) Legislative – reporting required	Remote Incident is not expected to occur more than once or twice every XX man hours. Example – an accident involving major debilitating personal injuries
Minor Minor injury. No threat to the public Loss of less than (financial value) Legislative – no reporting required	Unlikely Not likely to occur – possibly once in the operational life cycle of the pipeline Example – a major pipeline rupture

Pipe Line Safety (2000) includes a 'manageability status' to the assessment of each hazard, as depicted in the table to follow:

Table 5: Manageability status of risks

Risk	**Manageability**		
	Probable	**Possible**	**Unlikely**
Extreme / High Risk (7-9)	High Alert	High Alert	Caution
Medium Risk (4-5)	High Alert	Caution	Safe
Low Risk (1-3)	Caution	Safe	Safe

NCI-Fredrich (2010) considers similar risk severity categories and suggest ‘high risk’ to lead to ‘fatality, major injury, or long term illness’, ‘medium risk’ to lead to ‘injury or short term illness’, and ‘low risk to lead to ‘other injury or illness’. They include examples of risk levels arising from hazards as per the table below:

Table 6: Assessment matrix for quantifying risk by example

Hazard		**High**	**Medium**	**Low**
Falls from height	More than 2 meters 2 meters or less	X	 X	
Tripping				X
Collapse		X		
Manual handling	Depending on the object handled		X	X
Moving objects				
Electricity	Greater than or equal to 480V 240V 110V and below	X	 X	 X
Contact with moving machinery		X		
Fire		X		
Harmful substances	Depending on the substance concerned	X	X	X
Noise and vibration	Depending on exposure levels	X	X	X
Steam / pressurised Fluids / powered Mechanical Equipment / electrical Power distribution		X		

While the above serve as mere examples, a greater range of hazards and associated risks will need to be investigated and included if the model as an outcome of this study is to be put into practice.

NCI-Fredrich (2010) states that ‘severity’ x ‘likelihood’ will provide a measure of risk arising from a hazard or a range of hazards and can be seen as an enabler exerting pressure to alter a design, and if not practicable designers should be able to justify choices made, and further suggest that a range of hazards and risks be weighed up as "… it is more important that measures are taken to prevent one fatality, than several minor bruises." (NCI-Fredrich, 2010)

Carter and Smith (2006) consider HIRAs in an overall context and include design in general – not specifically architectural design. They contend that accident causation models focus on how hazards lead to accidents, and that risk assessments is a practical means of risk management. However, they insist that the problem lies in hazards which are not identified as control measures cannot be implemented without awareness.

Method statements are a conventional means of assessing risk, but the level of hazard identification thereof remains questionable. A comprehensive method statement should include a description, a location, a work sequence, necessary resources, and risk assessments. They suggest that despite method statements, hazard identification levels are not what they should be (Carter and Smith, 2006).

As aforesaid, the rationale for performing risk assessments is the consideration of hazards relative to the probability of occurrence and the severity of their consequences. The process involves the estimation of the hazard frequency of occurrence and the corresponding severity, the evaluation of the risk based on frequency and severity, and the response via control measures (Carter and Smith, 2006).

In the event that a hazard or hazards are not identified, the probability of occurrence will be uncontrolled and the subsequent severity will remain uncontrolled, not that it is expected that 100% of hazards will be identified. Carter and Smith (2006) believe that there are two barriers to improving hazard identification. Firstly, there are 'knowledge and information barriers', which constitute a lack of information sharing, a lack of resources, the subjective nature of hazard identification, and reliance on tacit knowledge – that anchored in the head of people and not documented. Secondly, there are 'process and procedure barriers', which constitute a lack of a standard method, and an unclear structure of tasks and related hazards.

They suggest that tacit and other knowledge be adequately documented and captured on data bases for access to all, and that knowledge contained within construction processes and procedures be harnessed, yet should remain adaptable to the requirements of specific construction projects. With adequate knowledge and access to knowledge in place, a comprehensive structure for the building of fully integrated method statements could vastly improve hazard identification. With this as basis a new task based IT tool was developed toward improved building of method statements and subsequent hazard identification and risk assessment and management (Carter and Smith, 2006). They advocate the HSE (1998) who sum things up saying that "A risk assessment is nothing more than a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm."

It becomes questionable as to whether architectural designers are carefully examining their work in terms of the above quotation, and a provisional research study undertaken in South Africa it was found that "… architectural designers do not adequately conduct hazard identification and risk assessments during the design process." (Goldswain and Smallwood, 2009)

Given the importance of HIRAs and the need for architectural designers to undertake them, architectural designers would need a sound appropriate knowledge. Hazards and risks have been interrogated over time, and some researchers and authors have attempted to develop 'design recommendations' toward combatting them. These are catered for in the section to follow.

2.5.5 Design recommendations

This section follows the need for architectural designers to have a sound knowledge of HIRAs and assumes that an enhanced knowledge of existing 'design recommendations' would also assist in designing for construction H&S. The section is included in order to demonstrate the range of, or at least extensive examples of, design recommendations made through the contributions of researchers and authors. By reading or interrogating the included lists, the potential hazards and risks which the design recommendations are meant to mitigate can be envisaged.

Extensive research undertaken by Behm (2006), with the support of Veltri and Gambatese, determined that in 151 of 450 cases studied, approximately one third, that the hazards contributing to accidents could have been mitigated if designing for construction H&S, or what he calls 'design-for-safety', measures had been implemented. The extent of his research is not entertained here, but his extensive design suggestions are.

Extracted from Behm (2006), who advocates the previous design recommendations made by Gambatese and Weinstein, the following 'existing design recommendations' are included. It is suggested that designers should:

- design special attachments or holes at elevated work areas to provide permanent, stable connections for supports, lifelines, guardrails, and scaffolding;
- disconnect, reduce voltage, or re-route power lines around the project before it begins;
- include the name, address, and telephone number of local utility companies on the drawings;
- locate on contract drawing the existence of overhead power lines and their location in relation to the new structure;
- design columns with holes at 21 and 42 inches above the floor level to provide support locations for lifelines and guardrails;
- provide permanent guardrails around floor openings;
- design domed, rather than flat, skylights with shatterproof glass or add strengthening wires. Design guardrail protection around skylights;
- design a parapet to be 42 inches tall. A parapet of this height will provide immediate guardrail protection and eliminate the need to construct a guardrail during construction or future roof maintenance;

- review the condition and integrity of the existing structure and indicate any known hazards or deficiencies on the contract drawings;
- design and schedule permanent stairways to be built as soon as possible in the construction phase and used by the construction workers;
- minimise the amount of night work;
- design perimeter beams and beams above floor openings to support lifelines (minimum dead load of 5400 lbs). Design connection points along the beams for the lifelines. Note on the contract drawings which beams are designed to support lifelines, how many lifelines, and at what locations along the beams;
- design the slope, width, height, turning radius, and surface treatment of traffic surfaces with consideration of the anticipated size, weight, and manoeuvrability of the construction equipment;
- during road work, slow down the ongoing traffic as much as possible by closing down adjacent lanes, posting flag-people to control traffic, or running lead cars to guide the adjacent traffic;
- indicate on the construction drawings the location of existing underground utilities and mark a clear zone around the utilities;
- note on the drawings the source of information and level of certainty on the location of underground utilities;
- orientate the project layout or grade the site accordingly to minimize the amount of work on steep sites;
- design the finished floor around mechanical equipment to be at one level ie. no steps, block-outs, or slab depressions;
- allow for pedestrian traffic to be isolated from construction vehicular traffic;

- design and schedule materials to be painted and / or insulated prior to erection or placement;
- allow adequate clearance between the power lines and the structure;
- employ police officers to patrol around the project site to help with traffic;
- for pre-cast concrete members, provide inserts or other devices to attach fall protection lines;
- re-route power lines around the project site before construction begins;
- avoid road work and maintenance during peak traffic volume periods of the day;
- for access doors through floors, use doors that immediately provide guarded entry around the hole perimeter when the door is opened;
- design members which are of consistent size, light weight, and easy to handle;
- avoid stair landings constructed separate from the stairs;
- consider using prefabricated stairways which can be erected as one assembly;
- design and schedule safe tie-ins to existing utilities;
- ensure that electrical system design meets all National Electric Code requirements and the requirements of National Fire Protection Association;
- consider using pre-fabricated metal timber fasteners for wood connections instead of end nailing or toe nailing;
- design handrails and top rails of a stair-rail system to withstand at least 200 pounds applied within 2 inches of the top edge in any downward or outward direction, at any point along the top edge;
- design and schedule handrails, guardrails, and stair-rails to be erected as part of the structural steel erection;

- provide a guardrail along the perimeter of the tank roof;
- provide connection points for lifelines at the centre of the tank roof;
- consider the erection process when designing and locating member connections;
- consider alternative steel framing systems which reduce the number of elements and where beams are landed on supports rather than suspended between them;
- avoid performing road work on Friday and Saturday nights;
- detour public traffic around the project site;
- to prevent accidents resulting from tired construction workers, do not allow schedules which contain sustained overtime;
- in embankments directly adjacent to the road edge, provide an initial bench at the road grade to provide room for crews to work, and
- provide structural support at the edge of roadways to keep heavy construction equipment from crushing the edge and overturning.

According to Beams' (2006) 'new design recommendations' it is suggested that designers should:

- design appropriate and permanent fall protection systems for residential roofs to be used for construction and maintenance purposes. Consider permanent anchorage points, lifeline attachments, and /or holes in perimeter for guardrail attachment;
- design appropriate and permanent fall protection systems for commercial roofs to be used for construction and maintenance purposes. Consider permanent anchorage points, lifeline attachments, and / or holes in perimeter for guardrail attachment;

- when design features such as ventilation systems, trash chutes, chimneys, and elevators, cause floor openings to occur during construction, provide a warning in the plans and specifications for construction, and design in permanent guardrail systems and sequence them in early in the construction process for use by all contractors;

- before demolishing or renovating any roof structure that is damaged, ensure that an engineering survey is performed by a competent person to determine the condition of the roof, trusses, purlins, and the structure itself to evaluate the possibility of the structure and its components failing during the work, and to evaluate how fall protection devices will be incorporated into a damaged structure;

- for tower type structures, design a cable-type lifeline system into the structure that allows workers to be hooked onto the structure and allows for their movement up and down the structure;

- design scaffolding tie-off points into exterior walls of buildings for construction and renovation purposes;

- design and schedule handrails, guardrails, and stair rails to be built as part of the erection process;

- before demolishing and renovating any structure, ensure that an engineering survey is performed by a competent person to determine the condition of the structure, evaluate the possibility of unplanned collapse, and plan for potential hazards;

- design appropriate tank anchor points on the interior of the tank for construction and maintenance purposes;

- consider the existing site and its potential hazards in relation to the heavy equipment required to perform the scope of work. Provide a warning and information to constructors;

- design appropriate and permanent fall protection systems for inside elevator shafts to be utilized during construction and maintenance. Consider anchorage points and lifeline attachments;

- consider alternative methods for pouring concrete when specifying concrete pours below or next to overhead power lines, such as the use of a pumping truck;

- consider pre-fabricating work stations and fall protection systems into the constructed structure;

- provide warning through the plans and specifications when electrical systems create floor openings;

- specify the need for a permit-required confined space programme when utilising flammable materials inside tanks;

- when specifying roof materials which are not suitable for walking, such as corrugated fibreglass panels, ensure they are distinguishable from safe secure walking surfaces on the roof, or install guardrails around the surfaces not suitable for walking;

- when designing an atrium in a building, design permanent guardrails, anchor points, or other fall protection mechanisms so that they are sequenced early in to the schedule to allow their use by construction workers;

- where job site access is limited, consideration should be given to alternating work schedules or short term interruption of work tasks to allow additional clearance for crane set-up and use;

- do not design elevated exterior structures, and equipment, next to roof edges;

- design periodic turnouts into long straight roadways. This allows trucks to turn around, minimises reverse motion, and allows for passing of other vehicles;

- the flaggers, establish an alternate layout of the work zone, such as closing additional lanes of the highway;

- for projects that occur on or near steep slopes, provide a warning and information with respect to the site conditions in the construction documents;

- in the design of commercial and industrial buildings, consider if sheet metal could be utilised as a walking surface, either intentionally or unintentionally, and specify appropriate sheet metal gauge for walking and the appropriate screws for strengthening;

- during highway construction activities, posted speed limits should be reduced and strictly enforced to increase the safety of highway workers;

- consider that structural members can be utilised as work areas during construction, and design for their stability;

- consider the environmental conditions and the other construction work occurring near trenching and how it will affect the condition of the trench;

- do not specify trenching activities adjacent to existing structures. Review how the specified trenching activities will affect the adjacent structure;

- evaluate soil conditions, provide that information, and specify proper trenching and shoring based on the conditions in relation to the specified work;

- consider electrical conduit / wiring and sequence it in before permanent ceilings or walls are constructed which would limit access during installation, and

- design wood framed walls to be no more than 8 feet high; when higher walls are specified, provide a warning to the constructors to not lift these higher walls manually.

The vast range of design recommendations offered above include, *inter alia*, recommendations relative to aspects of construction sites, inclusion of H&S features incorporated into the permanent design of structures, inclusion of H&S information and warnings in appropriate design and construction documentation, appropriate scheduling of activities, establishing of procedures for specific activities, and includes the need for all persons involved to possess the appropriate competencies.

Mroszczyk (2005) cites examples of design recommendations originating from Weinstein (2005), Gambatese (1997), and Behm (2005), and segregates these into two aspects. Firstly the 'suggestion' is made, and then it is supported by the 'purpose' alongside. Due to the original sources, similarities to the list by Behm (2006) are evident.

Suggestion:	Purpose:
• Design prefab units that can be built on the ground and erected in place.	• Reduce worker exposure to falls and being struck by falling objects.
• Design underground utilities to be placed using trenchless technologies.	• Eliminate safety hazards associated with trenching.
• Allow adequate clearance between structures and power lines.	• Overhead power lines are hazardous when operating cranes.
• Design 42" parapet walls.	• Eliminate need for fall protection.
• Design permanent anchorage points.	• Provide fall protection anchorage during construction and future maintenance.
• Specify primers, sealers, and other coatings that do not emit noxious fumes.	• Reduce noxious fumes.
• Design permanent anchorage points in residential roofs.	• Provide fall protection anchorage for roofing contractors during future maintenance.
• Design cable type lifeline system for tower structures.	• Allows workers to hook onto structure and move up and down during future maintenance.
• Design window cills to be 42 inches above floor level.	• Eliminate need for fall protection during construction and future maintenance.
• Design permanent guardrails around skylights.	• Prevent workers from falling through skylight.

The inclusion of the purpose relative to each suggestion as offered by Mroszczyk (2005) provides for better understanding. As with the earlier topics, an appropriate knowledge of ‘design recommendations’ will assist architectural designers in designing for construction H&S by combatting hazards and risks.

2.5.6 The regulatory design framework in South Africa

As suggested in the introductory part of this thesis, The Constitution of the Republic of South Africa (Republic of South Africa, 1996) and the OHS Act No. 85 (Republic of South Africa, 1993) form the legal basis for protection of workers, while The South African Construction Regulations underpin the OHS Act (Construction Regulations, 2003, Geminiani *et al*., 2005).

This section does not dwell on those, but considers the regulatory ambit in which architectural designers operate – those with which architectural designers interact in their daily work routines. These include the part played by the SACAP (Republic of South Africa, 2010b), and the Application of the NBR also known as the South African National Standards (SANS), part 10400 (Republic of South Africa, 2010a).

The Architectural Professions Act, No. 44 of 2000, provides a code of conduct ensuring that all architectural designers are registered with the SACAP, which expects all registered persons to competently carry out their duties with integrity. It is an offence to conduct any sort of architectural business if not registered, or if registration has lapsed (SACAP, 2008). While the SACAP does not emphasise designing for construction H&S, it expects architectural designers to carry out their duties with integrity.

Architectural designers are graded for registration purposes based on qualifications and experience. There are four main categories of registration as follows: Professional Architect (PrArch); Professional Senior Architectural Technologist (PSAT); Professional Architectural Technologist (PAT), and Professional Architectural Draughtsperson (PAD). Each category is supplemented by candidacy registration categories for those aspiring to register (SACAP, 2008).

The SACAP provides registered members with gazetted guidance (Republic of South Africa, 2010b) on a range of aspects. This includes a 'Framework for the Professional Fees Guideline', which considers, *inter alia,* time based and percentage based fees relative to the provision of 'standard service', 'partial services and additional services', 'guideline fees for professional services', the 'engagement of architectural professionals', 'use of the professional fees guideline', and the professional fees guideline'.

While professional fees are obviously important, they are considered to be the reward for the services undertaken. Relative to the SACAP, the services undertaken by architectural designers are subjected to six 'architectural work stages' (Republic of South Africa, 2010b). These include:

Stage 1 – Inception:

This stage includes the receipt, appraisal, and report back of the clients' requirements with regard to the brief provided by the client, the site and its rights and possible constraints, the need for a range of consultants, the expected project programme, and the likely methods of contracting.

Stage 2 – Concept and viability:

This stage includes the preparation of the initial design and the need to provide advice regarding the space utilisation and relationships, the intended materials and building services, and any functional and technical aspects within the design. It also includes the need to check the design relative to land use rights, anticipated project costs, and the intended programme.

Stage 3 – Design development:

This stage seeks to confirm the complexity and scope of what is envisaged, consult and review the design with the local authorities, develop the design in terms of structure, components, materials and services, and to involve consultants in order to coordinate services, cost, and the programme.

Stage 4 – Documentation and procurement:

This stage comprises a breakdown or split. Firstly, stage 4.1 focuses on the preparation of documentation for local authority submission. This involves technical coordination with consultants, preparing baseline specifications, reviewing cost and programme with consultants, and gaining permission from the client to submit to the local authority.

Secondly, stage 4.2 calls for the completion of documentation and calling for tenders by obtaining client permission, obtaining offers from tenderers, evaluating of offers and recommending tender award, preparing contract documentation, and finalising signing of the contract.

Stage 5 – Construction:

This stage surrounds the administering of the contract. This entails the handover of the site to the contractor, the issue of suitable documentation, appraisal of subcontract information, performance of principal agent duties expected by the agreement, assessing progress and issuing of practical completion certificates, and assisting the client with obtaining the occupation certificate.

Stage 6 – Close out:

This stage involves the close-out of the project and includes documentation, handover to client and operation of the project. This encompasses fulfilment of the contract and issuing of certification, and issuing of all final drawings and technical documentation to the client together with any undertakings from contractors and subcontractors.

The six SACAP architectural stages of work (Republic of South Africa, 2010b) embrace a typical project from start to completion of construction and provide a structure which assists architectural designers in the everyday role relevant to construction projects. It is noted that construction H&S is not entertained by the SACAP within the six stages.

Beyond the SACAP, a further regulatory framework which assists and provides regulatory direction to architectural designers in their everyday work routine is the NBR, also known as SANS 10400 (Republic of South Africa, 2010a).

Further to that, some literature relative to construction H&S entertains building components or the trades associated with them, which are in line with the parts of South Africa's NBR. Safe Work Australia (2010) includes relevant statistics for example the earlier used "… while the majority of serious claims for 'body stressing' in 'concrete services' was double the overall rate with 70%, while 'bricklaying services' and 'tiling and carpeting services' tied at 43% followed by 'glazing services' with 42%." Also included earlier was "… construction activities, which give rise to a range of ergonomic problems are concreting, reinforcing, formwork, structural steelwork, masonry, roofing, building fabric, plumbing and drainage, electrical, floor finishes, suspended ceilings, painting and decorating, and paving and other external work" (Smallwood, 2006b), and Gangolells *et al*. (2010) identified a broad range of main processes such as earthworks, foundations, structures, and more.

It is therefore suggested that the building components relative to the NBR have applicable reference.

The NBR embraces the Bill of Rights incorporated into the Constitution of the Republic of South Africa stating that everyone has the right "... to an environment that is not harmful to their health or well-being … and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures ..." (Republic of South Africa, 2010a)

The NBR further serves to "... ensure that buildings will be designed and built in such a way that persons can live and work in a healthy and safe environment" and claim that the regulations "... should be concerned only with the health and safety of persons in a building." (Republic of South Africa, 2010a) It is noted that this does not suggest the inclusion of the H&S of construction workers, however some parts are inclusive to an extent.

What follows does not attempt to overview the NBR, but serves to list and briefly address the purpose of the 26 parts of the NBR (Republic of South Africa, 2010a). There is a vast amount of interrelationships between the parts, for example many parts are to be read and understood in conjunction with Part T 'Fire Protection', and that of Part X 'Environmental sustainability. The parts include the following presented below.

Part A: Administration – This part denotes the need for application to applicable local authorities to perform construction work or demolition operations and requires quality plans and specific processes to be in place. It provides an administrative overview of building processes and expects specific qualifications, competencies and appointment of all persons involved. It provides building occupancy classifications for cross referencing purposes with the range of regulations.

Part B: Structural design – This part denotes the requirement for all parts of the building and its components to be sound in terms of strength, stability, serviceability and durability inferring the design, the materials, and methods of construction.

Part C: Dimensions – This part regulates dimensions and heights of components, rooms, and buildings.

Part D: Public safety – This part attempts to regulate physical aspects of buildings in order to prevent discomfort and injury to users through control of access, level changes, and ramps, and includes security access to swimming facilities.

Part E: Demolition – This part serves to regulate demolition and promote safety of demolition operations, safe-guard basements, and prohibits dangerous demolition methods.

Part F: Site operations – This part also serves to control building sites and site operations toward protection of the public, services, and adjoining properties including local authority property, and expects geotechnical investigations under specific circumstances.

Part G: Excavations – This part puts stability controls in place and serves to protect the public, services, and adjoining properties.

Part H: Foundations – This part seeks structural integrity and the transmission of building loads safely to the ground through adequate design and construction of foundations.

Part J: Floors – This part aims toward structural stability of floors and ensures that they can support their own loads and the loads imposed on them, and promotes safety through specific floor finishes according to occupancy classification and room type.

Part K: Walls – This part requires structural soundness of walls to give support and to transfer loads to the foundations, to allow suitable fixing of roof structures, to resist water penetration and offer appropriate fire resistance.

Part L: Roofs – This part requires roofs to resist live and dead loads, to be durable and weatherproof, to disperse water and not allow ponding, to offer insulation and appropriate fire resistance, and to allow adequate height within rooms and buildings.

Part M: Stairways – This part includes expects stairways to sustain the live and dead loads to which it may be subjected, permit safe movement of persons between floors or levels, have dimensions appropriate to the use including balustrades. It also regulates elements in the immediate vicinity of stairs.

Part N: Glazing – This part requires glazing to safely sustain loads imposed by wind, and other factors, prevent water penetration, and be apparent and offer safety in impact according to its usage.

Part O: Lighting and ventilation – This part requires minimum standards pertaining to natural and artificial lighting and ventilation, and must be suited to specific room and building usage without compromising H&S.

Part P: Drainage – This part regulates the disposal of water-borne sewage in order to ensure a healthy, safe environment and does so in accordance with the expectancy of occupancy classifications.

Part Q: Non-water-borne means of sanitary disposal – This part regulates sewage disposal in areas without water-borne sewage in order to ensure a healthy, safe environment, and regulates the construction, access, and siting thereof.

Part R: Storm-water disposal – This part regulates the control of storm-water in order to store it or remove it without compromising people or property.

Part S: Facilities for persons with disabilities – This part regulates parking, access and facilities for people with disabilities in accordance with the occupancy classification in order to promote the H&S of disabled users.

Part T: Fire protection – This part regulates building design, construction and equipment in order to control smoke and the spread of fire including the spread to adjacent properties. It also promotes safe access and egress, and aims to ensure structural integrity for specified durations during a fire.

Part U: Refuse disposal – This part regulates refuse disposal through provision of refuse chutes and refuse collection areas, and applicable access.

Part V: Space Heating – This part regulates design, construction and installation of heating services to ensure safe operation. If flues are required, they must safely remove smoke, fumes, or noxious gasses produced by the heating system.

Part W: Fire installation – This part regulates fire extinguishing means through expected installation of fire protection services, and water supply as necessary, suitable to the occupancy classification of buildings.

Part X: Environmental sustainability - This part is currently under development and will eventually constitute a range of sub-parts toward environmental sustainability. In general it aims to minimise the use of a range of resources, and provides guiding regulations pertaining to optimum efficiency and use of resources within the built environment, which impact on the natural environment.

To date, Part XA' Energy efficiency in buildings' has been implemented and serves toward the reduction of energy usage, mainly in the form of electricity, and achieves this through guiding regulations relative to the insulation of building components and the use of 'smart' materials (Republic of South Africa, 2010a).

Part XB 'Water efficiency in buildings' will follow once developed and approved, and Part XC will most likely constitute 'recycling of building materials' (Lemmer, 2011).

Ultimately, the purpose of the NBR (Republic of South Africa, 2010a) is to promote the safety of building occupants, surroundings and the environment. Strength and structural stability, durability, resistance to the elements, lighting and ventilation, services and systems, fire control, and environmental aspects contribute to the well-being of people and the environment.

This section considered the regulatory ambit in which architectural designers interact in their daily work routines. These included the SACAP architectural stages of work (Republic of South Africa, 2010b), and the NBR (Republic of South Africa, 2010a). These later serve toward a key component of the model in question.

2.5.7 Summary

Numerous researchers and authors have advocated the benefits of designing for construction H&S. It is estimated that up to 50% of construction accidents leading to loss of life, injury, and illness can be avoided, or at least mitigated through the process.

In order for architectural designers to engage in designing for construction H&S, a sound knowledge of construction technologies, processes, and programming is essential. Undertaking of HIRAs by architectural designers is a key aspect in order to mitigate hazards and risks through the design mechanism. Simply put 'find it', 'assess it', and 'fix it' through the design process. A range of design recommendations with some added purpose was included as examples of what architectural designers can consider during the undertaking of HIRAs, and throughout the design process. 'The regulatory design framework in South Africa' included the SACAP architectural stages of work and the NBR as guiding regulations which architectural designers consider, or should consider, in their everyday work routine.

It is anticipated that architectural designers would need a sound understanding of these aspects if they are to engage in designing for construction H&S, however from a design aspect, this section cannot be considered all-encompassing. While what follows is relevant to design and the design process, it has been included in an independent section due to broader relevance.

2.6 INTERNATIONAL APPROACHES AND MODELS

2.6.1 Foreword

The previous section included a focus on design and mechanisms toward embracing designing for construction H&S.

This section considers some international approaches and models toward mitigating construction hazards and risks. The approaches and models are much broader than mere 'design', hence the inclusion in a separate, but linked, section.

What follows includes relevant discussion on the UK's Construction Design and Management regulations. These are known by two acronyms and are referred to as the CDM regulations or the CONDAM regulations, dependant on literary authors. The Gateway model stemming from the CDM regulations is then included, and followed by an Australian model, the Construction Hazard Assessment Implication Review (CHAIR).

Although broader mention is included, the discussions included are mostly directed at the design realm.

2.6.2 The CDM regulations

Prior to the 2007 amendments to the CDM regulations, Hetherington (1995) in his paper "Why involve design professionals in construction safety?" considered the UK's CDM regulations, which took effect on 1 January 1994 (Neil, 1994). The regulations, in brief "… place a statutory duty on clients (among others) in respect of health and safety for building and maintenance work." (Neil, 1994)

To elaborate, Hetherington (1995) includes some general principles and design related aspects of the CDM:

- all those who can contribute to the improvement of site H&S do so, thus overcoming the effects of fragmentation of the industry;

- H&S is considered, planned for and managed at every stage of the project, from design, through tendering, to the management of site works and subsequent maintenance and demolition of the structure, and
- all those involved in the project, including designers and contractors, are competent and adequately resourced to deal with the H&S issues associated with the project.

In order to meet these regulatory demands, Hetherington (1995) further suggests that clients should appoint a 'planning supervisor' as well as a principal contractor. He advocates that the role of a planning supervisor is to ensure that design professionals take H&S into account throughout the design process and that relevant H&S information is available at tender stage. Management and co-ordination of H&S during construction is suggested to the form part of the principal contractor's role. Upon project completion, the planning supervisor must then ensure that all relevant H&S information is given to the client to aid future maintenance and construction work to the existing structure.

More specifically, design professionals fit best into the notion of 'prevention is better than cure'. Hetherington (1995) suggests that design professionals are best equipped to eliminate H&S hazards up front through design and specification processes, while Mroszczyk (2005, p1) references Hecker in support of this notion by suggesting that "… a fairly large percentage of construction accidents could have been eliminated, reduced, or avoided by making better choices in the design and planning stages …" of projects.

If such hazards cannot be avoided, then priority must be given to protect the workers and the public from the related hazards. The CDM 'designer responsibilities', according to Hetherington (1995) are therefore to:

- alert clients to the duties placed on clients by the regulations;
- design out foreseeable risks so far as is reasonably practicable in balance with other design considerations;
- reduce risks which cannot be avoided, and

- co-operate with, and pass information to, the planning supervisor to ensure continuity on H&S matters.

If the above are duly considered by design professionals and information passed on as required, then the planning supervisors, according to Hetherington (1995), should:

- advise clients on how they can discharge their obligations under the regulations;
- ensure the HSE is notified of the specified project information;
- ensure that an initial H&S plan is prepared, based on information supplied by the client and the designer, and
- ensure that a H&S file – a record of relevant information, which becomes the H&S manual for the completed structure, is prepared.

The introduction of the 2007 CDM regulations, which took effect on 6 April 2007 (CDM, 2007) offered new insights toward the protection of construction personnel and the public, and place duties on all persons involved in construction projects.

While many of the general principles remain intact, some important changes to parts 2 and 3 are summarised here. It is expected that:

- full cooperation is expected between all persons at work on same or other sites;
- full cooperation to ensure the H&S of all persons affected by construction work;
- full account of the general principles of prevention must be taken relevant to construction work;
- the client must take reasonable steps to ensure the management of construction without risk to all persons;

- the threshold for notification of construction project is at the point upon which any appointments are made by the client;
- the former appointment of 'planning supervisor' is replaced by the appointment of a 'CDM co-ordinator' to assist both client and co-ordinate H&S, and
- the former duty of the 'planning supervisor' to prepare a H&S plan is now a principal contractor responsibility.

Relative to this research, the 'duties of designers' expressed in the CDM (2007) regulations are summarised. Designers:

- shall not commence work without the client being aware of his duties;
- must avoid foreseeable risks in: undertaking construction work; anything likely to be affected by construction work; cleaning windows and other transparent structures; maintaining permanent design features, or using a structure designed as workplace;
- must exercise regulatory safety measures in designing structures used as workplaces, and
- must provide information to stakeholders about design aspects and maintenance aspects.

A summary of the 'additional duties of designers' (CDM, 2007) states that:

- on notifiable projects, designers shall not commence work without the appointment of a CDM co-ordinator, and
- designers will provide CDM co-ordinators with adequate information about design, construction, and maintenance of projects.

The approach provided by the CDM regulations aims to improve construction H&S at all levels, however specific reference to the design aspect has been included here. The approach ultimately gave rise to the UK's Gateway model which follows.

2.6.3 The Gateway model

The CDM regulations of 1994, since superseded by the CDM regulations of 2007, together with the Office of Government Commerce (OGC) framework created avenues for the development of the 'gateway' approach which identified five sequential project phases needing effective planning, namely the concept, feasibility, design, construction and maintenance phases (HSE, 2004a; Cameron *et al*., 2005).

This approach ultimately gave rise to the gateway model, which relies on good people management as opposed to paperwork management and moves ownership of H&S hazards and risks upstream in a "... structured, systematic, logical, rigorous and transparent ..." (HSE, 2004a, x) manner and offers a means of assessing designers' and contractors' work, which includes performance assessments at given intervals throughout the mentioned phases.

The gateway model realises the need for continuous model improvement and supports, but is not limited to large construction projects. In collapsed form, the model saves time on smaller projects by combining a number of critical factors within the given gateways, also known as 'Consolidated Gateway Reviews'. Support tools are also included in the form of a 'tool box' which aims at improving general project planning and integrating health and safety planning (HSE, 2004a).

The HSE (2004a) cautions that the gateway system could become too bureaucratic if not well managed, while simultaneously highlighting the benefit of the system in that rather than merely providing a range of check-lists, the project team is required to sign-off all items prior to confidently progressing.

In more detail, the phases offered by Cameron *et al*. (2005) and the HSE (2004a) are critical to the success of the gateway model. The 'Gateway Model for Management of Construction Health and Safety' (HSE, 2004a, 11) for large construction projects represents the inclusion of all five phases with sub-requirements and gateway check-points, as well as expecting suitable documentation to be continually developed and records kept for inclusion in a project H&S file. These are considered in outline as follows:

The concept phase:

This phase examines the 'possible need for a project' with the necessary appointments by the client and the role of the client coming to the fore, as well as trying to 'define user needs', which includes related policies and procedures, end user and maintenance needs, and creates an opportunity to register any H&S risks.

Gateway 1, a 'strategic review' then follows to articulate identified risks and ensure support for the project and provisional financial inclusion for H&S risks. At this point, a description of the project must be kept in the project H&S file (HSE, 2004a).

The feasibility phase:

This phase considers various 'options to meet user needs' such as performance related issues throughout the life of the building and its uses and the preparation of initial concept designs, including related H&S considerations. To 'prepare a business case' follows through setting of objectives, critical milestones, budgeting, procurement and control measures relative to H&S control.

Gateway 2, an 'assessment of options' then takes place where key decisions are made with regard to a H&S strategy prior to further design taking place and the business case is confirmed complete with realistic timescales. The clients' consideration and management input must be recorded in the project H&S file.

The feasibility phase continues with a ‘project brief’ in order to define project objectives, measure success and communicate risks, all relative to H&S. Some ‘feasibility study options’ follow with the opportunity to consider specific sites and the H&S risks they could present. A ‘procurement strategy’ must then be confirmed in line with suitable H&S objectives, which must consider criteria for, and involvement of the supply chain.

Gateway 3, the ‘procurement strategy’ then follows and is an opportunity to ensure that the project and related plans are fully defined and that the necessary controls and funding, as well as the supply chain, are in place. Possible environmental hazards and site risks must be recorded and placed in the project H&S file (HSE, 2004a).

The design and planning phase:

This phase focuses mainly on preparation. It commences with ‘contract preparation’ programmes and specific requirements need to be developed and reviewed in terms of H&S. It then seeks ‘expressions of interest / vetting’ based on agreed criteria such as past performance, competence, and resources. ‘Partner / contractor selection’ through tendering or negotiation, based on project information, takes place and the decisions made must include H&S consideration.

Gateway 4, based on ‘team selection’ seeks to confirm that the business plan is being followed and that the envisaged controls are being used. It also ensures that risk management and change management plans are in place and that all technical issues have been addressed. Records of policies, systems for identification of design hazards and risk management, risk registers, and proof of competence and resources must be placed in the project H&S file.

The design and planning phase then continues with an expectancy to ‘award contract’ and establish the team with H&S duties and ensure a responsibility matrix is in place. The ‘outline design’ emanating from a functional brief including red, amber, green (RAG) lists, indicating the H&S status of design aspects, and design risk management should follow, and co-ordinated drawings with build-ability and maintainability in mind should be prepared.

Gateway 5, namely ‘outline design’ takes place here, with the purpose of ensuring that design has sufficiently progressed to ensure statutory submissions and permission to commence construction, as well as ensuring that no more major changes will occur, being an attempt to ‘freeze’ the client. Possible instructions can be given and construction may commence at this point providing an adequate H&S plan is in place. Information pertaining to significant design and construction hazards must be recorded and placed in the project H&S file, together with a record of the prepared construction H&S plan.

‘Detailed design’ and co-ordinated drawings now follow with the process including design risk management for build-ability and maintainability in place, as well as H&S plans. Various repeats of processes could be involved in this phase dependant on sequence and progress of the interrelated issues.

Gateway 6 for ‘detailed design’ is partly as per gateway 4 in that it seeks to confirm that the business plan is being followed and that the envisaged controls are being used. It also ensures that risk management and change management plans are in place and that all technical issues have been addressed. However, it adds that if construction has actually commenced, then the design process must provide timely, quality information for construction purposes, as well as review the performance of the contractor, inclusive of H&S performance. Further / updated information pertaining to significant design and construction hazards and risks must be recorded and placed in the project H&S file, together with further / updated records of the prepared construction H&S plan (HSE, 2004a).

The construction phase:

This involves having the ‘works contract’ in place, which includes H&S issues and documentation pertaining to site establishment, contractor design changes, works packages related to inspections, audits and reporting, and commissioning and testing related to risks during use. ‘Handover’ then follows subject to final checks, commissioning and testing, including safety equipment and rescue procedures, and the inclusion of user management documents.

Gateway 7 for ‘project handover’ now follows, which confirms proper completion of the project and that the necessary testing has taken place. It also serves to confirm that management documentation for usage have been received to ensure ongoing risks, including maintenance risks, have been managed, as well as confirming lessons learnt for use on future projects. The completed H&S plan must be included in the project H&S file (HSE, 2004a).

The maintenance phase:

This final phase relies on ‘feedback’ pertaining to lessons learnt with respect to incidents and accidents during operation, as well as user feedback toward continuous improvement.

The final gateway, Gateway 8 seeks to ‘monitor and review’ the project in totality in respect of H&S. It strives to assess the original business plan in terms of what actually transpired and to ensure that any deviations do not compromise the original project objectives. It further considers lessons learnt in terms of value for money toward improving future projects, as well as confirming successful conclusion of the project, including all H&S parameters. A contract review, including H&S feedback, as well as ongoing maintenance reports must be included in the project H&S file (HSE, 2004a).

As suggested earlier, the phases offered by Cameron *et al*. (2005) and the HSE (2004a) are critical to the success of the gateway model. The HSE (2004a) presents the ‘Gateway Model Collapsed for Smaller Projects’ representing the inclusion of only four phases with sub-requirements and gateway check-points, and expecting suitable documentation to be continually developed and records kept for inclusion in a project H&S file. These are considered in outline as follows, and are suggested to be more time saving for smaller projects.

The concept and feasibility phase:

This collapsed phase combines the first two phases of the main model and commences with a 'strategic assessment' of appointments to be made by the client and the role of the client coming to the fore, and considers H&S policy, user's maintenance needs and a risk register for H&S hazards. It then moves on to 'options & business plan', which considers H&S performance specifications and maintenance over the whole life of the project, as well as budgeting, and control measures and documentation relative to H&S control. Finally 'procurement strategy' is taken into consideration in line with suitable H&S objectives, site considerations and site risks, and considers criteria for, and involvement of the supply chain.

The previously discussed Gateway 1, Gateway 2, and Gateway 3 are now combined and termed G1 'Invest', which, *inter alia*, suggests the need for financial project support and financial inclusion for H&S risk, the making of key decisions in terms of H&S strategy, confirming the business case with realistic timescales, ensuring that project related plans are properly defined, and that the supply chain meets expected criteria. Once again, it is expected that all issues be recorded and placed in the project H&S file (HSE, 2004a).

The design and planning phase:

This phase focuses mainly on preparation. It begins with 'team selection', which includes the need for programmes and specific requirement development in terms of H&S milestones. It then seeks selection criteria based on past performance, competence and resources, and uses project information for tendering or negotiation purposes and all decisions made must include H&S consideration. This phase continues with an expectancy to 'award contract' and establish the team with H&S duties and a responsibility matrix in place. The 'outline design' emanating from a functional brief as before and includes red, amber, green (RAG) lists as a level of risk indication and design risk management, coupled with co-ordinated drawings undertaken with build-ability and maintainability in mind. Construction may now commence providing an adequate H&S plan is in place.

The original Gateway 4 and Gateway 5 are now combined and entitled G2 ‘Outline Design’ which, *inter alia*, seek to confirm that the business plan and envisaged controls are being used, and ensuring that risk management and change management plans are in place together with ensuring that all technical issues have been addressed. It further ensures that design for submission and commencement of construction is adequate and that no more major changes are expected. Yet again, all issues must be recorded and placed in the project H&S file.

‘Detailed design’ and co-ordinated drawings once again follow with the process including design risk management for build-ability and maintainability in place, as well as H&S plans. Again, various repeats of processes could be involved in this phase dependant on sequence and progress of the interrelated issues.

Gateway 6 becomes G3 ‘Construct’ and continues to confirm that the business plan is being followed and that the envisaged controls are being used. It also ensures that risk management and change management plans are in place and that all technical issues have been addressed. It further confirms that construction has actually commenced, and that the design process is providing timely, quality information for construction purposes, as well as reviewing the performance of the contractor, inclusive of H&S performance. All issues must still be recorded and placed in the project H&S file (HSE, 2004a).

The construction phase:

Similar to before, this involves having the ‘works contract’ in place, which includes H&S issues and documentation pertaining to site establishment, contractor requirements, works packages related to inspections, audits and reporting, and commissioning and testing related to risks during use. ‘Handover’ then follows subject to final checks, commissioning and testing, including safety equipment and rescue procedures, and the inclusion of user management documents.

Gateway 7 now becomes G4 ‘Handover’, which as before confirms proper completion of the project and that the necessary testing has taken place. It also serves to confirm that management documentation for usage have been received to ensure ongoing risks, including maintenance risks, have been managed, as well as confirming lessons learnt for use on future projects. The completed H&S plan must be included in the project H&S file (HSE, 2004a).

The maintenance phase:

This phase relies on 'feedback' pertaining to lessons learnt with respect to incidents and accidents during operation, as well as user feedback toward continuous improvement.
Gateway 8 now becomes G5 'Feedback', which considers the project in totality in respect of H&S. It strives to assess the original business plan in terms of what actually transpired and to ensure that any deviations do not compromise the original project objectives. It further considers lessons learnt in terms of value for money toward improving future projects, as well as confirming successful conclusion of the project, including all H&S parameters. A contract review, including H&S feedback, as well as ongoing maintenance reports must be included in the project H&S file.

As earlier mentioned, support tools are also included in the form of a 'tool box'. It is not necessarily expected that each and every tool be utilised for every project, but that the users of the model and the tools can decide, firstly, whether the specific tool will facilitate general project planning, and secondly, whether it facilitates integration of construction H&S (HSE, 2004a).

The eight tools included in the tool box are briefly reviewed below.

The 'responsibility chart' (HSE, 2004a) is a matrix used as a management planning tool to capture designated tasks, the role players responsible for the tasks and the dates of expected task action, inclusive of H&S integration. Keeping the chart at a basic level can assist in promoting a buy-in situation as opposed to provoking resistance, and can be used throughout projects, or for specific project stages, such as the gateways. The matrix can be used to ‘load’ the chart, with the acronym used directly from HSE (2004a) as follows, and the letters applied to the matrix:

- L: Lead & co-ordinate. This person is in charge and makes the final decision;
- O: Output information received. This person is informed of decisions made;
- A: Advise. This person is consulted and gives advice to be considered, and
- D: This person has to do the task.

The chart should be drawn up by a leading, competent, authority responsible for the project. The chart may take time to draw up, but this input information is fundamental to project planning and should align with regulations such as the CDM regulations. Once developed, the chart is easily maintained and updated and can become almost generic in use for other projects.

The ‘option evaluation chart’ (HSE, 2004a) is useful in summarising various options linked to expected factors. It requires input in the form of brief qualitative statements, deemed best for subjective H&S issues, or significant quantitative values related to each factor. Input to the chart may originate from numerous sources such as clients / project team in the form of strategic decisions, designers in the form of development decisions, or contractors in the form of assessment of construction methods, and some factors could include aesthetics, function, time, initial cost, life-cycle cost, environment and the relationship between build-ability, maintainability, and H&S. The chart to a large extent does not change the way of thinking, meaning that the decisions reached are normally on a more informal basis, which are now captured on a chart as a working document and as a record. However, what the chart does is to encourage H&S input and exercise applicable options, providing there is a champion driving project H&S with client support to derive best risk mitigation.

‘H&S hazard workshops’ (HSE, 2004a) are essentially group participatory meetings, which draw on each member’s knowledge and experience in order to identify H&S risks. These meetings could be formal, informal, integrated as part of a broader meeting or workshop, or stand alone and more specific to H&S. The meetings can be held at any stage of a project. Strategic issues can be discussed during the concept and feasibility stages, while meetings involving contractors can be useful to feed issues concerning build-ability into the design phase. Planning and short term planning involving contractors and subcontractors can be enhanced through regular meetings during the construction phase, which can contribute toward H&S and productivity. All meetings should serve mainly to manage risk through identification of risk sources, quantification of their effects, developing management responses to the risks and making provision for residual risks in project estimates. Historic data from comparable projects, brainstorming and checklists can be used to assist in the identification of risks, and all identified risks should be categorised and captured in a suitable document or table. Some identified general construction risks which impact on H&S, as compiled from HSE (2004a, 43), are noted as follows:

Project Team / Organisation:	Resources and competence to manage H&S
Communication Risks:	H&S information
Environmental Risks:	Contamination of workers or others
Design Risks:	H&S due to build-ability and maintainability
Construction Risks:	Contractor's competence, technology used

A multi-stakeholder approach, including commitment of the client, is essential from the outset of a project. Early risk identification draws attention to policies and identification of mechanisms toward risk management. The HSE (2004a) does caution that advance planning and costing of such workshops is required to eliminate them being seen as an unexpected, add-on cost.

'Safety, health, and environment (SHE) information on drawings' (HSE, 2004a) offers huge potential for designers to communicate project hazards or offer H&S advice, and can be used over the full life-cycle of a project. Hazard Identification Drawings can be used to identify type and location of risks, while a SHE Box used on the drawings can be used to draw attention to residual risks. The information contained in a SHE Box can be cross referenced to other documents such as drawings, method statements and the H&S

plan. The HSE (2004a) cautions that separate, dedicated drawings allow easier communication of H&S issues and that overloading and duplication on other busy drawings may prove counter-productive, while ‘layers’ within Computer Aided Design (CAD) packages can prove useful to facilitate the process. Further caution is given in that “SHE information is merely an input to the contractor’s risk assessment process and the designer is not expected to do the contractor’s job.” (HSE, 2004a)

The ‘red, amber, green lists’ (RAG lists) tool uses the notion of traffic lights on construction documentation, where red indicates a stern warning, amber suggests proceeding with care, and green suggests safe to proceed. It is suggested that the lists be kept short and focus on issues yielding maximum risk mitigation. These are suggested to work well, and H&S meetings should examine lists to ensure suitability and negate designer ‘error’ (HSE, 2004a).

The ‘risk register’ as a tool should be continuously updated throughout the duration of a project and each risk identified should be recorded in a structured manner and applicable action taken. The risk register should not be cluttered with common everyday issues, but should focus on those where the greatest positive H&S impact can be made (HSE, 2004a).

The ‘H&S milestones on projects’ tool is used in tandem with bar charts or networks, which focus on the durations of activities or projects. Activities used to manage construction H&S can be included, and the milestones aimed at showing key events and the relationship between events. Inclusion would suggest activities to be critical as project and H&S tasks (HSE, 2004a).

Finally, the ‘design change control’ tool is ultimately a tool for effective planning, and is used to implement H&S consideration into any design changes which may occur, usually under pressure, on a construction project. Change management reviews should, *inter alia*, check the overall status of change on the construction and H&S fronts. It is suggested that more specific risk reviews should take place when design changes occur (HSE, 2004a).

In summary, the gateway model, whether in full or collapsed form, *inter alia*, ensures interim assessments that consider H&S risks at various project phases, prior to continuing with the subsequent phases (HSE, 2004a; Cameron *et al*., 2005). Such risk management through effective planning at the early stages and throughout construction projects facilitates management of the traditional economic forces within construction projects, as well as the SHE risks, while still promoting quality in construction (Cameron *et al*., 2005). The range of tools incorporated into the toolbox is considered useful in terms of planning and design, management and construction, and ultimately maintenance and demolition. They may constitute additional up front work and documentation, but are useful in execution of tasks, including the construction H&S aspects. The fact that record keeping such as in the case of H&S files is paramount, designers and others may well find themselves defendable in legal situations (HSE, 2004a).

2.6.4 The CHAIR model

The CHAIR, which is an Australian 'tool' aimed at promoting a multi-stakeholder approach toward a reduction of construction H&S hazards and risks linked to design. The focus thereof, and the choice of the name 'CHAIR', is to give designers the "... opportunity to sit down, pause and reflect on possible problems" – a time for 'brainstorming' (WorkCover NSW, 2001, 4).

CHAIR was developed in consultation with designers and constructors, and recognises that design involves the need to combine construction H&S with, for example, "... operability, aesthetics and economics ..." (WorkCover NSW, 2001, 4), congruent with the influence the multi-stakeholder approach, which includes, *inter alia*, clients, designers and constructors.

Three specific phases exist in the CHAIR process. CHAIR ONE seeks the opportunity to make fundamental changes during the conceptual design stage. CHAIR TWO occurs once the detailed design becomes available, prior to construction, and focuses on construction as well as demolition concerns. CHAIR THREE takes place alongside this, with the focus on repairs and maintenance issues. These are elaborated upon later.

The thinking of CHAIR is included in the ‘principles of safe design’ (Australian Safety and Compensation Council, 2006), being ‘persons in control, ‘product lifecycle’, ‘systematic risk management’, ‘safe design knowledge and capability’, and ‘information transfer’, as well as the ‘hierarchy of control’ (Australian Safety and Compensation Council, 2006) model inclusive of ‘elimination’, ‘substitution’, ‘isolation’, ‘administration’, and as a last resort, ‘personal protective equipment’. CHAIR outlines ‘safe design’, as listed by Alwani-Starr in 1996, as follows (WorkCover NSW, 2001, 6):

- ‘Identify’ the hazards presented by potential design solutions and consider the risks these hazards will generate for construction workers and others who may be affected by the construction work such as members of the public;
- ‘Include’ H&S considerations among the design options so that they can avoid the hazards, reduce their impact or introduce control measures to protect those at risk where it is reasonably practicable, and
- ‘Forewarn’ the contractor of the residual hazards that have been identified within the design and will need to be managed during the construction work.

If the hazard(s) cannot be eliminated, consider (WorkCover NSW, 2001, 6-7):

- ‘Substituting’ the system of work or plant with something safer such as pre-assembled equipment at ground level rather than at height;
- ‘Modifying’ the system of work or plant to make it safer (e.g. ensure attachment points for lifting, window cleaning, and safety lines;
- ‘Isolating’ the hazard such as the introduction of restricted areas, and
- ‘Introducing’ engineering controls (e.g. prevent falls from buildings during construction / maintenance by increasing wall / edge height.

Three specific phases exist in the CHAIR process, where ‘brainstorming’ through the multi-stakeholder approach can occur (WorkCover NSW, 2001):

- CHAIR ONE seeks the opportunity to make fundamental changes during the conceptual design stage relative to construction, repair, maintenance and demolition hazards and risks. It makes use of 'guidewords', generic and overview, and divides the concept design into 'logic blocks', in order to promote discussion toward identification of hazards and risks among the stake-holders. It is important that the meeting takes place in a controlled and productive manner, and that all aspects of the meeting are well documented for further use and as a record of proceedings;

- CHAIR TWO occurs once the detailed design becomes available, prior to construction, and could involve the identified contractor for the project. It focuses on ways the design can be modified, as far as practicable, to reduce or eliminate construction and demolition risks only. 'Guidewords' are incorporated, but this time these are used together with a logical sequence of construction and demolition activities. The meeting must be well controlled with a full record of proceedings as before, and

- CHAIR THREE is more flexible in nature and takes place alongside / soon after the afore-mentioned, with the focus on repairs and maintenance issues, sometimes with the owner's repair and maintenance personnel available. It is aimed at identifying risks and reducing such risks through demonstration of appropriate repair and maintenance sequences and methods. Once again, a controlled meeting with a full record of proceedings is essential.

The CHAIR model makes use of generic 'guidewords' relating to each element of the design which serve to prompt discussion. Sub-prompts to the guidewords are also included for further stimulus. To each guideword a few simple questions are asked to further the discussion. Simple questions such as 'Can it happen?', 'If so, how?', 'So what?', and 'What do we need to do?' (WorkCover NSW, 2001). The specific focus is to use the 'guidewords' as prompts and the sub-prompts during the CHAIR sittings from a point of view of how they apply to the construction elements under consideration during the construction process.

Some examples of ‘guidewords’ together with sub-prompts are included here:

SIZE – too large, too small, too long, too short, too wide, too narrow;

HEIGHTS / DEPTH – working at heights, falls / struck by falling objects, scaffolding such as shape and space to fit, confined space, access / egress;

POOR ERGONOMICS – posture / manual handling, discomfort / fatigue / stress, effect on PPE, visibility issues such as lighting and sightlines, and slips, trips, falls;

TOXICITY – lead / asbestos, handling, precautions, ventilation, and

COMMISSION / STARTUP / SHUTDOWN – requirements, sequence.

It is possible to develop additional guidewords beyond the scope of those provided by CHAIR in order to emphasise other issues that may exist, however WorkCover NSW (2001) cautions that too many guidewords may turn the sitting into an arduous checklist and negate the ‘brainstorming’ efforts.

It is important to note that the Royal Australian Institute of Architects (RAIA) and The Australian Council of Building Design Professions are in support of CHAIR, with the latter believing “... that along with the quality and amenity of the built environment, its safety is also determined at the design stage.” (WorkCover NSW, 2001, 1)

2.6.5 Summary

This section considered some international approaches and models toward mitigating construction hazards and risks, and although kept separate from the earlier ‘design’ section served to enhance it.

An overview of predominantly the design aspects of the UK’s CDM regulations was included. These ultimately gave rise to the included UK Gateway model which entertained a range of phases in expanded and collapsed mode for large and smaller projects respectively. The phases included a number of gateways, which are really opportunities to review project status and the work undertaken, inclusive of H&S design and other H&S parameters. A range of tools were incorporated to assist the process, and recordkeeping was considered a priority.

The Australian CHAIR model was also included and predominantly gave designers the opportunity to sit down, pause and reflect on H&S and other issues arising within designs at different stages toward improving the H&S status of projects. CHAIR makes use of a range of ‘guidewords’ and sub-prompts to stimulate discussion during the sittings. Recordkeeping once again demonstrated its importance.

It is important to note that the UK’s gateway model stemmed from legal expectations of the CDM regulations, and that the Royal Australian Institute of Architects (RAIA) and The Australian Council of Building Design Professions are in support of CHAIR – and repeated here – with the latter believing “... that along with the quality and amenity of the built environment, its safety is also determined at the design stage.” (WorkCover NSW, 2001, 1)

2.7 CONCLUSION TO THE REVIEW OF THE LITERATURE

The range of local and international sources provided pertinent literature relative to construction H&S, and the need, opportunities and possibilities relating to designing for construction H&S. Unfortunately not all literature can be documented here, yet the review set the scene for the research process in the context of South Africa.

The wide range of construction hazards and risks to which construction workers are exposed ultimately leads to construction accidents which give rise to a high incidence of illness, injury, and death. This is not acceptable, and apart from the devastating effects of families, communities, and society at large, the more traditional measures of project success being cost, quality, and schedule suffer. Devastating statistics and a range of similarities across the globe prevail, while the poorest of countries and those with developing economies are worst off. South Africa fits the latter and its construction industry is the third most dangerous of 24 listed industries in the country.

While numerous avenues toward mitigation of construction hazards and risks have been explored, designing for construction H&S is probably least explored, especially in the context of poor countries, including South Africa. The literature recognised the importance of knowledge relating to, *inter alia*, construction technologies, processes and programming, HIRAs, existing design recommendations, and the regulatory design framework in South Africa if designing for construction H&S is to be taken seriously. Some international approaches and models were explored as potential contributors to developing knowledge relative to the cause. These included the CDM regulations, the UKs Gateway model and the Australian CHAIR model which provided much insight.

Ultimately, the review of related literature provided sufficient insight for this research to continue toward development of an architectural design model aimed at mitigating construction hazards and risks in the construction industry of South Africa.

It is anticipated that such a model can be fused into tertiary architectural education design programmes and CPD courses. Reduction of H&S hazards and risks through appropriate architectural design will save lives, reduce illness and injury, save on direct and indirect costs, improve quality, reduce legal encounters, improve labour relations, improve public relations and improve the image of the construction industry at large.

As Masterton (2011) insists, "... it would be a huge folly for us to reduce our focus on designing and constructing more safely. It must be our most important legacy."

3. THE RESEARCH PARADIGM AND METHODOLOGY

3.1 FOREWORD

In this chapter the methodological approach and general procedures used in this study are explained. These are presented in an integrated format to create a logical discussion closely aligned with the research process followed. The discussion includes research methods and data collection procedures comprising primary and secondary data, and integrates the target population, sample selection, interview design, and questionnaire design. It makes use of provisional studies to ensure the success of the main study which was undertaken by using research FGs within the AR paradigm. It also entertains the development of a provisional model and the need for validation thereof. Thereafter, it includes the ethical considerations used in the study and a brief summary.

3.2 RESEARCH METHODS AND DATA COLLECTION PROCEDURES

Research is a process whereby a practical problem is observed, which motivates a research question, which defines a research problem, which finds a research answer, which helps to solve the initial practical problem (Booth *et al.*, 1995). A range of research methods were employed during this research and relied on the bottom up approach of inductive reasoning, leading from an observation toward detection of patterns, developing tentative hypotheses for purposes of exploration, and ultimately generating conclusions (Trochim, 2006), and in this case a proposed model. As Cohen *et al* (2007) suggest: "… the logical development of these hypotheses … into a conceptual framework."

In order to shed a diversity of light upon the topic, an integration of intensive 'qualitative insights' and interpreting of 'quantitative survey data' (Olsen, 2004) were used at different stages of the research, ultimately what Leedy and Ormrod (2010) refer to as 'mixed method design' with the blending of the 'two traditions' generating a richer variety of methodological viewpoints (Trochim, 2006).

Secondary data was derived from a review of related literature integrated with an element of Document Analysis (DA). The review comprises two elements. Firstly, the search for relevant literature within a collection of published material relevant to a research question, and secondly the actual process of writing up the review. Johnson *et al.* (2011) suggested using an element of DA to "... extract excerpts, quotations or examples from the written record to support an observation ...", and further suggest that this "... allows access to subjects that may be difficult or impossible to research through direct, personal contact." Duignan (2008) suggests that such analysis can range from being general, to being more specific, and to a detailed analysis. Trochim (2006) refers to 'thematic analysis of text' where "… the identification of themes or major ideas in a document …" support research studies.

The secondary data comprised a range of local and international sources including books, journal articles, theses, conference papers, reports and online sources. The information gathered through the integrated approach as described provided the scope for a range of provisional studies aimed at progressive building of primary data.

Cumulatively, the secondary data and the data derived from the provisional studies served as basis for an AR methodology involving FGs in order to provide the primary data toward development of the proposed model. An elaboration of the provisional studies and the primary data gathering using AR FGs follows.

3.2.1 Provisional studies

van Teijlingen and Hundly (2001) propose provisional studies to be crucial elements of 'good study design', which increases the likelihood of main study success by providing 'valuable insights'. They refer to De Vaus' 1993 work and suggest provisional studies in order to mitigate risk, and promote the use of qualitative and quantitative methodologies for provisional studies. They argue that researchers should report on all phases of their studies, including provisional studies, which can inform research processes and likely consequences (van Teijlingen & Hundly, 2001). They further this notion claiming that "…qualitative data collection and analysis is progressive …" (van Teijlingen & Hundly, 2001, 3) and that subsequent studies will be improved due to valuable insights gained along the way.

Drawing on literature, four provisional studies were undertaken in order to progressively build information toward development of structured questions for use in the AR FGs. These were all presented as international conference papers and are included in the appendices (1 – 4).

A quantitative provisional study was undertaken in order to establish the perceptions of architectural designers in South Africa relative to mitigating construction H&S risks. A questionnaire comprising 15 appropriate statements and an open ended question was designed and distributed among 102 SACAP registered architectural designers in the Eastern Cape region of South Africa. A total of 18 responses equating to 17.5% were received (Appendix 1).

The findings of the first provisional study incited a qualitative provisional study in order to determine what would encourage architectural designers to proactively mitigate construction hazards and risks through design. A total of 13 semi-structured interview questions were developed, which included an open-ended final question. Approximately 60 telephone calls were made to set up interviews with architectural designers registered with the SACAP. A total of 12 interviews were secured, however only 10 took place due to two cancellations, thus equating to an overall response rate of 16.7% (Appendix 2).

The findings of the second provisional study provoked a third provisional study which was quantitative in nature, and sought to establish an architectural design model framework toward improved construction H&S in South Africa. A range of questionnaire types were included. Firstly, a questionnaire comprising 11 appropriate statements was designed. Secondly, two cross reference tables each comprising 30 response opportunities, inclusive of open-ended options, were designed. Thirdly, a third cross reference table was designed with 20 response opportunities, including an open-ended option. Finally, a separate open-ended question was included. The survey was conducted among 76 SACAP registered architectural designers. 12 responses equating to 15.8% were received (Appendix 3).

This prompted a fourth provisional study, which also used a quantitative methodology and sought to identify key inputs which could be integrated into the architectural design model framework identified by the third provisional study. A questionnaire comprising 20 appropriate statements, three semi-structured questions, and an open ended question was designed and distributed among 73 SACAP registered architectural designers. A total of 15 responses equating to 20.5% were received (Appendix 4).

The four provisional studies proved to be instrumental to the greater study, with progress being made from one study to the next. Their significant contribution forged the way forward and ultimately produced the line of structured questioning for the AR FGs. Chapter 4 'Establishing questions through exploration' discusses the provisional studies and gives rise to the said structured questions.

3.2.2 Action Research (AR) using focus groups

The AR paradigm using FGs (Dick, 2002; Cohen *et al.,* 2007; Azhar, 2007; O'Brien, 1998) was introduced in order to undertake further qualitative research to provide the primary data required to evolve the provisional model. "It can be used in almost any setting where a problem involving people, tasks and procedures cries out for solution …" (Cohen *et al.,* 2007) The AR approach or problem solving approach is well suited to this research in that it "... aims at building and testing theory within the context of solving an immediate practical problem in a real setting ..., which combines theory and practice, researchers and practitioners, and intervention and reflection." (Azhar, 2007) O'Brien (1998) proposes that AR "… aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously."

Thus, there is a dual commitment in AR to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process.” To this end, the client can be considered to be architectural designers registered with the SACAP.

The AR process involved the setting up of FGs sessions (Dick, 2002; Trochim; 2006, Leedy & Ormrod, 2010) comprising SACAP registered architectural designers. The multi-faceted set-up process is demonstrated here however the order does not necessarily represent a specific sequence of events:

- The number of focus groups needed to be established. Nielsen (1997) proposes more than one FG in order to improve representation, while Eliot and Associates (2005) propose three to four FGs, while Gatech (2004) proposes a minimum of three FGs. Due to time and dire financial constraints this research made use of two separate focus groups as described later, and returned to the FGs in order to validate the model (Chapter 7). The two FGs followed the same structure and approach in order to contribute toward development of a proposed model. Prompted by Dick (2002), the later validation sought “… to challenge the data and interpretations emerging from the earlier groups.”
- The potential members, or population, of the focus groups had to be established. Bryman and Bell (2007) suggest members to be those who can represent specific occupation groups, and advocate Kiely’s 1998 work which suggests repeatedly drawing FGs from the same pool. Dick (2002) suggests a ‘homogeneous group’ where building on ideas is more likely than creating conflict. Eliot and Associates (2005) suggest homogeneity as important toward disclosure of information by participants and further suggest that potential members can be drawn from an ‘existing group’. Following discussions with the research promoter, as the provisional studies comprised SACAP registered architectural designers, it was decided to involve the provisional study respondents due to their prior interest and demonstrated commitment to the topic;
- The size and structure, or sample, of the focus groups needed to be established. Bryman and Bell (2007) suggest having at least four participants in a FG led by a facilitator, who Cohen *et al.* (2007) suggests to be the researcher. Nielsen (1997) suggests six to nine members. Escalada and Heong (2009) suggest eight to ten

members the need for an assistant to take notes. While Dick (2002) suggests more or less eight to twelve people and Leedy and Ormrod (2010) refer to several participants, but not more than ten or twelve, Eliot and Associates (2005) claim researchers 'will never want' more than ten participants. With the desired range thus appearing to be between four and ten, seven participants per FG plus the researcher as facilitator and an assistant was considered realistic. It was attempted to secure eight participants per focus group in the event one, hopefully not more, last minute cancellations;

- A structure and range of questioning had to be developed for the FG sessions. Witzel (2000) suggests that 'inevitable previous knowledge' must be disclosed and will provide ideas for questioning during interviews, being FG interviews in this case. Dick (2002) supports this by suggesting that a prior collection of information and interpretation thereof is useful. The true value of the provisional studies paid dividend here. Escalada and Heong (2009) suggest 'key themes' incorporating probing questions and Nielsen (1997) suggests that the facilitator "… must follow a pre-planned script … and set goals …" pertaining to desired information, and that 'concrete examples' be presented to FG members. Bryman and Bell (2007) suggest the opportunity to 'inject' structure into the FGs, through having questions or topics, which allows more control and ensures that the research questions are addressed. Leedy and Ormrod (2010) suggest that a few questions and probes be prepared to ensure that no topics are missed during the process. Dick (2002) claims that structured FGs lead to a more controlled situation. Nine broad questions were developed and included in an electronic presentation together with an introduction. A range of corresponding probing questions and probing statements were developed, which were kept 'on hand' for probing as required, and was not included in the presentation;
- Suitable venues for the FG events had to be established. Leedy and Ormrod (2010) suggest video recording and audio recording as beneficial to the process. Eliot and Associates (2005) suggest a familiar public setting with a comfortable venue, ample parking, and a circular seating arrangement. Escalada and Heong (2009) suggest a neutral venue with some privacy and a semi-circular seating arrangement. The researcher visited a number of venues for purposes of assessing

options in line with cost and suitability. Suitable venues were selected and secured, which are described later;

- Invitations had to be extended to potential participants. Escalada and Heong (2009) propose advance contact and a letter of invitation, followed by reminders the day before the event. As identified earlier, the potential participants, or population, being SACAP registered respondents to the provisional studies would be contacted. In order to remove any form of bias, and selection of potential participants was undertaken using 'Research Randomizer' (Urbaniak and Plous, 1997), an online random selection tool for research. The process included telephone calls in order of the coding provided by the randomizer to identified provisional study respondents. Those who accepted the challenge were sent an electronic invitation with complete details. Confirmation was expected, giving rise to the total sample for each of the two focus groups. Contact was made closer to the time to provide reminders;
- The 'scene' for the focus group sessions had to be set. Participants were to be welcomed (Eliot & Associates, 2002) and informed of the intended programme, which was scheduled to last for approximately two hours (Nielsen, 1997; Eliot & Associates, 2002; Leedy & Ormrod, 2010). Participants were to be asked to complete and sign the provided 'consent forms' (Eliot & Associates, 2002), as 'written permission' (Leedy & Ormrod, 2010) for the researcher to involve them in the focus groups. It was to be explained that the focus groups would be audio recorded for transcription purposes (Bryman & Bell, 2007; Eliot & Associates, 2005; Dick, 2002; Leedy & Ormrod, 2010), and that handwritten notes would also be taken (Leedy & Ormrod, 2010). Furthermore, it was to be explained that key themes and other information would be captured on butcher paper (Dick, 2002) to facilitate discussions and data capture.

Following consideration and organisation of the two FG sessions, and with the participants agreeing to attend, the process was set in motion. The target of eight participants for the first FG session was met, however only four participants could be secured for the second FG session. The first FG was hosted at the Blue Lagoon Hotel conference venue in the Buffalo City Metropolitan Municipality region, while the second was hosted in the Nelson Mandela Metropolitan University Conference Centre in the

Nelson Mandela Metropolitan Municipality region. The two regions are the largest centres in the Eastern Cape Province of South Africa, and are considered representative of the broader South Africa in terms of this research.

What follows introduces and demonstrates the implementation of the FG sessions. It is followed by the essential 'coding and demographics' thereof, while guaranteeing the anonymity of the participants. Participants of both FGs responded to the same nine structured questions.

3.2.3 The 'Buffalo City' focus group

On the 25 April 2013 the researcher as facilitator and the assistant as videographer and note taker arrived at the Blue Lagoon conference venue at approximately 07h30 in order to set up the venue and equipment prior to arrival and registration of the eight FG participants who were scheduled for registration, which included tea / coffee and muffins between 08h30 and 09h00.

Registration included an informal welcome and all participants were requested to fill in consent forms (Appendix 5) which they happily did. The consent forms included 'the aim of the focus group' and a 'participant consent statement' inclusive of an anonymity guarantee. Relevant 'particulars of participant' details were required to be filled in for basic demographic and contact information.

A formal welcome was given and the purpose of the research and the FG was explained. The discussions based on the nine structured questions supported by probes from the facilitator followed. The process commenced at approximately 09h00 and concluded shortly after 12h00 with a 15 minute tea break from roughly 10h55 to 11h10.

The proceedings were video recorded with additional backup audio recording for transcription purposes and a few notes were taken down. Thereafter, the participants were thanked sincerely and were treated to a sit down buffet style lunch which concluded at approximately 13h20.

3.2.4 The 'Nelson Mandela' focus group

As a parallel session, it was considered essential to mimic the 'Buffalo City' FG as closely as possible. On the 13 June 2013 the researcher as facilitator and the assistant as videographer and note taker arrived at the Nelson Mandela Metropolitan University Conference Centre at approximately 07h40 in order to set up the venue and equipment prior to arrival and registration of the four focus group participants who were scheduled for registration, which included tea / coffee and croissants between 08h30 and 09h00.

Registration included an informal welcome and all participants were requested to fill in consent forms (Appendix 5) to which they candidly obliged. The consent forms included 'the aim of the focus group' and a 'participant consent statement' inclusive of an anonymity guarantee. Relevant 'particulars of participant' details were required to be filled in for basic demographic (see Section 5.4) and contact information.

The participants were welcomed and the purpose of the research and the FG was explained. The focus group discussions based on the nine structured questions supported by probes from the facilitator followed. The process commenced at approximately 08h50 and concluded at approximately 12h00 with a 15 minute tea break from roughly 10h45 to 11h00.

The proceedings were video recorded with additional backup audio recording for transcription purposes and a few notes were taken down. Thereafter, the participants were thanked sincerely and were treated to a sit down buffet style lunch which concluded at approximately 13h10.

3.2.5 Coding and demographics

In order to ensure that the researcher could track the data (Chapter 5) if necessary, it was essential to code the participants and number the responses given by the participants. As a result of both FGs responding to the same questions, the participants were given sequential coding. This means that the participants of the Buffalo City FG were coded as being numbers one to eight, while the participants of the Nelson Mandela FG were sequentially coded as being numbers nine to twelve.

The individual responses given by the twelve FG participants were numbered to align with the structured questions, with a ‘point’ and a further ‘numeric value’ thereafter representing the order of the commentary or data input per structured question. In Chapter 5, the participant code appears first, preceded by a ‘P’ for participant, while the response numbering follows in brackets. As an example, a typical response coding is P3 (1.11) followed by the response data.

Commentary or data offered by the researcher as facilitator to the FGs is coded as an ‘R’ generically, but with the extension ‘a’ relative to the ‘Buffalo City’ FG and the extension ‘b’ relative to the ‘Nelson Mandela’ FG, for example Ra and Rb. These are then followed by the same numeric system, for example Ra (1.2) or Rb (1.23).

The basic demographics of the participants was extracted from the consent form data which was completed on the day of the FGs and is reflected below, and demonstrates a mix of professional registration category, age, experience, and gender, which proved beneficial to the cause – ultimately that of qualitative data gathering.

Participants divulged SACAP registration numbers as proof of respective category registration however these are not included here in order to protect the anonymity of the participants. In the demographic table overleaf, ‘P’ denotes ‘participant’.

‘P’	Registration Category	Age	Experience	Gender
P1	Professional Architect	37	10 years	Male
P2	Professional Architectural Technologist	43	20 years	Male
P3	Professional Architect	58	33 years	Male
P4	Professional Senior Architectural Technologist	41	17 years	Male
P5	Professional Architect	26	3 years	Male
P6	Professional Architectural Technologist	55	31 years	Male
P7	Professional Architectural Technologist[2]	42	20 years	Male
P8	Professional Architect	28	5 years	Male
P9	Professional Architect	52	27 years	Male
P10	Professional Architect	67	43 years	Male
P11	Professional Senior Architectural Technologist	52	25 years	Female
P12	Professional Architect	40	15 years	Male

A summary of the demonstrated demographics offers a blend of professional registration categories. It includes: seven Professional Architects (58.3%); two Professional Senior Architectural Technologists (16.7%), and three Professional Architectural Technologists (25%). The latter figures are noted as being inverted by the SACAP downgrading of P7. The average age of the participants is 45 years with relevant experience averaging 20.75 years. The demographics are unfortunately skewed in terms of gender, with only one female (8.3%) being available to participate in the FGs.

The demographic mix of registration category, age and experience, and maybe gender to a lesser extent, proved invaluable to the cause and a wealth of qualitative data was generated. This was transcribed verbatim, hence the included grammatical errors, and is located in the ‘themes based on questions’ in Chapter 5.

[2] P7 was registered as a Professional Senior Architectural Technologist but was allegedly automatically downgraded due to a late annual registration fee payment. He aims to take the matter further with SACAP.

3.2.6 Assembly of the provisional model

While the data is located in Chapter 5 'the data: action research and focus groups', the 'interpretation and a provisional model' is presented in Chapter 6. While N-Vivo 8 software was initially used to categorise the raw data toward processing and analysis, overlaps of themes and wording appeared misrepresented within the categories. A parallel 'hands on' means of analysis was incorporated to ensure the data appears in the appropriate themes as demonstrated in Chapter 5. It is noted that some data straddles more than one theme, hence some repetition is evident. Such cases must be understood relevant to the appropriate theme.

In Chapter 6, the data arising in the Chapter 5 themes is synthesised in terms of related literature and the provisional studies and brackets the themes into appropriate model components, and gradually translates the outcomes graphically into a provisional model. The process realises more than just a model, and locates a 'core model' embedded within a greater 'process model'. The researcher and the research process evolved the provisional model, but the question arose as to whether the FG participants were in agreement with the research output.

3.2.7 Validation of the provisional model

Carter and Smith (2006) place emphasis on the need for feedback, and propose feedback as a means of validating research work undertaken and suggest that this presents the opportunity to compare the outputs of a system or model against a 'real system' in order to gain confidence in what is proposed. According to them, validation ultimately draws on the value placed in 'face-validity' expressed by Naylor and Finger in 1967, and allows users to consider a level of 'reasonableness' as proffered by Law and Kelton in 2000. "For many model development exercises, validation is a crucial aspect and a model cannot be considered complete without it." (Carter and Smith, 2006)

Following the development of the provisional model, a model validation questionnaire (Appendix 7) was developed toward validation of the model.

The questionnaire made use of quantitative and qualitative means and ensured the anonymity of the participants. It focussed on the six main components of the model by including a statement relevant to each model component or sub-component, with respondents being required to consider and indicate on a 'Likert' type scale of 1 (totally disagree) to 5 (totally agree), the extent to which they concur (Leedy and Ormrod, 2010). In order to maintain focus on the model components, an open-ended question was included directly below each model component statement.

Following questioning relative to each of the model components, a statement was included relative to the overall model and included rating scales as before, followed by an open-ended question relating to the overall model.

Ultimately, six statements relative to the use of the model measured against the six research hypotheses were included and included rating scales as before.

Following development of the questionnaires, a covering letter together with a copy of the provisional model (Appendix 6) was prepared. These were distributed by e-mail to the 12 members of the research FGs. The letter thanked the participants for their participation to date and requested their further participation. It also provided a 'simplified model explanation' to facilitate understanding of the model.

The results of the provisional model validation are located in Chapter 7 'Validation and refinement of the model', while the results relative to six research hypotheses are located in Chapter 8 'Testing of the hypotheses'.

3.2.8 Ethical Considerations

The population sample comprised of SACAP registered designers, who received the objective of the research in writing. Participation was voluntary and signed consent from participants was obtained. The research did not put participants at risk of harm. Anonymity was, and is, guaranteed and all data was and will be treated as confidential and solely for research purposes (Cohen *et al.,* 2007; Trochim, 2006; Leedy, 2010).

3.3 SUMMARY

This chapter included the methodological approach and general procedures used in the study. An integrated format was incorporated to create a logical discussion closely aligned with the research process. The discussion included research methods and data collection procedures comprising primary and secondary data, and integrated the target population, sample selection, interview design, and questionnaire design. It made use of four provisional studies to develop nine structured questions to ensure the success of the main study which was undertaken by using FGs comprising SACAP registered architectural designers as part of the AR paradigm. It also entertained the development of a provisional model and the need for validation thereof. It finally included the ethical considerations used in the study.

Beyond the validated model, Booth *et al.* (1995, ix) remind us that "... real research loops back and forth, moving forward a step or two, going back while at the same time anticipating stages not yet begun, then moving forward again", while in terms of data, Leedy and Ormrod, (2010) support Cresswell (1998) and consider this process to be an up and down 'data analysis spiral', really helical in nature. While this may have been achieved, at least for purposes of this study, the methodology used creates a platform for continual re-visitation as the researcher believes that any such model can be improved as more knowledge and information become available.

Chapter 4 which follows uses the four provisional studies toward 'establishing questions through exploration'.

4. ESTABLISHING QUESTIONS THROUGH EXPLORATION

4.1 INTRODUCTION

This chapter is dedicated to 'establishing questions through exploration'. It discusses a range of provisional studies, which were specifically designed in order to incite a better understanding of the topic at hand within the context of South Africa, but ultimately to establish a line of 'structured questions' required for data gathering within the AR paradigm using FGs as the main methodology (Chapter 3). The findings or themes arising from the provisional studies are translated into the said range of structured questions.

4.2 THE PROVISIONAL STUDIES

Four provisional studies were undertaken at different stages of the research. The initial study was truly exploratory in nature, while each of the later studies served to gradually build on the prior. The discussions which follow are deliberately concise, as the results were previously reported through published conference papers, copies of which are included in the appendices (1 – 4). A mix of quantitative and qualitative data emanating from the conference papers is included in the discussions.

4.2.1 The first provisional study

Relative to South Africa, the first provisional study (Appendix 1) was an exploratory survey entitled 'Mitigating construction health, safety and ergonomic risks: Perceptions of architectural design professionals' (Goldswain and Smallwood, 2009) "aimed toward determining the perceptions of architectural designers with regard to mitigation of construction health, safety, and ergonomic risks through appropriate design." The objectives sought to determine "… the: extent to which design dictates construction relative to health, safety, and ergonomics risks; extent to which architectural designers conduct hazard identification and risk assessments during the design process; level of design skills relative to construction health, safety, and ergonomics; extent to which appropriate design can mitigate health, safety, and ergonomic risks, and appropriateness of design education, in terms of health, safety, and ergonomics, and the mitigation of construction risks." (Goldswain and Smallwood, 2009) The table and the qualitative data which follows are extracted from the conference paper and is included for ease of reference.

Table 7: Degree of concurrence with statements related to designing for construction health, safety, and ergonomics

Statement	Response (%)						Mean score
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Appropriate design and specification can mitigate the use of hazardous materials, which cause illness and terminal disease	5.6	0.0	5.6	11.1	50. 0	27.8	4.05
Design dictates construction	0.0	0.0	0.0	27.8	55.6	16.7	3.89
Improved design education in terms of construction health, safety and ergonomics can mitigate hazardous construction work	11.1	11.1	16.7	5.6	38.9	16.7	3.43
Constructors are injured, including fatal occurrences, due to exposure to hazardous construction work	5.6	5.6	16.7	16.7	44.4	11.1	3.41
Appropriate design can mitigate hazardous construction work, which places constructors at risk	5.6	5.6	16.7	27.8	33. 3	11.1	3.29
Designers do not conduct hazard identification and risk assessments during the design process	0.0	5.6	16. 7	33.3	22.2	11.1	3.27
Appropriate design can lead to the improvement of construction health, safety and ergonomics	0.00	11.1	22.2	11.1	50.0	5.6	3.20
Constructors become ill, including terminal diseases, due to exposure to hazardous construction materials	16.7	0.0	22.2	27.8	22.2	5.6	3.14
Constructors experience work-related musculoskeletal disorders (WMSDs) due to the nature of construction work	33.3	5.6	16. 7	16.7	22.2	5.6	3.08
Design education inadequately prepares construction designers in terms of construction health, safety and ergonomics	11.1	16.7	16.7	22.2	16.7	16.7	3.00
Appropriate design can mitigate construction accidents, which cause injuries and fatalities	5.6	16.7	11.1	38.9	27.8	0.00	2.82
Design dictates construction leading to hazardous work being undertaken by constructors	0.0	16.7	33.3	22.2	27.8	0.0	2.61
Designers lack 'designing for construction health, safety and ergonomics' skills	5.6	22.2	27.8	16.7	27.7	0.0	2.52
Constructors are placed at risk due to a lack of 'designing for construction health, safety and ergonomics' skills	5.6	16.7	33.3	33.3	5.6	5.6	2.47
Appropriate design can mitigate the incidence of constructors experiencing WMSDs	33.3	11.1	16.7	22.2	5.6	0.0	2.40

Respondents were also posed an open-ended concluding question: "Do you have any comments in general regarding designing for construction health, safety and ergonomics?" 44.4% had no comments, 33.3% had one, 5.6% had two, 11.1% had three, and 5.55% had four, which equates to a mean of 1.0 comment per respondent. These are presented verbatim:

- "Take note that any construction site can be hazardous depending on the behaviour of the 'constructors' on site";
- "There are many safety procedures related to dangerous areas of construction, most of which are not followed by the constructors";
- "The nature of construction work is dangerous";
- "It is extremely rare for designers to specify hazardous materials – 99% of materials are accepted common-use materials";
- "Building at 1m can be as dangerous as at 20m – The contractor is responsible for using appropriate technology and systems";
- "Design cannot take a back seat due to improper health designs";
- "Although designers need to be more aware and practiced in appropriate and safe design, I feel that the constructors whos(e) job place them at risk, to (where possible) lias(e) & suggest optimum methods to ensure safety and achieve design requirements";
- "Practical training lectures would be useful for CPD purposes";
- "More emphasis should be placed on CHS in training in the construction industry";
- "By law, architects must instruct their client to appoint an H&S consultant to draw up an H&S plan and ensure that this is implemented. This is not a normal part of an architects work. Should a client ask the architect to do this, that's a different story";
- "Construction work is dangerous by nature";
- "All materials if not used correctly, can be dangerous";
- "A Professional contractor should have all the necessary skills and equipment to be able to deal with any design";
- "90% of all designs are conventional construction with no more than average risk";

- “Construction by it’s nature is hazardous (High rise, basements, machinery etc). How this is managed is the contractor’s responsibility. However, architects need to be informed by the industry how to assist safety thro’ designs”;
- “Besides that the design may be challenging and unconventional, constructors like short cuts and cutting costs even if it means carryout works unsafely. There is always a way to carry out works safely, but it is costly for unconventional projects”;
- “The client, the designer and constructor must always take responsibility to ensure that the works is carried out safely. We cannot point finger to one party it’s a joint responsibility”, and
- “There must always be health and safety officer on site 24hrs to makes sure works are carried out safely”.

“The most significant findings include: architectural designers do not adequately conduct HIRAs during the design process; appropriate design and specification can mitigate health, safety, and ergonomic risks; design education inadequately prepares architectural designers in terms of construction health, safety, and ergonomics and associated risks can be mitigated through improved design education.” (Goldswain and Smallwood, 2009)

4.2.2 The second provisional study

Relative to South Africa and following the findings of the exploratory survey, the second provisional study (Appendix 2) entitled ‘Design for construction health, safety, and ergonomics: Encouraging architectural designers’ (Goldswain and Smallwood, 2011) sought to determine “… what would encourage architectural designers to proactively mitigate construction hazards and risks through design.” The objectives were “… to determine the perceptions of architectural designers as to: whether they engage in ‘designing for construction health, safety, and ergonomics’ or not, and to establish the need for development of competencies; what mechanisms could be introduced which would promote engagement and commitment to the process, and what format the introduced mechanism should take.” (Goldswain and Smallwood, 2011)

The qualitative commentary inserted below is extracted the conference paper and is included for ease of reference.

To the question 'Do you believe that construction hazards and risks can be mitigated through alternative design?' 80% of respondents confirmed their belief, with commentary suggesting that:

- Everything has risks, which can be minimised through design and material choice;
- It is the responsibility of the architect to understand construction technology;
- Risks need to be identified and managed correctly;
- There are definitely ways, but the form of buildings should not change;
- Construction methods should take safety and worker ability into account;
- Risks can be reduced by pre-manufacturing and spending less time at high levels;
- One should mitigate risks, but this should not become a driver for design, and
- There is a lack of awareness and the profession should advise and set out preambles.

20% of respondents do not believe that mitigation of hazards and risks is a design issue. Commentary includes:

- It doesn't really matter as the risks and dangers are contractor responsibility, and
- It is not so much design as management of site procedure.

To the question 'Do you actively engage in 'designing for construction health, safety, and ergonomics'? (Please support your answer with an explanation of 'how' or alternatively with 'reasons' for not engaging)' 60% of respondents suggested that they do actively engage, yet the responses suggest that the understanding and level of engagement is minimal. Some selected commentary suggests:

- Some design occurs with health and safety in mind, but it cannot be specified on drawings;

- Not when taking form into account, but maybe when starting to detail things;
- It is kept in back of mind, but is not a sole reason;
- To a certain extent, risks are noted and sorted out;
- I think I do ... it's not at the forefront of one's mind, and
- One does or should ... we don't think about it enough.

40% responded to the negative, with commentary including:

- I don't think one can ... don't consciously think about it;
- I wouldn't say we actually design for it ... the challenge is to look at how it can be done;
- Inspectors check on how a contractor manages his staff, and
- Not specific, it depends on the project.

To the question 'Is there 'something' which could be introduced that would encourage architectural designers to engage in 'designing for construction health, safety, and ergonomics'?' 60% of respondents offered positive suggestions, which include:

- Educating people ... tedious to implement ... should not limit design;
- Ongoing education to keep it at the forefront of one's mind ... it's becoming more visible as a topic;
- It is more a case of awareness, even at university level ... it stems back to Architectural School days;
- One may be able to make up manuals ... needs to be brought to our attention ... an awareness is needed;
- Training should include on site experience ... mentorship is lacking, and
- Architects should have hands on knowledge of what the contractor encounters.

40% of respondents were less forthcoming with suggestions and commentary including:

- Nothing specific ... think it's logic;
- Wonder if it happens in high architecture ... nothing off hand;

- No – dangers come more from under-design by engineers, and
- Can’t think of anything off hand ... would hate design to be stifled. Is there a design criteria? ... I don’t think there can be.

To the question ‘In terms of your recommendation, is there any specific means or format which could be integrated into the design process in order to promote ‘designing for construction health, safety, and ergonomics?’ 80% of respondents offered positive input, while 20% did not respond. Commentary includes:

- Find out how to do it safely ... stipulate how it’s got to be done;
- Education ... consulting agents or representative visits ... buy-in is required;
- An ongoing process to sensitise people ... CPD makes it easier to introduce;
- Some sort of methodology is crucial ... a method or awareness of the building programme;
- Not sure of a format (earlier suggested manual) ... it should make a worthwhile contribution ... something which reminds one to think about it all the time;
- More time spent on the design development stage could benefit ... to build it in, we do Advanced Technologies as part of our design course ... it’s glanced over ... we don’t fully understand how things are put together;
- It should be integrated into the training process ... in terms of the architect going through six years of training, and
- Architects need to understand how buildings are put together and how methodologies are spelt out ... but the contractor is the expert in building.

To the question ‘How could the aforementioned means or format be integrated into your everyday design process?’ 70% of respondents offered positive commentary:

- It should be part of integral thinking ... part of design and documentation;
- Architects should build up specialist knowledge over time;
- It is up to the professional... we need to educate the client to trust the professional;
- The fundamentals of health and safety should be discussed, even at university, and should be monitored and recorded;

- Keep it real and honest – practical and buildable. Do not simplify form and make architecture less exciting and stimulating ... methodology should check and double check your decisions as you proceed;
- Education must be relevant and must address the real problems of design, and
- What must not happen ... we must be very careful with any manual ... it must not be prescriptive and must invite deeper thinking ... if you start closing doors, your design process will be stunted and you can't have that.

30% of respondents did not contribute effectively:

- Never really thought of it;
- We do specify that contractors should conform to safety standards, and
- Accidents seen are due to on site carelessness ... no problems where architectural designs are not safe.

To the question 'Do you feel you have the necessary competencies to 'design for construction health, safety, and ergonomics', and how could these competencies be enhanced?' 40% of respondents felt that they have the necessary competencies, although commentary suggests otherwise:

- Must do ... most definitely ... working with an engineer the combined effort must cover those sort of things;
- I believe I've got the competencies ... to enhance those competencies one would need to interact with contractor to find out how things could be improved;
- Yes, but we must understand our limitations ... ask for help when we need it and consult with specialists. Experience helps – and do the research, and
- We have the competencies because we are designers ... we can design anything. The only way to enhance those competencies is by being made more aware.

50% of respondents did not feel they had the necessary competencies, while 10% of responses could not be deemed valid. Commentary received includes:

- I don’t believe any of us do – we were never taught. What is known is purely through experience – if a detail causes a big problem it won’t be used again;
- No, I’m not a health and safety ‘fundi’. Aware, but learning as we go;
- No ... interaction of the team to thrash out ideas. Awareness is needed ... goes back to ‘varsity’ days;
- Not something we factor in enough ... but we don’t want it to govern form totally. Architects take thousands of different influences to determine form ... this needs to be one of them, and
- It would be arrogant to say that – maybe adequate but never enough. Education is needed to enhance competencies ... there’s a chasm between the two. We actually need to marry the thought processes.

To the question ’If designing for construction health, safety, and ergonomics could somehow be incorporated into tertiary education for architectural students, then how do you think it could be integrated?*’* 80% of respondents offered a way forward:

- It needs to be instilled from basics. It’s difficult, but there must be a way to define objectives ... to fit into Building Construction – the nuts and bolts – not into Design ... must be non-restrictive;
- Alternative construction usage could be enhanced ... risks are not clear. It could form a module with OHS incorporated ... or a subsection of Materials and Methods – what materials, how to use them ... what to use where;
- It will have to fit somewhere between Building Design and Construction, which run parallel ... the Building Construction component. How do we put a building together and how do we document it? It needs to be an integral component – a separate course won’t receive the emphasis it deserves. In the early years of architecture it needs to create awareness for architects;
- There must be a rational way of thinking ... even as simple as once drawn, imagine building it. Architectural education discourages it ... forget how, it doesn’t matter how it gets built ... at what point do we bring it into detail technology ... the subject Building Technology;
- It should be taught by an architectural professional, not a health and safety officer;

- It should start at root level – day one. Design and methodology go hand in hand like form and structure ... ‘varsity’ projects – how is it going to be built ... feasible, viable or too risky?;
- Incorporate it into Design and Construction courses – how to put it together. Architects can become more aware, but are not health and safety officers, and
- We need the correct packaging ... there is too much emphasis on spatial rather than detail. Incorporate it into a design problem – link into the detail – talk to the curriculum to decide what year to introduce it.

20% of respondents did not offer a way forward, with comments such as:

- Wouldn’t know, and
- It relies on common sense.

To the final question ‘Do you have any other comments or ideas in general with regards to ‘designing for construction health, safety, and ergonomics’?’ 70% of respondents offered commentary:

- It’s important ... an awareness needs to be made;
- One does not really think about it – it needs to be taught and awareness raised;
- The trade is becoming more aware of the problems;
- We need to understand alternative methods of construction. Recycle and re-use ... reduce manpower and reduce risk;
- Awareness and fairness – people doing a hard job – how do we make their day more comfortable. If teams are happy, they will be more aware and careful;
- Something can be developed. Hopefully we’re doing it anyway ... it’s something we need to be aware of, and
- It’s a new field ... not widely explored. We need research and new ideas brought to us. Information needs to be increased at tertiary education level and workshops held for the professionals.

The salient findings include: "architectural designers need 'designing for construction health, safety, and ergonomics' competencies; a guiding approach or model should be developed and incorporated into architectural education and on-going training; the guiding approach or model should be technologically grounded and should not stifle architectural freedom." (Goldswain and Smallwood, 2011)

4.2.3 The third provisional study

Drawing on the findings of the prior study, a third provisional study (Appendix 3) entitled 'An architectural design model framework toward improved construction health, safety, and ergonomics in South Africa' (Goldswain and Smallwood, 2012) aimed "… to establish a framework toward development of a guiding approach or model." The objectives were to: "… confirm whether a guiding approach or model would in fact encourage architectural designers to design for construction health, safety, and ergonomics; consider the form and nature of a possible model; establish if there was any extant documentation used by architectural designers to which a possible model could be attached or associated with, and consider how the model could be incorporated into architectural education." (Goldswain and Smallwood, 2012)

The quantitative tables and the qualitative commentary inserted below are extracted from the conference paper and are included for ease of reference.

Table 8: Degree of concurrence with statements related to designing for construction health, safety and ergonomics

Statement	Response (%)						Mean score
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Architectural designers would like a model which provides a series of ‘checklists’ which can be used during the design process	0.0	0.0	0.0	8.3	50. 0	41.7	4.33
A guiding approach or model would assist architectural designers in the process of ‘designing for construction health, safety, and ergonomics’	0.0	0.0	0.0	8.3	58.3	33.3	4.25
Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if there was a guiding approach or model in place to assist them	0.0	0.0	0.0	8.3	58.3	33.3	4.25
It would prove beneficial if the guiding approach or model was incorporated into architectural education and continuous professional development (CPD) programmes	0.0	0.0	0.0	8.3	58.3	33.3	4.25
Architectural designers need to improve their ‘designing for construction health, safety, and ergonomics’ competencies	0.0	0.0	8.3	16.7	50.0	25.0	3.92
Architectural designers would like a guiding approach or model which is flexible in nature and promotes a ‘buy-in’ situation	8.3	0.0	0.0	8.3	58.3	25.0	3.83
It would be beneficial to have an approach or model which includes a mechanism for interim assessments during the various stages of the design process	0.0	16.7	8.3	16.7	25.0	33.3	3.50
Architectural designers do not adequately engage in ‘designing for construction health, safety, and ergonomics’ because they don’t really know where to start or how to engage in the process	0.0	16.7	0.0	16.7	66.7	0.0	3.33
Architectural education in South Africa does not adequately prepare designers to ‘design for construction health, safety, and ergonomics’	0.0	0.0	8.3	25.0	50. 0	16.7	3.33
Architectural designers would like a guiding approach or model which provides a series of ‘prompts or keywords’ in order to engender deeper thinking during the design process	8.3	0.0	16.7	41.7	16.7	16.7	3.08
Architectural designers would like a guiding approach or model which is prescriptive and regulatory in nature	8.3	8.3	33.3	8.3	33.3	8.3	2.75

Table 9: Degree of documentation consideration or usage relative to the stages of the design process

<table>
<tr><th rowspan="2">Documentation</th><th colspan="6">Stage of design (SACAP)</th></tr>
<tr><th>Stage 1 : Inception</th><th>Stage 2: Concept and viability</th><th>Stage 3 : Design development</th><th>Stage 4 : Documentation and procurement</th><th>Stage 5 : Construction</th><th>Stage 6 : Close out</th></tr>
<tr><td>National Building Regulations</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td></tr>
<tr><td>Percentages (%)</td><td>00.0 25.0 25.0 08.3 25.0 16.7</td><td>08.3 08.3 00.0 50.0 25.0 08.3</td><td>00.0 00.0 00,0 16.7 16.7 66.7</td><td>00.0 08.3 00.0 33.3 16.7 41.7</td><td>08.3 00.0 16.7 08.3 16.7 50.0</td><td>16.7 00.0 33.3 08.3 08.3 33.3</td></tr>
<tr><td>Mean Score</td><td>2.83</td><td>3.00</td><td>4.50</td><td>3.83</td><td>3.75</td><td>2.92</td></tr>
<tr><td>Bills of Quantities (BoQs)</td><td colspan="3">Project specific BoQs will not be readily available for use during these early stages</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td></tr>
<tr><td>Percentages (%)</td><td colspan="3">N/A</td><td>00.0 00.0 25.0 08.3 41.7 25.0</td><td>08.3 00.0 16.7 00.0 16.7 58.3</td><td>08.3 16.7 08.3 08.3 16.7 41.7</td></tr>
<tr><td>Mean Score</td><td colspan="3">N/A</td><td>3.67</td><td>3.92</td><td>3.33</td></tr>
<tr><td>Work Breakdown Structure (WBS)</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td></tr>
<tr><td>Percentages (%)</td><td>50.0 08.3 08.3 00.0 16.7 16.7</td><td>50.0 08.3 00.0 08.3 16.7 16.7</td><td>41.7 16.7 00.0 00.0 33.3 08.7</td><td>41.7 25.0 00.0 00.0 25.0 08.3</td><td>50.0 08.3 08.3 00.0 16.7 16.7</td><td>58.3 08.3 00.0 08.3 16.7 08.3</td></tr>
<tr><td>Mean Score</td><td>1.75</td><td>1.83</td><td>1.92</td><td>1.67</td><td>1.75</td><td>1.42</td></tr>
<tr><td>Preambles for Constr. Trades</td><td colspan="3">Project specific preambles will not be readily available for use during these early stages</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td></tr>
<tr><td>Percentages (%)</td><td colspan="3">N/A</td><td>16.7 25.0 00.0 25.0 08.3 25.0</td><td>25.0 16.7 08.3 25.0 08.3 16.7</td><td>33.3 33.3 00.0 25.0 00.0 08.3</td></tr>
<tr><td>Mean Score</td><td colspan="3">N/A</td><td>2.58</td><td>2.25</td><td>1.50</td></tr>
<tr><td>Other (add below)
…………………
…………………</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td><td>U 1 2 3 4 5</td></tr>
<tr><td>Comment</td><td colspan="6">No other documentation was recommended by any of the respondents.</td></tr>
</table>

Note: Preambles for Construction Trades are not known to all countries. These preambles offer descriptive meaning and a minimum level of specification for materials, finishes and workmanship relative to a vast range of standard construction trades.

Table 10: Degree of concurrence relative to attachment of a guiding approach or model

Documentation	**Stage of design (SACAP)**					
	Stage 1 : Inception	Stage 2: Concept and viability	Stage 3 : Design development	Stage 4 : Documentation and procurement	Stage 5 : Construction	Stage 6 : Close out
National Building Regulations	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	16.7 16.7 25.0 00.0 16.7 25.0	08.3 00.0 16.7 41.7 16.7 16.7	08.3 00.0 00.0 08.3 41.7 41.7	08.3 08.3 08.3 00.0 16.7 58.3	16.7 00.0 08.3 00.0 16.7 58.3	16.7 16.7 16.7 00.0 08.3 41.7
Mean Score	**2.58**	**3.08**	**4.00**	**3.83**	**3.75**	**2.92**
Bills of Quantities (BoQs)	Project specific BoQs will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			16.7 16.7 00.0 08.3 16.7 41.7	16.7 16.7 08.3 00.0 00.0 58.3	25.0 25.0 08.3 00.0 00.0 41.7
Mean Score	**N/A**			**3.17**	**3.25**	**2.50**
Work Breakdown Structure (WBS)	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	66.7 16.7 08.3 00.0 00.0 08.3	75.0 00.0 16.7 00.0 00.0 08.3	66.7 00.0 16.7 00.0 08.3 08.3	58.3 08.3 08.3 00.0 16.7 08.3	66.7 08.3 00.0 00.0 16.7 08.3	66.7 00.0 08.3 08.3 00.0 16.7
Mean Score	**0.75**	**0.75**	**1.08**	**1.33**	**1.17**	**1.25**
Preambles for Constr. Trades	Project specific preambles will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			41.7 08.3 00.0 08.3 08.3 33.3	41.7 08.3 08.3 08.3 00.0 33.3	41.7 25.0 16.7 00.0 00.0 16.7
Mean Score	**N/A**			**2.33**	**2.17**	**1.42**
Other (add below) ………………… …………………	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Comment	**No other documentation was recommended by any of the respondents.**					

Note: Preambles for Construction Trades are not known to all countries. These preambles offer descriptive meaning and a minimum level of specification for materials, finishes and workmanship relative to a vast range of standard construction trades.

Table 11: Degree of concurrence with regard to the optimal form and levels of study suitable for inclusion of an approach or model in tertiary education

Form	Year / Level of study						Mean score
	Unsure	1	2	3	4	5	
Separate subject	41.7	33.3	25.0	8.3	0.0	0.0	**1,08**
Component of a subject	25.0	8.3	41.7	33.3	16.7	0.0	**2.58**
Module in various subjects	16.7	8.3	33.3	33.3	25.0	8.3	**3.08**

In response to the open ended question, 'Do you have any comments in general regarding the development of a guiding approach or model in relation to 'designing for construction health, safety, and ergonomics?', only three responses were received:

- It must be "... practical and relevant for implementing in the South African building environment";
- "Get the education up and running in tertiary institutes as it is becoming more and more of a factor in the design and production of every project", and
- "Tertiary education is a great start and professional aids would be very useful as well."

The salient findings include: "architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding approach or model in place to assist them; the model should be flexible in nature and should promote a buy-in situation as opposed to being prescriptive and regulatory in nature; the application of the National Building Regulations forms a suitable basis for development of the model, and the model should be incorporated into architectural education and CPD courses." (Goldswain and Smallwood, 2012)

Something which was not elaborated in the salient findings, but was included by nature of the matrix method of questioning was the cross-referencing of NBR with the six 'work stages' defined by the SACAP (Republic of South Africa, 2010). The cross-reference matrix in itself could thus be considered as a basis for development of a model, being the 'model framework' the preliminary study sought to identify (Goldswain and Smallwood, 2012).

4.2.4 The fourth provisional study

Drawing on the possibility of the cross-reference matrix as ‘model framework’, the fourth preliminary study (Appendix 4) entitled ‘Identification of key inputs toward development of an architectural design model aimed at improving construction health, safety, and ergonomics in South Africa’ (Goldswain and Smallwood, 2013) was undertaken.

Background objectives were to sanction earlier findings relative to: the need for a model and what would encourage architectural designers to engage in ‘designing for construction H&S, and the suitability of the model framework. The main objectives however were: to identify key inputs which could be considered alongside and incorporated into the model.

The quantitative based table and the qualitative commentary included below are extracted from the conference paper and are included for ease of reference.

Table 12: Degree of concurrence with statements related to development of a model

Statement	Response (%)						MS
	U	TD	D	N	A	TA	
Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding model to assist them	6.7	0.0	0.0	0.0	73.3	20.0	4.18
A guiding model should be technologically grounded and should not stifle architectural freedom	0.0	0.0	0.0	0.0	40.0	60.0	4.60
Architectural designers would like a guiding model which includes 'prompts or keywords' in order to engender deeper thinking during the design process	13.3	0.0	0.0	26.7	40.0	20.0	3.40
A guiding model should be flexible in nature and should promote a buy-in situation making architectural designers more willing to use the model	6.7	0.0	6.7	13.3	20.0	53.3	4.00
A guiding model should be prescriptive and regulatory in nature whereby architectural designers are forced by regulation to use the model	0.0	13.3	33.3	20.0	26.7	0.0	2.64
A guiding model should have a framework which is familiar to architectural designers and offers ease of use	0.0	0.0	0.0	0.0	66.7	33.3	4.33
Architectural designers use the application of the National Building Regulations (NBR) during the design process	0.0	6.7	6.7	13.3	26.7	46.7	4.00
Architectural designers use a Bill of Quantities (BoQ) during the design process	0.0	13.3	26.7	53.3	6.7	0.0	2.53
Architectural designers use a Work Breakdown Structure (WBS) during the design process	6.7	13.3	33.3	40.0	0.0	6.7	2.33
Architectural designers use the Preambles for Construction Trades during the design process	0.0	20.0	26.7	40.0	13.3	0.0	2.47
Architectural designers follow the SACAP 'work stages' during the design process	0.0	0.0	0.0	13.3	53.3	33.3	4.20
Architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics	0.0	0.0	0.0	26.7	40.0	33.3	4.07
Architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics	6.7	0.0	6.7	20.0	53.3	13.3	3.53
Consideration of 'local and international literature' would prove beneficial to developing a guiding model suitable for use in the context of South Africa	6.7	0.0	0.0	20.0	53.3	20.0	3.73
Consideration of suitable 'international models' would prove beneficial to developing a guiding model suitable for use in the context of South Africa	6.7	0.0	0.0	26.7	60.0	6.7	3.53
Consideration of existing 'design recommendations' would prove beneficial to developing a guiding model suitable for use in the context of South Africa	0.0	0.0	0.0	40.0	33.3	20.0	3.79
A guiding model should include a process which architectural designers can follow in order to design for construction health, safety, and ergonomics	0.0	6.7	0.0	33.3	46.7	13.3	3.60
A guiding model should include 'checklists' and allow opportunity for 'design notes' in order to assist the process	0.0	0.0	6.7	6.7	60.0	26.7	4.07

The related open-ended questions and responses follow:

‘Do you have any comments or suggestions regarding a possible framework for a guiding model?’

- Exposure of professionals to necessity of a model would highlight shortcomings in knowledge, and
- Good idea to relate to SANS 10400 (NBR).

‘Do you have any comments or suggestions regarding possible inputs into the framework of a guiding model?’

- Checklist, and
- Exposure and understanding of construction technologies.

‘Do you have any comments or suggestions relative to construction health, safety, and ergonomics?’

- Designers and architectural practitioners should be actively exposed to the physical construction process of projects to ensure a practical understanding of the erection and construction process and constraints;
- Use CDM regulations from the UK as a benchmark, and
- Very important as deaths / accidents far too high.

The findings relative to the ‘background objectives’ mostly arising from the previous provisional studies include: architectural designers would be more encouraged to design for construction H&S if they had a guiding model to assist them; a guiding model should be technologically grounded and should not stifle architectural freedom; a guiding model should be flexible in nature and should promote a buy-in situation making architectural designers more willing to use the model, as opposed to being prescriptive and regulatory in nature whereby architectural designers are forced by regulation to use the model; architectural designers would like a guiding model with ‘prompts and keywords’ in order to engender deeper thinking during the design process; a guiding model should include ‘checklists’ and allow opportunity for ‘design notes’ in order to assist the process; a guiding model should have a framework which is familiar to architectural designers and offers ease of use, and architectural designers predominantly use the application of the

National Building Regulations (NBR) and the SACAP architectural work stages during the design process (Goldswain and Smallwood, 2013).

The main findings include: consideration of ‘local and international literature’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa; architectural designers would need to understand the ‘causes of construction accidents’ in order to design for construction health, safety, and ergonomics; architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics; consideration of suitable ‘international models’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa; consideration of existing ‘design recommendations would also prove beneficial , and a guiding approach or model should include ‘checklists’ and allow for ‘design notes’ in order to facilitate the process (Goldswain and Smallwood, 2013).

4.2.5 Summary

Informed by literature, the provisional studies proved instrumental in guiding the main study direction and contributing to the success of this research. Accumulative findings, *inter alia*, demonstrate: that there is a need for ‘designing for construction health, safety, and ergonomics’ and that current limitations of architectural designers exist due to inadequate appropriate tertiary architectural education and on-going training; that a model, which is technologically grounded and should not stifle architectural freedom, should be developed and incorporated into tertiary architectural education and CPD courses; that a matrix which cross-references the NBR and the six SACAP ‘work stages’ could possibly form the basis of the model framework, and a range of ‘key inputs’ were identified toward development of the model.

The question arises as to how the information from the survey of related literature and the data gathered through the exploratory survey and the three pilot studies can contribute toward development of a provisional model?

4.3 THE STRUCTURED QUESTIONS

The findings or themes arising from the provisional studies were translated into structured questions required for gathering data from the FG participants. In accordance with FG protocol (Nielsen, 1997; Dick 2002; Bryman and Bell, 2007; Escalada and Heong, 2009; Leedy and Ormrod, 2010) as per the Chapter 3 methodology, the structured questions were deliberately broad or open in nature in order to ensure a broad, all inclusive range of responses from the participants. The provisional studies gave rise to eight structured questions, while a ninth was introduced to ensure exhaustiveness and to give participants an opportunity to 'assemble' a model – not that a true model was expected to arise. They are included here with the themes or keywords underlined for purposes of clarity:

- What would be considered as suitable key inputs for a 'designing for construction health, safety, and ergonomics' model?
- What would be considered a suitable framework for a 'designing for construction health, safety, and ergonomics' model?
- Within the suggested framework, is there a process which can support 'designing for construction health, safety, and ergonomics'?
- What requisite knowledge would architectural designers need to have in order to engage the suggested process?
- What mechanisms could be put in place to provide requisite knowledge to architectural designers?
- What would engender architectural designers to engage in 'designing for construction health, safety, and ergonomics'?
- In terms of the work performed by architectural designers, what would the improved outputs of using the model be?
- What becomes of the range of outputs produced by architectural designers?
- Is there anything we may have missed, and is it possible to 'assemble' a model from the information gathered?

The nine structured questions were posed to the participants of both research FGs in order to solicit rich qualitative data for the main study. The ‘action research and focus groups’ chapter which follows demonstrates the process and presents the arising qualitative findings.

5. THE DATA: ACTION RESEARCH AND FOCUS GROUPS

5.1 FOREWORD

This chapter draws heavily on the methodology described in Chapter 3 and the structured questions arising in Chapter 4 ‘establishing questions through exploration’.

Within the AR paradigm, the two planned FG sessions took place, and were successful in gathering a wealth of rich qualitative data.

This chapter ultimately presents the data stemming from the nine structured questions arising in Chapter 4, while the participants of both FGs responded to the same structured questions. The data is presented by theme, rather than by direct response to the questions due to broad discussions which crossed the ‘boundaries’ of individual questions.

5.2 THEMES BASED ON QUESTIONS

The purpose of this section is to locate all relevant data within recognised themes based on the responses given by the participants. The main themes which are considered to contribute effectively to the development of a model are independently divulged and supporting data, or responses, located therein. It is noted that specific aspects of the data are repeated in whole or as an excerpt within various themes in order to ensure that their relevance to the various themes is not overlooked during ‘interpretation’ (Chapter 6).

The overall mood of the participants toward the topic was positive in nature however the underlying perception that construction health, safety, and ergonomics as contractors responsibility was detected. This is included here as it does not contribute positively as a development theme. This is followed by the main themes (Sections 5.5.1 to 5.5.9), while some relevant additional themes arising from the FGs are exposed in Section 5.5.10.

The following excerpts from participants’ statements epitomise the underlying perceptions:

P3 (1.11)	… your mind is thinking about design, you're not thinking about the safety at this stage … you start thinking about it later on.
P6 (1.28)	I think Health and Safety has always been seen as a construction occurrence …
P3 (2.36)	… at the end of the day what it all boils down to is the designer is putting together a document that says to the contractor, when you are finished on the site Mr Contractor, this is what the building should look like. How you get it there with safety measures that need to be put in place to get it there, is your job Mr Contractor.
P3 (2.40)	... Mr Contractor you're the guy that's on the site, you are the one that is going to be working with the people that are building, you are responsible for them, put your safety plan in place.
P3 (2.42)	… we design the building. Mr Contractor you build it, please make sure of your safety.
P6 (2.142)	… I don't think we are actually going to be in a position that we can spec it, because that's not our training.
P4 (3.29)	… I admit myself, I realise I am totally disconnected in the design stage from a point of health and safety.
P1 (4.3)	I don't think we are the experts in what risks are out there.
P6 (6.3)	I think we first need to be aware that there is a problem - design related - before we actually encompass that problem …
P10 (1.36)	(Excerpt only) … Most of the accidents that happen on the site are not caused by designers. Most of them are caused by negligence from the workers. A lack of knowledge - some of them are poor supervision by a supervisor and there is a small percentage of them where people have given wrong instructions to the guys that cause accidents …
P9 (1.47)	We again come back to how the contractor handles it. There's again that fine line between what control you have.

Despite the exposed underlying perceptions relating to contractors, a wealth of data was generated. Given the nature of the topic within the context of South Africa, responses were initially slow and possibly even vague, but steadily gained momentum as participants became more conscious of the topic. Corresponding to the line of structured questioning, the themes which follow entertain the responses from the participants - often in discussion format. Cross-boundary data from other questions is also incorporated into relevant themes.

5.2.1 Theme 1: The search for key inputs into a model

This section embraces the first structured question being: 'What would be considered as suitable key inputs for a 'designing for construction health, safety, and ergonomics' model?'

Being the first structured question put to the participants, responses were slow and somewhat vague, however some ideas were generated:

P3 (1.1) Are we talking of any specific stage in the process of construction or are talking in general?

P6 (1.4) I think there is already a lot of study been done in terms of the construction stage of health and safety, but I think the emphasis here is on the design part of the architectural profession. Just as input there I would say just the study of the site initially just to see the complexities of the site to establish what dangers might be lurking once construction has actually been started.

P10 (1.8) Yes. What I am saying is there is a concern that we are designing so that it is not safe for the worker. What we've got to look at is, how do we design and how do we link the design process to the construction process, because very often we don't have any say in the construction process. So you might design something but it hadn't been thought through a particular process. The contractor comes along, or the client comes along and has some totally different idea, that makes it totally...

P12 (1.9) Maybe the technology is fantastic for us, but then when the guy actually gets to the site it is something completely different.

P12 (1.11) It is also a question of knowledge - what we know and what the contractor ultimately actually probably applies sometimes.

P1 (1.5) Are you looking for a deliverable as an input?

Ra (1.6) Mmmm – a deliverable – in other words?

P1 (1.7) Some sort of tracking document - like a checklist type of thing.

P10 (1.83) It is almost a tick box that you need to say - and flag them as a hazard from 1 to 5 or something.

Ra (1.8) Alright - a lot of these things might come out in the wash a little bit later?

P7 (1.9) Maybe the thing of how do you compile a checklist and who compiles it? If you look at the model that is across the board applicable to any project, then that model should be researched if it is a gazetted document for example. That means the model should obviously be researched and amended as per project - how do you form that model which you speak to kind of to get that model right. Who are the roll-players in other words?

P10 (1.23) Can I put a question back to you? The model that you are looking at, is that it affects the design?

Rb (1.24) Correct.

P10 (1.25) So it is not to do with the conditions relating to the workers under the responsibility of the contractor?

Rb (1.26) No, it is a model to help the designer to engage the process.

P3 (1.11) I would imagine Construction Regulations as they come as a starting point. My concern is that it is so vast - too big - it actually becomes too cumbersome to handle. If we would start to bring these things together at the design stage of the project, your mind is thinking about design, you’re not thinking about the safety at this stage. So that great big wad of construction regulations is actually a bit of a problem to try and handle at the design stage. You start thinking about it later on. Maybe as (P1), or whoever was saying, to have a checklist, a shortened version of a checklist which architects can use during the design stage, so that while he is designing he's thinking about these things.

Rb (1.88) It pretty much covers – now this is all under question 1, the key inputs. Are there any other suggestions regarding key inputs?

P9 (1.89) Regulations

Rb (1.90) Any specific regulations you're thinking of?

P10 (1.91) Yes. Besides your construction safety, it's your SANS, your whole environmental story, and then the normal town planning zoning and other restrictions. There are a lot of places near like airports, harbours, anything like that you get all sorts of restrictions and things that come in. Another one that we had, which I haven't specifically mentioned as it comes under the site issue is Geotech – especially up in the Transvaal.

P9 (1.92) It has to speak to the model though.

P10 (1.93) Surely it must be one of the tick boxes.

P9 (1.94) For a specific project - not for a general thing.

Rb (1.95) Geotech is part of the SANS you have mentioned already … (Excerpt only).

P10 (1.33) (Excerpt only) … I'm talking about a site – and I'm talking about health and safety in the design aspect. There is a need to have the basic understanding of how these requirements impact on the designer and how the designer interacts with that. Again one needs to be looking at the thing not where the rule book is influencing the design totally …

P2 (1.26) Would choice of materials for design come into it at all?

Ra (1.27) Choice of materials definitely comes into it.

P2 (1.28) Research on those materials will be needed.

P6 (1.29) I think Health and Safety has always been seen as a construction occurrence and I think we need to adopt it on the architectural side as well. It is everyone's responsibility at the end of the day.

P3 (1.33) We haven't touched on the ergonomics before.

Ra (1.34) Sorry. Health, safety and ergonomics is part of - maybe we should just touch on what it is. It is part of the Health and Safety risk, in other words you pull muscles, damage your back, it is health, safety and ergonomics. There is an argument that says ergonomic is a focus on its own and there is another argument that says ergonomics is part of health and safety, so just bare that in mind as we go along.

P3 (1.35) I just want to give an example on ergonomics, say you are designing something that is out in the sticks where they cannot get a crane on site, and those kinds of problems and you have to design a building that has a 15m truss, how are they going to get it up? Those are the kind of things we should start thinking about. Ergonomics should also come into the study - what entails ergonomics when actually building.

Based on relevant literature and the preliminary studies undertaken, the facilitator used a range of probing questions and statements to solicit further responses from the participants relative to key inputs. Many responses are brief and to the point, but no negative or contradictory responses were provided:

Ra (1.12) Ok, is there any relevant literature out there that can guide us?

P6 (1.13) There is already Health and Safety on construction sites. One needs to adopt that, use that as a basis and to assist with the design process. (P3 nods)

Ra (1.14) Could one use any recent studies toward a key input into a model – would they contribute toward a model?

P3 (1.15) Yes, they would.

P9 (1.22) I am not aware of any recent studies, but if there are any they would serve as role models.

Ra (1.16) Could the causes of accidents contribute as a key input?

P6 (1.17) Oh yes!

Rb (1.34) (Excerpt only) … could information on causes of accidents actually feed into the model?

P9 (1.35) Yes, I said here (making own notes) reported incidents. I think that need to be reported to the Department of Labour or something. Court cases?

P10 (1.36) There are also a hundred and plenty unreported accidents – those not serious enough to be reported … (Excerpt only).

Ra (1.18) Information on hazards and risks?

P3 (1.19) Oh yes, they can contribute.

Rb (1.39) (Excerpt only) … we suggested that causes of accidents can contribute too - as an input - and going with that could information on hazards and risks serve as an input to the model.

P10 (1.40) Your hazards, especially with chemicals and use of flammable materials or other hazardous materials. I mean one needs to understand that and the working conditions that go with it. I'll chuck another one at you. To me it yet again becomes partly a construction risk. Long-span roofing - there are very strict conditions under which it is safe to work with that sort of thing.

P10 (1.44) It comes back to the kind of structure that is fine, legally in a city centre site where you only going that way (gestures upward) you might be going down first, so then you obviously have shoring, piling, all those things related with the below ground basements and things. Otherwise your restricted site in any of the city centres where you are working over public areas, and the restrictions what do you design in and is it your responsibility to do it - and on my side I think yes – hoardings and things - we need to specify it.

P12 (1.49) I mean I think we've been thinking about going up or down or left or right and windows and those sort of things but I think what one should think about is not only how to build the building, but you should also think of the building or whatever type of structure it is being broken down in different components. Yes, if you go up it is hazardous, but once the structure is up then the specification and application methods if you can call it that - of things like floors, walls, ceilings, that kind of thing, then I think there is more scope of probably specifying or trying to design a better solution, so that the guy doesn't stand on a little "koekerige leertjie" (spindly ladder) to get up there so that maybe the installation goes in whilst the scaffolding is up - looking at the floor structure for example. So maybe that is the other way of looking at it, not just bringing it up but when the building is there. I think there is more scope actually getting that. That way we can probably say listen the guy is not going to lay the carpet until such time as the walls are painted or something like that.

P11 (1.50) You should have a program...

P10 (1.51) You see, that's what I am saying where is that line?

P12 (1.52) I think the line is probably where if you know that this carpet or the glue that they use for example is going to get completely stuffed up - the guys are going to float more toward the ceiling than down on the floor. You say that according to specifications you are not allowed to lay the carpet with that 'thing' until such time as the whole building has been evacuated or the doors are on or the lights are in.

P10 (1.55) We have an example at the hospital a couple of years ago when the chap had to work overtime and he had to do the toilets and do the change room, the supervisor came past everything is lekker - he goes to grab his supper downstairs - the guy laying the vinyl has got the glue tin open, his mate comes in (shows action of lighting a cigarette) – explosion, and the guy lands in ICU. Now that is not a design aspect that you mustn't do this - and no smoking - that is a construction thing so there is this line. We need to make the guys aware of the hazards but we are not the contractor.

Ra (1.21) (Excerpt only – See R (1.21) earlier) … Could existing international models serve as key inputs into the model?

P4 (1.22) Yes (nods from numerous participants)

Rb (1.56) (Excerpt only) … Could existing international models serve as key input to a South African model?

P9 (1.57) It certainly could. For instance, if there's an Aussie model then I think it could be applied.

P10 (1.58) Yes and no. Why I am saying no is generally we are dealing with a workforce that is not adequately trained. So any international model has to be adapted … (Excerpt only) … So whatever model we are doing has to be broadened …

Rb (1.59) Ok two things there, yes the Aussies have a model - the CHAIR model (Construction Hazards Assessment Implication Review) - that is the first one that you are talking about and secondly it is not my wish to adopt a model from elsewhere but the question is 'can an international model serve as an input to develop a model?'.

P9 (1.60) Of course yes.

P10 (1.61) It can, but again … (Excerpt only).

Ra (1.23) Ok, on-going research and development?

P6 (1.24) Yes, I think that's important.

Rb (1.84) Could on-going research and development serve as a key input into the model? Obviously research and development on the topic.

P10 (1.85) I think very much so. I think also what goes hand in hand with that is to get co-operation from the architects to feed back on the outcomes of projects - especially when you have unusual projects or high hazard projects.

Rb (1.86) So the feedback will actually get noted and looked into and pumped back into whatever is happening?

P10 (1.87) Yes, if you are coming up with finding specific problems that would affect others.

Rb (1.64) Could design recommendations serve as a key input?

P10 (1.65) Just clarify that - when you say design recommendations?

Rb (1.66) Yes, if there are other researchers or other practices in other countries who have made recommendations for design practices - if I can put it that way - could design recommendations - in other words recommendations to resolve health and safety issues and risks through the design process.

P10 (1.67) Probably yes - again one needs to look at what is the environment in which that design recommendation has been made against our environment.

R (1.30) Ok gents, so the kind of things we have mentioned on recent studies, causes of accidents, hazards and risks, international models, research and development – can we reach consensus that these type of things would actually contribute as an input to the model?

P4 (1.31) Ja (Colloquial for 'yes').

Rb (1.95) (Excerpt only) … Based on what we have spoken about here the information, studies, cause of accidents, hazards and risks, international models, research and development, design recommendations – regulations has come to the fore - can the group reach consensus on the proposed key inputs?

P10 (1.96) Did you write client requirements there?

Rb (1.97) Yes, I'm making brief notes here and it's been recorded.

P9 (1.98) Yes, all of those most definitely can contribute.

Beyond the first structured question, a range of responses crossed the boundaries of other structured questions and contributed to 'Theme 1', being that of key inputs. The following lends support to international approaches or documentation as a contribution to key inputs:

P1 (2.17) Can you actually give your definition of CDM, or what do you see as CDM?

Ra (2.18) CDM are your UK Construction (Design and Management) Regulations - the 2004 version and I think the latest is the 2007 version, I don't think it's evolved any further than that, but yes CDM certainly - the use of it - it does apply to the design process and the management processes or the rest of it. Are you all familiar with CDM?

P1 (2.19) That's what I mean, I have an idea of what it is, I'm not sure if anyone else does.

Ra (2.20) I hear exactly what you are saying now with CDM, your Construction (Design Management) Regulations were specifically developed for the UK market. Are they adaptable to the SA? To what extent and will that work, how cumbersome are they? Or why don't we just pick up the pieces and bring it to SA and use it. If you just go back to my title, which is in SA, we are looking for something which is suitable and could possibly encourage engagement from South African architectural designers. So maybe what you are saying about CDM we go back to our original question, or previous question as one of the key inputs?

P7 (2.21) It was mentioned, not the specific document. It was mentioned - something from another country, but it must be adaptable for SA.

The following lends support to the need for hazard and risk identification, as a contribution to key inputs:

P1 (2.70) (Excerpt only) … so there is an inherent risk of digging down trenches 3, 4, 5m down and say people - it has to be hand dug for whatever geomorphic reason and we have to have personnel down below ground level. I think the professional should identify risks …

P12 (2.11) (Excerpt only) … just before you have a tender - say for example the engineer tells you – do you know what, we thought we can do that but you know what we need 50 million skyhooks now to achieve that goal. That throws the whole thing out. You know what I mean?

P10 (2.12) I agree, I have just been there.

P12 (2.13) Well I am busy with it that is why I am so irritated because there's the thing don't tell me now there is a pipe running there now after three months. That influences the design … (Excerpt only).

P10 (3.60) It also goes around your health and safety plan that you issue at tender stage. So you are identifying the risk. The problem comes in when you haven't identified a risk.

Rb (3.61) Who identifies it – the designer?

P10 (3.62) The designer.

Rb (4.20) (Probing statement) … Architectural designers need to be able to identify hazards and undertake risk assessments.

P9 & P10 (4.21) Yes (nods all round).

Rb (7.19) It was suggested that all hazards and risks cannot be eliminated, but what can designers do if they are aware of unresolved hazards and risks?

P10 (7.20) They should come up with a mitigation plan with the constructor.

P9 (7.21) As long as you identify the risks, I think the contractor can then address it.

The following lends support to the need for research or data resource as a contribution to key inputs:

P4 (9.34) (Excerpt only) In my mind one of the first things I would need is some sort of research or data resource so that I can start understanding the risk class or something for the priorities that one should focus on …

P7 (9.38) (Excerpt only) … With that goes research, we are talking about health and safety now.

P9 (2.22) Yes there is, there would be case studies or previous examples. Quite recently I was asked to put together a brief for a fire station and I went to two books that have design criteria for fire stations. So that and also got two documents off the internet, both American unfortunately, but there are documents out there on how to design this…

P10 (2.23) There is a lot of information out there it is obvious to see what is relevant to our conditions in terms of the planning input.

P12 (2.24) But by default architects should actually when they get a brief of any sort they should sit and review what has been asked for and actually look at those things. You get my idea – look at precedents – American or whatever.

P9 (3.34) What about software? If there was a software program. I mean these - Revit and things are already thinking and calculating the volume of materials when you draw you already start calculating the project’s materials - is there not software or aspects of software that can be brought in, that when you design a roof over a swimming pool it is going to throw out a whole lot of red flags and say have you thought of - so that the architect doesn’t have to – some things are done for him by the design programme.

P10 (3.35) I think the trouble is the detail that you need for that to do it, it is too late in the process. When it comes to the technical stuff - some of it can happen yes, but I think a lot of these things have to happen even before you get to the detailed design. It is more in the concept, it is in the ideas, it is in the thought process. You need to tackle these things before it goes on to the computer or a piece of paper. It is a whole process that you need to go through – like call up a list, I have done this one, I need to do this one….

The range of key inputs generated by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but in terms of a model the question arises as to ‘what is their purpose or what are they being ploughed into’?

5.2.2 Theme 2: The search for a model framework

This section embraces the second structured question being: ‘What would be considered a suitable framework for a ‘designing for construction health, safety, and ergonomics’ model?’ An extensive discussion took place and interesting framework possibilities emerged.

The following items portray a need for the framework to be ‘broken down into smaller bites’ and specific ideas were generated:

P10 (2.3) Could it not be a tick box check list of some sort, where you have highlighted all the key issues and things - or some sort of assessment matrix, and if it’s showing high risk then it’s something you flag to take further.

P10 (2.14) Take a step back to the previous topic – your consultants, your professional team and how it is appointed or put together - the risk there becomes enormous, an ever increasing thing. Where the appointment is made by the client not based on competency or experience, the risk to the designer goes up like that. In a lot of these state issues where it has been appointed for other reasons, the designer has got no control over the competency of the other professions.

P12 (2.15) And I think that is probably one of the tick boxes.

P3 (2.3) I think that framework needs to be broken down into smaller bites. If you are going to give a guy a document that is massive, there is no way that he is going to have the time to look at it. He is going to be aware that it is there, but if you give a framework that is broken down into bite sizes – things to think about at the design stages, things to think about the working stage, things to think about when the contractors on site, that you can refer to. I think that's going to be a lot more useful than some massive document. That's why you will find there are probably a lot of guys that aren't even looking at the Construction Regulations right now. It is just too cumbersome.

Ra (2.4) So you are suggesting while you're designing or if a problem arises on site, you can target a specific area and say 'that's what I want to look at'.

P3 (2.5) Yes

P6 (2.11) Your building regulations (NBR) stipulate a lot of safety stuff about your trench widths and heights of your handrails, those issues related to health and safety.

Ra (2.12) So building regulations (NBR) are considered during the design process?

P7 (2.13) Your municipal bylaws as well, not that they'll override them (NBR) - there might be certain bylaws that you'll have to abide with as well.

P9 (2.39) I think in a certain way, the NBR set out guidelines, otherwise how would we know a wall needs to be 6m long without a support, you wouldn't know about it, unless there is a regulation set about it.

P10 (2.40) Your local town planning regulations, they have a huge impact on your design.

P9 (2.41) Yes, I think primarily the NBR and some of the bylaws.

P12 (2.42) Yes, I think the National Building Regulations, but then the other problem is some of the local authority people do interpret things differently as well.

P6 (2.22) I don't think we need to re-invent the wheel. We should just possibly use what we can and adapt. Not adapt, but modify it to suit.

P2 (2.23) And use the existing structure of whatever the document is.

P3 (2.24) It might have existing framework to it that works.

P10 (2.45) To come back to having some matrix or tick-box - you need to take cognisance of all these things, are you compliant, if you are not there is a process that you have to apply. It is really putting together a list of all the things that effect, or could affect the issue, and then it's a thing – are you within the parameter or do you have a circumstance that needs you to take additional precautions.

P9 (2.46) A tick box was mentioned - and I am thinking of along the line of a procedural manual that would form the broad outline.

P9 (2.51) Do the existing construction regulations not form a framework? I must ashamedly admit I am not that familiar with them to say that they do, or they don't …

Rb (2.52) As far as the Construction Regulations go, and my limited understanding of them - they are basically telling the architects to get out there and design for construction health and safety which incorporates ergonomics, but they don't really guide how to do it. They tell you it's your responsibility but they don't help you to do it.

P10 (2.53) That's right. They're also telling the client that he has a responsibility.

The life-cycles of buildings were brought into the equation:

P10 (2.80) The framework will have to look at the life cycle of the building not just the design and construct phase.

Rb (2.81) ... and the life cycle constitutes?

P12 (2.82) I would very much say the client …

P10 (2.83) From concept to final demolition. There a lot of buildings that go through three, four cycles in their lifespan, and it's becoming more complex.

Although incorporated as a 'cross boundary' possibility into Theme 1 'key inputs', the discussion of the CDM regulation actually transpired within the Theme 2 'framework' discussion. It is repeated here for consideration:

P1 (2.17) Can you actually give your definition of CDM, or what do you see as CDM?

Ra (2.18) CDM are your UK Construction (Design and Management) Regulations - the 2004 version and I think the latest is the 2007 version, I don't think it's evolved any further than that, but yes CDM certainly - the use of it - it does apply to the design process and the management processes or the rest of it. Are you all familiar with CDM?

P1 (2.19) That's what I mean, I have an idea of what it is, I'm not sure if anyone else does.

Ra (2.20) I hear exactly what you are saying now with CDM, your Construction (Design Management) Regulations were specifically developed for the UK market. Are they adaptable to SA? To what extent and will that work, how cumbersome are they? Or why don't we just pick up the pieces and bring it to SA and use it. If you just go back to my title, which is in SA, we are looking for something which is suitable and could possibly encourage engagement from South African architectural designers. So maybe what you are saying about CDM we go back to our original question, or previous question as one of the key inputs?

P7 (2.21) It was mentioned, not the specific document. It was mentioned - something from another country, but it must be adaptable for SA.

The facilitator made an attempt to broaden the discussion and to solicit further responses:

Ra (2.25) (Excerpt only) … Is there a professional body which guides architectural designers?

P1 (2.26) That's my other question. Say you were to be judged as being negligent in terms of health and safety or construction design, or designing for manufacture on site, who would that person be and how would they audit you? What terms of reference could they use as you went past this stage and didn't do x, y and z? How could they prove that you didn't do x, y, z for instance?

Ra (2.27) Well they are not going to say - I do not know who that person would be, the 'policeman' whoever he is? Could he not say, show me your documentation to prove that you considered it?

P1 (2.28) I'm kind of asking you the question, but I don't have the answer (A deviated discussion ensues).

Ra (2.35) I do understand that. We're dwindling off the topic a little bit, and we have time limits. We are looking for a framework for a model and certain documentation has been discussed. Is there a professional body which guides architectural designers? This has ended up as a pretty broad discussion, which is all good. But looking at a professional body - is there anything that they've got to guide the design process? (A deviated discussion ensues)

Rb (2.26) Is there a professional body which guides architectural designers?

P9 (2.27) There is a compulsory body which is SACAP and to practice as an architect in South Africa you have to be registered with SACAP in whatever category. Then there is a non-compulsory body, there might be more, but for the PR Arch there is the SA Institute of Architects with its pillars like in the Eastern Cape we have the ECIA. For non-professional architects there are bodies like SAIAT, the Institute of Architectural Technologists. So there are bodies, but do they support the design process – possibly?

P10 (2.28) They don't monitor and control it, they - especially SAIT - provide a lot of information.

P9 (2.29) They do also foster awards, like recognising excellence in design…

P10 (2.30) but they do not review or crit, or comment on…

P9 (2.31) but they have articles – they feature buildings and sometimes they criticise the buildings and…

P10 (2.32) but it is not a case of you submit your design and the guy says ok.

P3 (2.46) I don't think so - not in terms of safety.

P7 (2.47) If you are talking about SACAP (professional body) and SAIAT (voluntary association) is that the body you are referring to?

Ra (2.48) Umm, yes?

P7 (2.49) Well they don't have it, definitely not in East London.

Ra (2.50) I am not talking about health and safety, I am talking about the design process.

P7 (2.51) Yeah, I know. Again there might be a review amongst people, but I don't know if there is an official professional body. I don't know.

To keep focus and gain deeper insight, the facilitator backtracked to the NBR and provided a probing statement, based on the provisional studies, which generated much discussion:

Ra (2.52) (Excerpt only) … 'The framework of the NBR reflects an ideal framework for a model'. I'd like you to respond to that statement?

P7 (2.52) Can you explain the framework of the NBR then?

Ra (2.53) The NBR has broken down as you know into parts and most of the parts reflect - apart from part A reflects administration as you probably know, while most of the other parts reflect building processes or building components.

P7 (2.54) That's what we said earlier, maybe there is another 'part' to it.

P3 (2.55) I think it could be, if we take for example if we take any one of the parts – the part on walls for example - if they are brought in a section in the part - when it comes to safety in terms of the construction of the walls, which is all in there in terms of designing a structure and things like that. If you think about what happens if they are building the wall, what do you have to design that they can in fact build it safely safety? Maybe these things need to come into each sections, so I would say ...

Ra (2.56) So you could integrate safety into each of the components is a lot easier than...

P3 (2.57) So it would be a lot easier for an architect to pick it up there than have a completely separate document, which is going to sit there on your shelf and one day you may look at it. It is a possibility.

Ra (2.58) Ok, so you're telling me that Architects, when they consider walls for example we got to add the consideration of health and safety into the design aspect of the wall. Ok, that's interesting enough – any other comments on that statement?

P6 (2.59) If you have the NBR electronically, we can just cut and paste it onto our drawings (chuckles all round).

P4 (2.60) All these documents become quite a thing to deal with, I tried to work through them on several occasions; it is over a 100 pages long where the previous version was about 20. If you add a couple of pages to each section would be better. I think for the checklist, those are all functional requirements and for we as designers when you first sit down to design those are conceptual items you need to consider. Maybe a very simple checklist could be a way to focus on these issues.

P2 (2.61) Maybe that refers back to the National Building Regulations and the categories?

Ra (2.62) Ok, so the density of the document as you put it, becomes bigger and more cumbersome as we add things to it. If that is a concern would a parallel document recognising those parts work so that that you could...

P4 (2.63) (Nods) We already understand the framework.

Ra (2.64) You already understand the framework. Ok, so using the framework as a parallel system?

P4 (2.65) (Looking at P3) I know what you are saying about a separate document. It just kills me if it's going to disappear into a bigger document.

P3 (2.66) When you're busy designing you go and check the National Building Regulations for certain aspects, then you forget that maybe at the end of the document there is a section towards safety. That is why I argue to make it a specific section of the document might be a good idea to make an architect or designer aware that there are safety aspects that need to be looked at.

Ra (2.67) Very possible … further down the road, at this point I have no intention to try and ask for anything to be put it into the NBR. I don't think that is my purpose at this point.

Ok, can we concur that the NBR structure might form part of the opportunity for a model framework?

P2 (2.68) What if it is something like XA where you have certain regulations that you have to comply with. Do we not comply - ok refer to a SANS 204, in other words go and refer to the safety model. If you have any concerns about the design you have to refer to additional documentation.

Ra (2.69) Ok, so it is a reference to different aspects – cross referencing.

Rb (2.64) If I can call us back to the framework. I have one or two statements here as opposed to questions, and maybe you can respond to my statement - The framework of the NBR reflects an ideal framework for a model - National Building Regulations.

P10 (2.65) If you just look at the headings, yes. When you look at the NBR - if you just look at the index it'll cover the points.

Rb (2.66) The breakdown of the parts?

P10 (2.67) Yes, but don't look at what is in it - they just serve to confuse the issue because one of the greatest problems with that is the parts don't talk to each other.

Rb (2.68) So the parts could form a framework?

P12 (2.69) It could probably, but I would not use that on it's own.

P10 (2.70) If you come back to where you have a list, that document, when it's finished, the index would provide a list of items. But it does not cover everything, this is the problem.

P9 (2.71) It does address aspects of design. The depth of excavations as an example comes to mind …

P10 (2.72) There's a gap in the front – but once you get to the technical side there is a lot of relevance.

The discussion veered off track and the facilitator intervened:

Ra (2.81) Gents, what you are discussing is absolutely relevant and I am capturing it. I am just bringing you slightly back to order for a moment. This feeling of the NBR, and yes I take cognisance of awareness of risks and notification to contractors and whatever, do we think the NBR breakdown constitutes a framework?

P4 (2.82) Definitely (nods from numerous participants).

With discussions leaning heavily toward the NBR, the facilitator looked toward alternatives and focused on the earlier mentioned SACAP as professional body:

Ra (2.83) Ok, just to further that before we get off this question. It's another probing statement: The SACAP stages of work reflects an ideal framework for a model. Slightly contradictory, but it is a statement.

P3 (2.84) Ja, it can.

Ra (2.85) It can?

P6 (2.86) Just read that (statement) again.

Ra (2.87) The SACAP stages of work reflects an ideal framework for the model.

P7 (2.88) Ja, I agree with that.

Ra (2.89) Which goes back to the question of does the professional body guide the design process? So if we are agreeing with the SACAP stages of work, are they providing some guidance in the design process. If you are agreeing with this statement then it talks to the previous question about the professional body, but anyway the statement on the table is 'the SACAP stages of work reflect an ideal framework for the model'. Can we think about that for a moment?

P10 (2.85) The stages of work – that is like the summary, what happens within those stages and what are the implications. It does define the cycles up until occupation of building.

P12 (2.86) But it does not actually help us. That actually only serves so that the client understands how we claim fees and how the things actually comes together. It's really theoretical. I don't think so.

P9 (2.87) I did write earlier when you were talking, I said here concept design, cost estimate program and risk assessment. So I thought possibly a risk assessment report could be built into the SACAP work stage. For example stage 2 would be preliminary design, so you would produce a preliminary design, preliminary cost estimate, preliminary programme and a risk assessment report - which is not there at the moment.

Rb (2.88) So you are considering these risks in the early design stages?

P10 (2.93) right before anything further happens…

Rb (2.94) concept and feasibility

P10 (2.95) it is part of the feasibility…

Rb (2.96) which is stage 1 of SACAP.

This led to a discussion on what constitutes design, and its link to the SACAP stages of work:

P1 (2.90) No, can I say no, there is only one stage and that is the design stage, because its inception, its design, it's not detail design...

Ra (2.91) Is detail design not design?

P1 (2.92) If you're thinking about design why can't we see detail design as technical design, not design.

P4 (2.93) That's in stage 1 to 3 and 4 is documentation …

P1 (2.94) Stage 4 is municipal submission, which is documentation, but it's not design it's handover and completion and other stuff. The damage is done, you know if there was a risk and it was not identified you have passed the point of no return.

Ra (2.95) Passed the point of no return … Ok, we're busy building - what happens if a variation order comes into play?

P1 (2.96) Ok, but then you go back to stage one, you go back to first principles, but you are on site.

Ra (2.97) So we can consider construction, health, safety and ergonomics through the SACAP work stages but particularly early stages. Is that what you suggest?

P7 (2.98) I think for the majority, the bulk of it is Ok. If a VO comes along we assess it as part of the overall design which goes back to the beginning.

Ra (2.99) So early consideration, Stage 1, 2, 3, are we saying if we talk to the problem early in the process, you're possibly making bigger impact and see it through from there, or what are we …?

P7 (2.100) It is your design - your first few stages - it is not documentation for construction health and safety. It is design.

Ra (2.101) Let's just consider documentation for a second, what documentation do you produce?

P7 (2.102) Well it becomes the documentation we've done in Stage 4, that is your documentation about your technical, your detailing, your technical spec writing and stuff like that.

Ra (2.104) Is spec writing design or isn't it?

P7 (2.105) That's up for debate. It depends on what you define as design.

Ra (2.106) Health, safety and ergonomics - in the SACAP design stages or stages of design? Health, safety and ergonomics - if I specify something that is …

P7 (2.107) I think in the design development stage, you might know what specs you wanted to write here, I am sure you have considered your materials while designing, you might not physically write it down but you might have considered it.

Ra (2.108) But is it part of the specifications, so it touches on Stage 4?

P7 (2.109) It depends what you consider design or not. Some people would see it as design of the building, others might say detail is design. Other people say spec writing is a design. Some people say landscapers are called architects. It's all about how you perceive it.

Ra (2.110) I am glad you brought it up. Is detailing part of design?

P5 (2.111) I would say so …

P6 (2.112) I would say so to a degree (general concurrence by nodding).

Ra (2.113) Is specification part of design?

P7 (2.114) It's part of the design … It's part of making the design work.

Ra (2.115) Ok, so for what it is worth, where the designer places the breakpoint in what design is and what documentation is, but it's all part of design – is this what you're saying - to an extent at least?

P1 (2.116) Yes (nodding from participants).

With the NBR and the SACAP stages of work on the table, the facilitator attempted to establish the way forward:

Ra (2.117) Ok … so we have made two statements here. We've made a statement that the NBR forms a bit of a framework and we made a statement that the SACAP stages of work forms part of a workable framework. Which one do we lean to?

P7 (2.118) I'm still inclined to go with the National Building Regulations.

P4 (2.119) Ja, so would I.

Ra (2.120) Or can we integrate them?

P10 (2.103) I want to see - need how they see that happens, because as I say the NBR generally deal with technical issues.

Rb (2.104) Technical issues - do the technical issues get considered during different work stages?

P10 (2.105) Yes, but they might be considered over and over again. Most of them come into the early phase and then you get into the technical phase. I can't see that you can take the NBR and split them up into stages.

P12 (2.106) I can't see that happen, no …

P10 (2.107) At each stage you have to look at them or certain aspects of them.

P7 (2.121) Maybe, with difficulty.

P3 (2.122) If you think of it, you're trying to put a document together for a framework - the two of them are not really going to gel. The one is talking about parts of a building and the other one is talking about the processes.

Ra (2.123) The one is talking about the parts and the other about the processes - design processes is that what you are saying?

P3 (2.124) Yes.

Ra (2.125) So at what stages of SACAP design do you consider the NBR?

P3 (2.126) Basically all the way through.

Ra (2.127) All of them?

P3 (2.128) Ja ... your initial design concept you're not really thinking building regulations, you're thinking special relationships and things like that. As you start developing your design you start looking at that ... and as you go further into documentation stage, your detailed design and your specifications you'll look more and more at them (regulations).

Ra (2.129) So at various stages of SACAP you will consider the NBR.

P3 (2.130) Maybe not so much during work Stage 1, maybe more in work Stage 2 on.

Ra (2.131) I'm seeing an interaction of the two - Stage 3 regulation X, Stage 2 regulation B - they interact? Do we put them together as a framework, can we - is it possible or do we just stick to the NBR?

P3 (2.132) I think we'll have great difficulty in trying to put the two together. The one is specific items and the other one is processes, which includes all of those items.

Ra (2.133) So the two definitely do talk to each other?

P3 (2.134) They talk to each other but you wouldn't be able to integrate them as one.

P1 (2.235) Can I answer with two questions. One is if we integrate the SACAP side which is a professional body how does that talk to the other side of the fence with the contractor, because the NBR sits between the contractor and professionals?

Ra (2.136) Are we talking about the use of the NBR or the NBR as framework?

P1 (2.137) If you try to merge SACAP and the NBR it would favour more the professional side and more the professional 'oke' purely on the architectural side. What about other professionals - if another professional were to specify something, would they not entertain it?

Ra (2.138) This is a model for architects to use for designing for construction health, safety and ergonomics - and as somebody here said earlier, we need to think about what the contractors are thinking and what the contractors need and whatever - but the focus is on the architecture, and obviously or presumably the architectural designer would be thinking about construction during the design process. So is it a separate entity?

P1 (2.139) I just think it would be difficult to - because as a designer you have expertise in design and someone who works on site has expertise in construction. I don't profess to know if I was doing a large scale plan, I am thinking non-domestic now, I wouldn't know how to spec - maybe there are products out there that can do fancy things, I wouldn't know how to. I would spec something by trying to ask for buy-in as to how does this thing comes together? I couldn't tell him how to do it, I would be looking for people to say this is how this could come together. I would be saying but I want it like this, the client likes it like this, I've designed it like this for whatever reason. How does this thing come together - there is a risk? I couldn't tell how to do it, it is not my profession, but I will be made aware of it. How do we put it all together?

Ra (2.140) Mmmm - so we need to balance the process.

At this point the NBR appears to prevail as framework option, and the participants find difficulty in integrating or merging the NBR with the SACAP stages of work:

Ra (2.153) (Excerpt only) … Ok, so just generally the NBR reflects an ideal framework and the SACAP stages of work reflects and ideal framework and it might be difficult to integrate them. Is that a summary of what you're saying?

P4 (2.154) Yes (numerous nods).

Beyond the second structured question, a range of responses crossed the boundaries of other structured questions and contributed to 'Theme 2', being that of a model framework.

An additional framework consideration relative to the scope of building or structure emerged:

P6 (3.42) And then again on the same topic, should we not be identifying in terms of frameworks what particular projects need more spotlight placed on health and safety than others - ok - it is just a question?

Ra (3.43) Mmm - you're talking building types.

P1 (3.47) (Excerpt only) … what accidents or risks were out there, what risks need to be mitigated. Then again, I don't think on domestic scale but multi-storey yes, but not domestic scale …

P10 (1.3) The construction industry is broad based, so you go from domestic, to institutional, to industrial, to commercial, to high rise, and then to specialist projects. Each of them, to my mind, have totally different requirements in terms of project design.

P10 (1.16) Well obviously the first thing you are looking at is what the client's requirements are or what are we designing - and it goes back to the type of facility that we are designing and depending on what that facility is there is a risk factor that comes with it, whether it is a residence, are we designing single story, double story, multi-story, is it high-tech is it low-tech?

P10 (1.18) Yes, site, the site, is it urban, is it rural? One of the biggest risks you have in the rural areas is that getting to the site can be a problem … (Excerpt only).

P10 (1.20) You've also got to take into account what are the specific needs for that facility. I mean is it just a residence, fine. Is it a high-tech thing that needs lots of insulation or special conditions in the building that affects design too.

P10 (3.7) Again – what are you wanting to consider? When you look at the ergonomics and all the rest, what are we looking at - how are the guys going to build it? So right up front we are making a decision as to the kind of structure we will use.

Rb (3.8) So once again it is building type?

P10 (3.9) It's building type – or not building type, but construction type.

The importance of the SACAP work stages re-emerged relative to a discussion on 'H&S experts':

P6 (4.12) Ja, but they are also more experienced in what they do, because that is there job. So in terms of the design they can certainly give us pointers that say on this design stage these are the points you should look out for...

P2 (4.13) But generally they only come in at contract stage...

P6 (4.14) Yes, I know, yes, they know already what the problems are...

P2 (4.15) They should be more involved in Stages 1, 2 and 3.

Ra (4.16) Ok, interesting, anything else in terms of knowledge - what knowledge do we have and what do we need? Think about that.

P7 (4.17) I think we mentioned that with a thorough site investigation, it is still part of the first stage, how do you tell the H&S guy what you're about if you haven't investigated what you want to do? It is the same as engaging all the other dudes.

Ra (4.18) You’re are talking about the stages and you are talking about the sites?

P7 (4.19) So it is up the architectural person whether he engages with the H&S guy at stage 1 or 2 or at what point. If you go to stage 3, and you haven’t got him in yet, and he comes and let’s call it ‘bugs’ your design, because you haven’t considered H&S regulations - then it’ll be a bit silly.

Ra (4.20) You are talking about site, you’re talking about structure, you’re talking about design stages, I am seeing a continual link between the design stages and the SACAP - I mean the SACAP design stages and the NBR components?

P7 (4.21) If you’re talking about design – then we’ve got to – got to consider it.

Ra (4.22) Yes, I’m just commenting. Anything else?

P8 (4.23) I mean if you look at the SACAP stages, as he said it is a process and the first stage is the appointment of consultants, whether it is a structural engineer or a H&S specialist, it encapsulates that, it doesn’t not encapsulate it.

Further ideas relative to a model framework were generated in the concluding discussions, which asked participants to ‘assemble’ a model on the provided flipchart.

The link between the NBR and the SACAP stages of work, and the importance of the SACAP stages of work becomes clearer:

P7 (9.40) (Excerpt only) … That might include the NBR as one whatever its going to be called if it is a separate SANS or whatever? From there he has gauged information now in a very broad sense, as part of inception, and from there he is going to, as part of his design process, be focussing obviously on health and safety … This is really Stages 1 to 3 … there is a very clear line between work Stages 1, 2, 3 and work Stage 4 … documentation … specifications etc…

Ra (9.47) So you are referring to what we have spoken about earlier where the health and safety design aspects can come in pretty early, in Stage 1 to 3 which is the SACAP work stages?

P7 (9.48) If it's (H&S) going to be a major shareholder it needs to come in early - it depends how serious this is, if it is not that serious maybe it can come in further, but I hear you're talking about designing.

Ra (9.49) Early stages you say?

P7 (9.50) It's early stages yes, so in stage 4 is monitoring and change, in other words 'tweaks' as whoever was saying. We're not getting everything, so just now an engineer would say, you know what, that beam needs to be 600 not 300 or whatever it is. So if possible tweaks as health and safety but it is more monitoring and that goes right to Stage 5, right through. The end process - work Stage 6 which could incorporate stuff like document findings, in other words you documented the project, it is now being built - you've done your findings and now you are going to recycle it back into the industry from a point of view of updating that.

P7 (9.58) (Excerpt only) … we get to the point of the in-office situation, and this is where we come to our 'model' if you want to call it that.

Ra (9.59) How to design?

P3 (9.60) Yes. This is where we come to our checklist. In the checklist we have an issue of when do you check, ok, basically each work stage … your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report …

Ra (9.67) Give me some examples of what you might be checking?

P3 (9.68) Well, ummm, well heights of buildings. Maybe what should come in here, not just Construction Regulations but also have to be NBR as well - very important, I think. It needs to come in here as well. Then from that training, a document needs to be put together highlighting issues that have come out of there, so the guy can always be aware of it when he is busy designing. That checklist doesn't have to be static, it can become bigger and bigger as things get added to it.

Aspects or components relative to the NBR were brought into the discussions:

P12 (1.49) (Excerpt only) … you should also think of the building or whatever type of structure it is being broken down in different components. Yes, if you go up it is hazardous, but once the structure is up then the specification and application methods if you can call it that - of things like floors, walls, ceilings, that kind of thing, then I think there is more scope of probably specifying or trying to design a better solution …

The need to somehow integrate or merge the NBR and the SACAP stages of work becomes more apparent:

Ra (9.73) In the earlier discussion the NBR came out as a possible framework and both yourself and the previous speaker have spoken about the SACAP stages as well somewhere along the line?

P3 (9.74) That's where you go back to this process (refers to flipchart) here - when do you check, which work stage? In each work stage you have to check - after each work stage you pick up your checklist and you go through.

Ra (9.75) You are talking about NBR, the arrow, does that relate to the checklist?

P3 (9.76) I would say 'yes', because what is in there needs to be in here.

P7 (9.77) Health and safety is part of it.

Ra (9.78) So that is part of the framework really, we're going to check accordingly. Ok- I'm understanding it now.

P3 (9.79) To link your processes and your NBR which is specific parts of the building, the process would be - we use a checklist at the end of each stage.

Ra (9.80) So parts of the building are important?

P3 (9.81) Yes, the parts come in here, so when you are doing your work Stage 1, you're almost finished with work Stage 1, of course you have been thinking about it while you were doing the project, then you do your checklist and make sure that you have dealt with all the issues in work Stage 1, and each time you get to another work stage completion, you do the same thing again so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

Ra (9.82) Very interesting!

P3 (9.83) Then you have one checklist. You don't have a massive document - it might get quite big - I mean your NBR has got how many parts in it – at least 24.

Ra (9.84) So it is a checklist which you can look at after each work stage?

P3 (9.85) At each work stage – Ja (Colloquial 'yes'), and then you are combining your processes with your items as well.

The model framework issues generated by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but in terms of a model the question arises as to 'what system or process could be followed within a framework'?

5.2.3 Theme 3: The search for a working process

This section embraces the third structured question being: 'Within the suggested framework, is there a process which can support 'designing for construction health, safety, and ergonomics'?

The responses and discussions which follow portray a range of possible supportive processes:

Ra (3.1) We have two discussed frameworks, and is there a process that can work within one of those?

P1 (3.2) What we have used before is the process where the contractor produces method statements after you've identified any risks on site. Like using your NBR specs to call for these statements on parts A to X addressing your risks - the walls are higher - obviously temporary bracing - you have designed wind posts at whatever centres to support the walls during construction while the material hasn't gone off – how does he temporarily prop those to create a safe environment around it, should it fall, etc. So we can call for that at construction stage - or prior to an operation happening.

Ra (3.3) In terms of process, I am thinking from a design aspect - can I maybe ask a question - a probing question: Do architectural designers attempt to finalise the status of their designs at each stage of the design process before progressing? Each stage now for example your SACAP stages as mentioned before.

P3 (3.4) I find it very difficult - there is no cut-off point. It is backwards and forwards processes until you get to the final. You can't say I have now finished Stage 1, I can carry on to Stage 2. The ideal of course would be to say I am finished with work Stage 1, work Stage 2 now it is the final stage of development, call it if you want to preliminary working drawings if you want to.

P10 (3.3) You go back, it is a constant review.

The facilitator made an attempt to broaden the discussion and solicit further responses:

Rb (3.4) During this constant review situation, is there opportunity for inclusion of health, safety and ergonomics considerations?

P12 (3.5) Of course yes.

Rb (3.6) Any suggestions as to how?

P10 (3.7) Again – what are you wanting to consider? When you look at the ergonomics and all the rest, what are we looking at - how are the guys going to build it? So right up front we are making a decision as to the kind of structure we will use.

Rb (3.8) So once again it is building type?

P10 (3.9) It's building type – or not building type but construction type.

P9 (3.10) The question is – Is there a process to support safety in design. At the moment is there a process? The answer to that is probably at the moment – No.

P7 (3.6) I think it's automatically there in varying degrees. I did a house once where I specified a large pane of glass. I didn't consider how the hell they'd get it to the first floor. So yes, the next time I design a house I'll consider how and chat to the contractor. I think sometimes you work through the stages and other times you work to your own initiative.

Ra (3.7) Is there opportunity to scrutinise the design in terms of health, safety and ergonomics?

P2 (3.8) Are you referring to like a checklist?

Ra (3.9) Mmmm - it might include a checklist if one exists, or existed at some point, but from a designer point of view could anybody sit down and say ok I've done my design to a certain stage, is it possible to sit down and look at my design and ask myself health, safety and ergonomic questions?

P3 (3.10) I think it is very possible to do it.

P12 (3.15) If the designer can refine the design and say there might be better processes or whatever the case might be to achieve the goal, one needs the knowledge. So those kind of things in the mechanism whether via consultation, whether the client says we must use that guide or that process whatever the case is, so I am jumping now, but that is the kind of thing to support the design. They do feed in. Design is very much an animal which you are dealing with, which is not a fixed thing.

Rb (3.16) So just to cut back to where we were, there is opportunity for inclusion once…

P10 (3.17) There is opportunity for inclusion - whether the client accepts that is another story.

The concept of a checklist arises yet again, and the discussion includes the NBR and the SACAP stages of work:

P7 (3.11) I am thinking about a checklist, if you have it as an addition to it. Like people specialising in SANS 204 (NBR) - if they can check your drawings for example, it might be a good idea if they check it from a specialist point of view to see if you have the finer details right. There might be somebody in your office or a specialist out there which can do it as part of the process. I am kind of reading through it, meeting him once a month and then we can go through the health and safety issues as much as you need someone or a professional specialist in the SANS 204 regulations, as much as you find you can have specialists in anything - you may have a mechanical engineer who can become part of your process before you put that Stage 4.1 together as part of your final drawings, now can we go back to where is it pertinent or more pertinent in the first 3 stages. By the time you get to the structure of the building I think it can be part of the process, part of the design. You need to possibly know it yourself very well, or if you're a bit rusty on it you find someone who knows more than you - if there is a document to follow – a document or framework.

Ra (3.12) So do we concur that there is opportunity to sit down and scrutinize our designs as we progress - when and how could we do that?

P6 (3.13) Is it not something we're already doing – is it not part of the design process? It is not like kind of we have to like say now health and safety has to come into it - Is it not part of the overall design process?

Ra (3.14) Mmm - It should be, it is not being done, but it should be.

P7 (3.15) It depends on the extent to which you want it to be done.

P9 (3.19) Yes of course, and I think a lot of this happens subconsciously to the architect because it is part of the design process. I would say probably in 99.9% of the cases, elements of health and safety are solved not by design but by technical aspects of construction – example - The Newton Park swimming pool that I was involved in as the Project Architect, we were told that we couldn't drain the pool, because the area had a high water table, so we had to leave the water in the pool, but we had to cover, we had to roof the pool. So we knew we had a pool however many metres long which we could only use one span across, the engineer solved this with a triangular girdle, made up of three pieces, not because of health and safety but because that was the longest piece of steel we could get. He bolted the three sections together, then to span the pool crosswise we had to span it obviously clear span, again a steel girdle, now the water in there we didn't consider health and safety at all, but we solve the problem by just getting PE's biggest crane which came and lifted these things right over the roof of the pool and drop them down on the other side. So…

Rb (3.20) subconscious …

P9 (3.21) Yes, we knew obviously that the water was a risk and the steelworkers were going to be working above water and the fall was about higher than 30m high, or whatever it was that they had to fall before they hit the water and heaven knows they were full of kit so they would have sunk like a stone. Those aspects actually never came into the design, we knew we had to span the clear span and we made this girder and we found the biggest crane that could lift these trusses and drop them over.

P11 (3.27) There is also something that if you are working on a project for instance where let's say it is an extension to an existing building, the client and tenants are not going to move out. Say for instance the PE airport when we worked on that, that thing was done in phases. We have actually developed from the architect side which area are we going to work in at what stage, and by doing that a lot of issues also got resolved, because you don't only have to think of public safety, it's people that were working in the building plus the actual contractor's staff.

The facilitator draws on the possibility of an administrative process, and issues of responsibility come to the fore:

Ra (3.16) Yes – your 'glass' was a very good example by the way. Is there anything we can introduce to facilitate the administration side of designing for construction health, safety and ergonomics?

P3 (3.17) We must try and get away from the administration side of it, nobody has time and we are not getting paid for it – so at the end of the day rather incorporate it in the design process – in design thinking, rather than in an administrative 'thing' that you need to go through. I'll rather do that though than produce more paper.

Ra (3.18) I am not suggesting a specific magnitude of paperwork or anything like that, but for instance talk has been made about a checklist.

P3 (3.19) If we speak about a simple checklist – then it is fine - If it's too detailed it will never work.

Rb (3.36) Call up a list. This is on your administration side of things.

P10 (3.37) The last thing we need is more administration.

Rb (3.38) Is there any documentation which could be introduced, remembering this is 'process', to facilitate designing for construction health, safety and ergonomics?

P9 (3.39) Yes, there are some guidelines. The existing SANS 10400 XA are pretty much guidelines and a similar thing for health and safety would definitely work.

P12 (3.40) Most definitely.

Rb (3.41) Similar to SANS.

Ra (3.20) Ok, so something - we are not talking about the extent or magnitude of paperwork, but something like a checklist may work.

To go back to your question earlier (P1), who monitors this and who keeps check on it and all the rest of it, and if something does go wrong - can documentation not assist you in proving that you have considered health, safety and ergonomics?

P3 (3.21) Ja, it probably can.

Ra (3.22) So you can protect - you feel you can protect yourself somehow?

P9 (3.45) If there was an HSE assessment report as part of your report to the client - or if it forms part of the submission to the local authority – or if the local authority had a tick-box of things you've complied with like NBR and …

P10 (3.50) I think what you got to do is you got to have a health and safety review, don't forget he has to provide a plan and he has to identify at that point are there risks and if he points out there is a risk in the way the design and construct has been requested, if he points that out to you don't respond to it, then I seek that there is…

P12 (3.51) Of course yes, then there is most definitely …

P10 (3.52) … there is a problem, but if he doesn't point it out it becomes a grey area, and again it has to be looked at in terms of what is accepted practice – if what you are designing is within the accepted practise it is very difficult to be able to say - but if it is no that it is an unsafe practice - then it is a problem. The contractor as part of his responsibility should be reviewing what you ask him to construct.

P9 (3.53) Possibly then there needs to be - as part of our contract administration - almost like an agreement. Then I go back to this, I like this tick-box thing, but if you sit down as architect and contractor, the contractor goes through all these things and he signed to say that he has reviewed it and that there are no risks.

P10 (3.60) It also goes around your health and safety plan that you issue at tender stage. So you are identifying the risk. The problem comes in when you haven't identified a risk.

Rb (3.61) Who identifies it – the designer?

P10 (3.62) The designer.

P9 (3.63) Right there is a major problem, because the health and safety specifications that we are putting out, I suspect if it landed up in a court of law we would fall seriously short, because we are not qualified. From the municipality side we've got a standard health and safety specification to literally put out irrespective of, and I think if that comes to a court of law you are going to have serious problems.

P10 (3.64) What we have done is we write a project specific one, you know if the client - there is the client spec and there is the project spec and this overwrites what is in the clients spec.

P4 (3.23) I found with the Part A application form it is a very frustrating process, it is in fact a very interesting exercise – every time having to force yourself to go through it. I think it is like structured - it could initially raise one's awareness of what to think about, just to keep on reminding yourself.

P2 (3.24) And take on responsibility there - you should possibly have an additional part where somebody is responsible for that - like there is an engineer responsible for structure - a competent person.

Ra (3.25) What do they do - on the forms that you're talking about?

P2 (3.26) If somebody at the submission stage is responsible for not necessarily covering all the health and safety aspects, but is responsible for ensuring that it is done during the construction process.

P4 (3.27) I think the NBR has been stressing the point that we are the competent person responsible for these issues.

P2 (3.28) But, have we been trained to do that?

P4 (3.29) I think that's important – maybe we should be. We need to accept that we need to take responsibility for these issues in the design stage. I admit myself, I realise I am totally disconnected in the design stage from a point of health and safety. So we get on to site and see a plasterer balanced on a bucket on top of a drum on top of the scaffolding and you realise something is not right.

Ra (3.30) So there are - are we suggesting that, and we don't need to conclude exactly what, but we've got ideas of - that some administration could come in the process?

P7 (3.31) Basically the Form 2. That's what we've got to sign if you've got an agent working on site, an agent been people working under a municipal agent. They've got to have a reference book to say that they comply.

P3 (3.33) It goes back to question of administration.

Ra (3.34) It goes back to the question of administration and …

P3 (3.35) … and right now I don't think there is any way we can protect ourselves.

P6 (3.44) If administration is really going to become a pain in the butt, which it can become, and you are doing a little en-suite addition and you have to sit through that volume of admin in terms of health and safety, then I must just change my profession.

P3 (3.45) You've got to remember obviously that if your time is going to be taken by that kind of administration you're not going to re-coup your time in terms of cost – if you're going to charge your client for that, your client will say you're insane.

The facilitator probes to solicit a broader range of responses:

Ra (3.37) Just a couple of statements, I am not going to dwell on them, you can react as you wish - Architectural designers should consider H&S in their design options.

P10 (3.66) Yes (participants nod).

P7 (3.41) Also overseas there are more complicated buildings being built in the first world countries - that is more available than here. I think the complexity high rise etc. has possibly got to do with the high mortality or injury here.

P6 (3.42) And then again on the same topic, should we not be identifying in terms of frameworks what particular projects need more spotlight placed on health and safety than others - ok - it is just a question?

Ra (3.43) Mmm - you’re talking building types.

Given limited responses, the facilitator delved:

Ra (3.46) The design selection should reflect consideration of H&S. Taking your options, does your design - your chosen design out of those options - should it reflect that you have considered H&S?

P10 (3.68) Well any of them should reflect.

P1(3.47) What we used to do (participant once worked in the UK), with this legislation as it is here, the H&S officer has been appointed once you go onto site, but this has to happen at the design stage. So kind of an H&S or CDM expert should have been employed at the design stage to review documentation as a stage process and he must review it as an expert reviewed it with knowledge of what accidents or risks were out there, what risks need to be mitigated. Then again, I don’t think on domestic scale but multi-storey yes, but not domestic scale. So again that comes back to like a checklist or do you need a CDM or a H&S officer which can foresee risks, and then it would be a standard document on just how to plaster a wall properly.

Ra (3.48) Mmm - There should be opportunity for design reviews?

P4 & P5 (3.49) Yes (with nods all round)

P10 (3.70) Where?

Rb (3.71) In the design process.

P12 (3.72) By the designer.

Rb (3.73) By the designer or whoever.

P10 (3.74) I do not believe that it should be statute. You have to be very careful here because who is reviewing it? It comes back to a statement I made and this is while we have been interacting with John at the moment, and I am saying that you cannot have a guy who is a general practitioner to come and review a design because unless he is a qualified architect he doesn't understand the process. So to have some guy who was a construction management student who has now gone no into health and safety …

Rb (3.75) Okay maybe the architectural office that's producing the design?

P11 (3.76) I think it happens in most practices …

P10 (3.77) There must be an internal review.

P9 (3.78) Maybe review is the wrong word, when it is internal I am quite happy to use the word review, but when it is external maybe the word review is not right. I would not have a problem with taking a design of mine to someone like John Smallwood and him to pull holes into it with suggestions, but to review the design - and I think it is a choice of words, because architects are terribly touchy about their designs.

Rb (3.79) Review their design 'in terms of' health, safety and ergonomics?

P9 (3.80) Yes, I don't have a problem with that.

Due to the discussion losing momentum, the facilitator introduced a few quick checks based on relevant literature and the preliminary studies, and some earlier responses:

Ra (3.50) H&S checklists would facilitate the process?

P9 (3.82) Absolutely.

P10 (3.83) Yes (Participants nodding)

P7 (3.51) Yes, an easy question. Craig Goldswain to compile (chuckles all round).

Ra (3.52) H&S record keeping would facilitate the process?

P4 & P7 (3.53) Yes (with nods all round)

P9 (3.85) Yes, I think it would.

P10 (3.86) You mean through the design process?

Rb (3.87) Yes

P10 (3.88) Recording H&S decisions made. There may well be external factors that fed the choices made - let's say in a construction method. You may be making a choice that has a higher risk, because of other factors. It needs to be recorded 'why' and then how you mitigate the risk.

Rb (3.89) Recorded and responded to – that's what you are saying?

P10 (3.90) Yes.

Ra (3.54) H&S should be considered when variation orders occur?

P4 & P7 (3.55) Yes (with nods all round)

P10 (3.92) Definitely yes.

P9 (3.93) I think so. Is there such a thing as a VO (quips – laughs all round)?

Ra (3.56) We spoke about forms and signing forms and whatever - the last point here is signing off the work, or re-visiting the process, as a means of ensuring designing for H&S commitment.

P2 (3.57) The responsible person can sign it off.

P1 (3.58) The responsible person should sign it off – and then – maybe that goes to complexities. Maybe domestic we can sign off, but multi-storey maybe we don't, and an expert comes in.

P10 (3.95) The problem with signing off is you are signing off your documentation or your process, you can't sign off what the contractor is going to do.

Rb (3.96) Yes, we are talking about the design process here.

P10 (3.97) Okay – ja (Colloquial 'yes') - and I think the checking of drawings by the Project Architect or the responsible architect especially where you are using technicians or people who are not PR Arch's - there is a whole responsibility thing depending on the project and the ability of what that person can sign off in terms of the SACAP regulations. So on a complicated building you can't have the technician sign off and check the drawing. It is a quality control thing even if you don't have ISO there is an internal quality control process thing that is linked to this.

Beyond the third structured question, a range of responses crossed the boundaries of other structured questions and contributed to 'Theme 3', being that of a working process.

One theme which proved integral to discussions prevailed:

P1 (1.7) Some sort of tracking document - like a checklist type of thing.

P10 (1.83) It is almost a tick box that you need to say - and flag them as a hazard from 1 to 5 or something.

P3 (1.11) (Excerpt only) … Maybe as (P1), or whoever was saying, to have a checklist, a shortened version of a checklist which architects can use during the design stage, so that while he is designing he's thinking about these things.

P10 (2.3) Could it not be a tick box check list of some sort, where you have highlighted all the key issues and things - or some sort of assessment matrix, and if it's showing high risk then it's something you flag to take further.

P4 (2.60) (Excerpt only) … I think for the checklist, those are all functional requirements and for we as designers when you first sit down to design those are conceptual items you need to consider. Maybe a very simple checklist could be a way to focus on these issues.

P3 (9.60) Yes. This is where we come to our checklist. In the checklist we have an issue of when do you check, ok, basically each work stage … (Excerpt only).

P3 (9.68) (Excerpt only) … That checklist doesn't have to be static, it can become bigger and bigger as things get added to it.

P10 (1.93) (With reference to a 'geotech' discussion) … Surely it must be one of the tick boxes.

Rb (1.95) Geotech is part of the SANS (NBR) we have mentioned already … (Excerpt only).

P11 (2.5) I think a lot of it's got to do with client requirements.

P10 (2.6) I think the process comes out at the time.

P11 (2.7) At the time yes – very true - and the budget.

P10 (2.8) The other ones which obviously have a major impact is the ability for the client to define his brief at the start of the project, and I think the big risk is when the client comes to you and he does not actually know what he wants and you give the initial input and very often you get to the point of construction and he says that is not what he actually wanted.

P9 (2.9) I thought that was all of the time - isn't it?

P10 (2.10) Now everything changes and you get all sorts of compromises, so to me that is a high risk. The inability to define brief and it has impact on the designer…

P12 (2.11) The other one that I also think is very important, we as designers get also input from other consultants.

Further evidence and examples of options and selection was also evident:

P2 (1.26) Would choice of materials for design come into it at all?

Ra (1.27) Choice of materials definitely comes into it.

P2 (1.28) Research on those materials will be needed.

P10 (1.40) Your hazards, especially with chemicals and use of flammable materials or other hazardous materials. I mean one needs to understand that and the working conditions that go with it. I'll chuck another one at you, to me it yet again becomes partly a construction risk. Long-span roofing - there are very strict conditions under which it is safe to work with that sort of thing.

Rb (1.41) Especially here in PE where the wind blows (quips).

P10 (1.42) Anywhere the wind blows, but yes, to me those are aspects we should be looking at. Then again when you come to contractors and their equipment, is it the designer's responsibility - the fact that we need a tower crane or does it become a construction responsibility?

Rb (1.43) Yes, there is a fine line between it – absolutely, and it is about choices during the design process and this is the idea of the model. The model has to guide choices.

P12 (1.52) I think the line is probably where if you know that this carpet or the glue that they use for example is going to get completely stuffed up - the guys are going to float more toward the ceiling than down on the floor. You say that according to specifications you are not allowed to lay the carpet with that 'thing' until such time as the whole building has been evacuated or the doors are on or the lights are in.

P3 (1.35) I just want to give an example on ergonomics, say you are designing something that is out in the sticks where they cannot get a crane on site, and those kinds of problems and you have to design a building that has a 15m truss, how are they going to get it up? Those are the kind of things we should start thinking about. Ergonomics should also come in the study; what entails ergonomics when actually building.

P10 (1.36) (Excerpt only) … when we come to design things is where members are undersized … Its the type of material we use, the size and mass of the material, the location of material in relation to the building, especially in high rise …

P12 (2.11)	(Excerpt only) … do you know what, we thought we can do that but you know what we need 50 million skyhooks now to achieve that goal. That throws the whole thing out. You know what I mean?
P10 (2.12)	I agree, I have just been there.
P12 (2.13)	Well I am busy with it that is why I am so irritated because there's the thing don't tell me now there is a pipe running there now after three months … (Excerpt only).
P7 (2.75)	Just as a point - while you design a 10m cantilever off the building, is there a possibility during the design process that you could engage with the contractor and ask if it is it actually physically possible to do this with all our thinking, or sorry guys let's make it 5m, hence I feel engaging in it during the design process - along guidelines.
P10 (1.18)	(Excerpt only) … There are a lot of things that can have an impact on the design. If you can't get your materials there, if you have to carry it on the back of a bakkie or something, it impacts on how you design. There is a whole logistics chain …
P1 (7.18)	Excerpt only) … that you start specifying different materials or start utilising different construction techniques for certain elements, if you knew they mitigated a risks. So you'd start looking for pre-fabrication if you knew there is a risk like walls falling down for example. Then maybe new products would start coming on the market and you would specify them - like there's new greener products coming onto the market, you start specifying a greener product because there is more benefit. But that knowledge of why you're specifying it is known - if there is knowledge that whatever you're doing can mitigate risks on site, you'd start using it.
P1 (8.8)	After a while you would become satisfied that what you specified causes no risk and you become...
Ra (8.9)	So it is like a learning curve and you?
P1 (8.10)	Once you get to a recipe that you know is fool-proof, it talks to a standard – and informs the next one.

The need to review designs as work proceeds is evident:

P12 (2.24)	But by default architects should actually when they get a brief of any sort they should sit and review what has been asked for … (Excerpt only).
P10 (2.25)	It is a very important point - the review of the brief - is the client's brief realistic? … (Excerpt only).
P10 (3.70)	Where?
Rb (3.71)	In the design process.
P12 (3.72)	By the designer.
Rb (3.73)	By the designer or whoever.
P1 (9.27)	(Moves to the flipchart) We have to start the review of the design first (sketches a block with the word 'review' in it).
Ra (9.28)	Review of the design?
P1 (9.30)	Like an analytical review.
Ra (9.319)	OK, first you are going to do the design and then the review has to come in here at some stage.
P1 (9.32)	I don't know at what stage? Well, as early as possible, I'm guessing. I think we need some input here, I don't know if we are strong enough to know all the problems.
P3 (9.74)	That's where you go back to this process (refers to flipchart) here - when do you check, which work stage. In each work stage you have to check - after each work stage you pick up your checklist and you go through.

Evidence suggests a relationship between checklists and design reviews:

P10 (2.3) Could it not be a tick box check list of some sort, where you have highlighted all the key issues and things - or some sort of assessment matrix, and if it's showing high risk then it's something you flag to take further.

P10 (2.45) To come back to having some matrix or tick-box - you need to take cognisance of all these things, are you compliant, if you are not there is a process that you have to apply. It is really putting together a list of all the things that effect, or could affect the issue, and then it's a thing – are you within the parameter or do you have a circumstance that needs you to take additional precautions.

P3 (9.74) That's where you go back to this process (refers to flipchart) here - when do you check, which work stage. In each work stage you have to check - after each work stage you pick up your checklist and you go through.

P3 (9.81) Yes, the parts (NBR) come in here, so when you are doing your work Stage 1, you're almost finished with work Stage 1, of course you have been thinking about it while you doing the project, then you do your checklist and make sure that you have dealt with all the issues in work Stage 1, and each time you get to another work stage completion, you do the same thing again so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

Ra (9.82) Very interesting!

P3 (9.83) Then you have one checklist. You don't have a massive document - it might get quite big - I mean your NBR has got how many parts in it – at least 24.

Ra (9.84) So it is a checklist which you can look at after each work stage?

P3 (9.85) At each work stage – Ja (Yes), and then you are combining your processes with your items as well.

P7 (9.86) That checklist might be added in your office as your work experience allows you to check while you are busy.

P3 (9.87) And then as you go through your checklist, you are going to say ok right at this stage I need my specialist in here.

From an administrative point of view - that of legal protection:

P1 (2.26) That's my other question. Say you were to be judged as being negligent in terms of health and safety or construction design, or designing for manufacture on site, who would that person be and how would they audit you? What terms of reference could they use as you went past this stage and didn't do x, y and z? How could they prove that you didn't do x, y, z for instance?

Ra (2.27) Well they are not going to say - I do not know who that person would be, the 'policeman' whoever he is? Could he not say, show me your documentation to prove that you considered it?

P1 (2.28) I'm kind of asking you the question, but I don't have the answer.

P12 (3.57) If there is an incident and I think there is a lot of these guys what they do is they assume they know everything - the contractors as well - that they can build anything anyhow in anyway and then if something does happen, it is easy for them to say okay it is the architect's fault or whatever the case is. What I am trying to say is the review – us making sure that the contractor understands the building and how it is going to be constructed.

P11 (3.58) The onus is on us to make sure that the contractor understands it…

P3 (9.60) (Excerpt only) … Then there is also an issue of - to show that you have in fact done that. The word that I hate but unfortunately I can't get away from it is your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report. All this documentation gets added to your close-out report to your client.

On the point of changes to design during construction:

P1 (2.94) Stage 4 is municipal submission, which is documentation but it's not design it's handover and completion and other stuff. The damage is done, you know if there was a risk and it was not identified you have passed the point of no return.

Ra (2.95) Passed the point of no return … Ok, we're busy building - what happens if a variation order comes into play?

P1 (2.96) Ok, but then you go back to Stage one, you go back to first principles, but you are on site.

P10 (2.61) (Excerpt only) … the designer is responsible for ensuring that the building is built to that specific design. The designer – nobody else can sign that off.

Rb (2.62) Yes, you are talking about no deviations.

P10 (2.63) Well yes, you have to report deviations … (Excerpt only).

The design process issues generated by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but in terms of a model the question arises as to what knowledge architectural designers would need in order to engage the said processes?

5.2.4 Theme 4: The search for requisite knowledge

This section embraces the fourth structured question being: 'What requisite knowledge would architectural designers need to have in order to engage the suggested process?'

The responses and discussions which follow portray a range of possible knowledge requisites:

P 4 (4.1) I think first off, a full understanding of the relevant information that is already there.

Ra (4.2) Anything else?

P1 (4.3) I don't think we are the experts in what risks are out there.

Ra (4.4) You don't know the risks out there?

P1 (4.5) What are the major risks on sites, what are the major hazards, what should we be mitigating against?

Ra (4.6) So you need to understand the risks and hazards involved - is that right?

P1 & P3 (4.7) (Both participants nod)

Ra (4.8) Ok.

P2 (4.11) So they engage in a much earlier process?

P6 (4.12) Ja, but they are also more experienced in what they do, because that is there job. So in terms of the design they can certainly give us pointers that say on this design stage these are the points you should look out for...

P2 (4.13) But generally they only come in at contract stage...

P6 (4.14) Yes, I know, yes, they know already what the problems are...

P2 (4.15) They should be more involved in the Stages 1, 2 and 3.

P10 (4.1) They need to have a basic design health and safety - construction health and safety background … (Excerpt only).

P10 (4.4) First one to me goes around experience and I would say that the average designer does not have the knowledge.

P9 (4.5) I would agree with that wholeheartedly.

P10 (4.6) Because we are pushing out people from university in an exceedingly fast rate, who - a lot of them are entering the market without ever being in an office. They have been doing their course with having done no practical during the course and during their holiday work, they have done nothing. Tech is even worse and you are putting these people out there and especially your Technicians are suddenly Designers now, where previously they were Technicians. They do not understand the process, they do not understand the construction process, they are not taught building construction per se anymore.

P10 (4.8) You can’t buy experience and there needs to be, and again it comes to your in-service training of some sort which is not available at the moment. There needs to be an understanding that this is part of the Designer or Architect’s roll.

Probably 10% of the Architects understand the need or process - to everybody else, it is a Whoa! I don't want to be involved.

P10 (4.12) They need to understand the construction process.

P9 (4.13) But you need the context as in the need for it.

Rb (4.14) Yes.

P9 (4.15) We need to understand - why is it necessary?

Rb (4.16) The need for it and maybe a little about the background for it and the impact it's got on society - and that …

P9 (4.17) Then yes, then definitely yes.

Broader discussion ensued, but given limited related responses the facilitator probes:

Ra (4.24) Ok, a couple of statements here … Architectural designers need to understand the causes of accidents.

P3 & P4 (4.25) Yes, as before (nods all round).

P10 (4.19) Yes (nods all round)

Ra (4.26) Ok - they need to be able to identify hazards and undertake risk assessments. We're talking about hazards and risks - would it be beneficial if architectural designers could identify hazards and risk assessments?

P3, P5 &P7 (4.27) Yes (nods all round)

P9 & P10 (4.21) Yes (nods all round).

P4 (4.28) I think that comes back to education.

Ra (4.29) Ok, it comes back to education - right - Architectural designers need to be aware of any existing design recommendations to aid the process?

P3, P4, P5 &P7 (4.30) Yes (nods all round)

P9 & P 10 (4.23) Yes (nods all round)

Ra (4.31) Architectural designers need to understand the "lifecycles of buildings"?

P7 (4.32) In other words how do you repair it in 30 years time?

P3 (4.33) and how do you get rid of it in 30 years time?

Ra (4.34) How do you get rid of it – we're talking demolition?

P3 (4.35) Yes.

P10 (4.25) Yes (nods all round).

Rb (4.26) You see these are not new comments, you brought a lot of them to the fore.

P10 (4.27) I think everyone needs to understand the construction process. We are sitting at the moment with a situation, we have a huge part of the industry that doesn't - they have no idea how that is going to turn into a building. You can't design, and design safely if you don't understand the construction process.

P9 (4.29) That is not being emphasised sufficiently even at university level. I considered myself fairly practical when I had finished varsity, because I had worked for a year and a half for Architects fulltime as well as all my holidays, barring one, while I studied and the first job that I got to do as a qualified architect, not registered, qualified – I could not do it.

P10 (4.30) I'll give you an example – we had, a couple years ago, a lady who came from UPE, a bright girl, she was asked to go and do a little old house plan and submit it – she could not even understand the basics of what was needed to submit a plan for a small thing. There is no training anywhere in the system to equip them to go and practice – it's all theoretical - everything that used to be in the courses …

P9 (4.31) I agree.

P10 (4.32) When I studied up in Johannesburg, part of our thing we had to go and build a structure, I think we built little shelters at a sports ground. I know here in PE they used to do it - they actually made the architectural students go hands-on and build something somewhere.

P9 (4.33) There must be far more emphasis on actual technical knowledge.

P10 (4.34) That has gone totally out of the thing. The Tech guys are even worse, because it is all on paper these days, it is not even paper anymore – it's a computer exercise.

Ra (4.36) Ok, so it is not only construction, we're talking about repairs or maintenance and demolition.

So, In general if architectural designers knew something about these things, it would help in the design process. Is that what we are talking about?

P3 (4.37) Ja (numerous nods)

Beyond the fourth structured question, a range of responses crossed the boundaries of other structured questions and contributed to 'Theme 4', being that of requisite knowledge. Selected responses from the first structured question relative to the 'key inputs' tend to overlap with the notion of requisite knowledge:

P6 (1.13) There is already health and safety on construction sites. One needs to adopt that, use that as a basis, and to assist with the design process. (P3 nods)

P2 (1.26) Would choice of materials for design come into it at all?

Ra (1.27) Choice of materials definitely comes into it.

P2 (1.28) Research on those materials will be needed.

P12 (1.9) Maybe the technology is fantastic for us, but then when the guy actually gets to the site it is something completely different.

Rb (1.10) So what you say it is a bit of a mismatch.

P12 (1.11) It is also a question of knowledge - what we know and what the contractor ultimately actually probably applies sometimes.

P3 (1.33) We haven't touched on the ergonomics before.

Ra (1.34) Sorry. Health, safety and ergonomics is part of - maybe we should just touch on what it is. It is part of the health and safety risk, in other words you pull muscles, damage your back, it is health, safety and ergonomics. There is an argument that says ergonomic is a focus on its own and there is another argument that says ergonomics is part of health and safety, so just bare that in mind as we go along.

P10 (1.20) You've also got to take into account what are the specific needs for that facility. I mean is it just a residence, fine. Is it a high-tech thing that needs lots of insulation or special conditions in the building that affects design too.

P9 (1.28) Knowledge, it should go in there.

P10 (1.29) Yes, it comes down to that what he is saying is...

P11 (1.30) Just the basic knowledge, generally … (Excerpt only).

P10 (1.33) (Excerpt only) … I'm talking about health and safety in the design aspect. There is a need to have the basic understanding of how these requirements impact on the designer and how the designer interacts with that …

Selected cross-boundary responses from other structured questions may be worthy of consideration. These range from regulatory matters, to international approaches and technologically based issues and include:

P6 (2.11) Your building regulations stipulates a lot of safety stuff about your trench widths and heights of your handrails, those issues related to health and safety.

R (2.12) So building regulations are considered during the design process?

P7 (2.13) Your municipal bylaws as well, not that they'll override them (NBR) - there might be certain bylaws that you'll have to abide with as well.

P1 (2.17) Can you actually give your definition of CDM, or what do you see as CDM?

Ra (2.18) CDM are your UK Construction (Design and Management) Regulations - the 2004 version and I think the latest is the 2007 version, I don't think it's evolved any further than that, but yes CDM certainly - the use of it - it does apply to the design process and the management processes or the rest of it. Are you all familiar with CDM?

P1 (2.19) That's what I mean, I have an idea of what it is, I'm not sure if anyone else does.

Ra (2.25) So we can use international models as input towards whatever becomes eventually of this? (nods from numerous participants)

P1 (2.72) If it is design, but there could be instances in the design process that you have to cater for - for climatic conditions or whatever. Designing at a place with high wind speeds and you have a façade system, so how do you get that up. So there is, I think it is identification of risks and it you have tried to mitigate once you create a system, I tried this system, that system and we can’t get away from it you need this, because that satisfies XA for example you need this type of glass and it is a big sheet of glass and it is heavy and it’s double glazed and I have to have it for that, so it gives you health and safety risks.

P2 (2.76) The contractor is not always involved at the design stage though.

P7 (2.77) Ja, but ...

P2 (2.78) Yeah, I agree he’s got the experience.

P7 (2.79) Ja, but there is nothing wrong with engaging with the contractor.

P7 (2.107) I think in the design development stage, you might know what specs you wanted to write here, I am sure you have considered your materials while designing, you might not physically write it down but you might have considered it.

Ra (2.149) ...there’s an excavation risk, you will probably need shoring - make sure it is adequately designed by an engineer.

P6 (2.150) Yes, but one has to be careful there as well, because you might exclude something, because you are also not knowledgeable enough on that subject.

P7 (2.151) Not knowledgeable enough to write the health and safety spec.

P6 (2.152) That’s correct, so there might be something you overlook, which should also be brought to his attention, about high winds and putting up scaffolding and all sorts of things - you might not highlight that. So it also comes down to your own personal knowledge in your field so you’re treading on the professional contractor and you are trying to dictate his terms. But it is good to highlight certain areas, but it’s not limited to. It might be your perception that it is a dangerous field so you bring it to his attention, but there might be something that you overlook which is equally important, but I don't think we need to write those specs.

P12 (3.15) If the designer can refine the design and say there might be better processes or whatever the case might be to achieve the goal, one needs the knowledge. So those kind of things in the mechanism, whether via consultation, whether the client says we must use that guide or that process whatever the case is … (Excerpt only).

P10 (3.31) Again this comes to the form of project plan or project process and that becomes actually more important than the architectural design, because it is a process of how do you do it safely … (Excerpt only).

Ra (7.19) Based on knowledge - ok, you'd start using it. Well...

P1 (7.20) It is linked.

P4 (9.34) In my mind one of the first things I would need is some sort of research or data resource so that I can start understanding the risk class or something for the priorities that one should focus on, so while designing, possibly statistically, what in this specific type of project - what one should bear in mind.

P9 (5.15) We need more communication, you know there is SAIA. They've got a periodical that comes out. So maybe in the periodicals there need to be articles on health and safety or maybe case studies.

P10 (5.16) I see there is a lot under the Project Management side.

Rb (5.19) Yes

P10 (5.20) There needs to be more interaction between the two.

Rb (5.21) Part of it was – are there professional bodies that can provide requisite knowledge and we have basically touched on it here before I've - sorry who was it, SAIA, who else?

P10 (5.22) The SACPCMP.

P9 (5.23) Construction Management and Project Management …

Rb (5.24) What other means are there of identifying and providing requisite knowledge?

P12 (5.25) To identify?

P9 (5.26) Electronically – articles on the internet or maybe communication via the Institutes so that they could publish it. I think there could be a newsletter…

P10 (5.27) You said earlier - the MBA should be involved. They would get the feedback from the construction side.

Rb (5.28) MBA.

P9 (5.29) There is actually a mechanism in place at the moment where there is what they call a joint practice committee, I sit in on it but from the municipality side. The Institute of Architects is represented, there are quantity surveyors, engineers and construction industry and they meet once every three months at the MBA building. Aspects like this could be discussed as well, and that then feeds through to all the members.

Rb (5.30) Are you on that committee?

P9 (5.31) I sit in on the municipality side not the architect side.

Rb (5.32) Does the committee currently discuss designing for health, safety and ergonomics?

P9 (5.33) Not designing, but they do discuss health and safety issues. Not so much designing, but that could possibly be raised, but that is a good mechanism. It is the only place really where everybody is together.

Rb (5.34) Yes, interesting.

P9 (5.35) Sorry - the other one is the CESA, it is some or the other engineering thing and they were also tied up with health and safety.

Rb (5.36) Is it Consulting Engineers or Civil Engineers?

P9 (5.37) Consulting Engineers – CESA

P10 (5.38) … I am not sure if it is construction or civil it is M&E (mechanical and electrical), all of which has a huge impact on the design and safety aspect.

The requisite knowledge issues exposed by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but in terms of a model the question arises as to what will enable such requisite knowledge?

5.2.5 Theme 5: Mechanisms to provide requisite knowledge

This section embraces the fifth structured question being: 'What mechanisms could be put in place to provide requisite knowledge to architectural designers?'

The response to this question was relatively concise and relevant responses are included below:

P3 (5.1) I don't know whether lately at university you actually go through the NBR. I know when I was studying, building regulations was something you found out only when you got out into the big wide world.

P7 (5.2) If you think what's out there, we go off the topic now, but it is ridiculous that you don't - sorry I'm only talking about a Technikon point of view – I don't know what you guys did at varsity.

P3 (5.3) Certainly, my days at varsity we never touched on the NBR.

Ra (5.4) So tertiary architectural education is a mechanism?

All (5.5) Yes.

P9 (5.1) Well obviously formal courses come to mind.

P12 (5.2) Exactly (Others nod).

P9 (5.3) It needs to be a subject which they need to pass in their final year.

P9 (5.7) It must be specific. Another aspect that was mentioned is CPD, those of us who are not covered by any - but not only to cover people who are not qualified, but to continue your learning experience.

P12 (5.8) Provided that the CPD thing actually teaches you and it is not only an attendance thing.

P10 (5.9) It has to be an interactive hands-on thing, but there needs to be a follow-up with this. Like you were saying you actually need to learn from what is going on out there.

P11 (5.10) The other aspect is, maybe it doesn't affect you so much, but a lot of these CPD courses has become a money making exercise.

P12 (5.11) That is what I was alluding to, actually.

P4 (5.7) I think CPD is probably also an opportunity.

Ra (5.8) CPD generally - how do we ensure that it is sustainable - keeping the education or CPD up to date? How do we ensure that it becomes a process?

P3 (5.9) Well we have to make it part of the curriculum.

Ra (5.15) (Excerpt only) … Could on-going research facilitate the process and make sure that education is up to date?

P3 (5.16) All the kind of stuff that the safety guys have experienced on site, that should be fed back into the education system. So the guys who are becoming out of the university are already aware of what is expected and what to cover when they design.

P8 (5.17) They will have to make it a 15 year course (chuckles all round).

P3 (5.18) Ok, so once they walk out of university they are at least aware - not going to find out in the big wide world that you start your own practise after 2 years and you still don't know all these things and then the first project that you do the whole wagon hits the wheel and you're sitting with it and you don't know what to do.

P2 (5.19) Ja, they should be trained to identify concerns in design.

Ra (5.20) Ok, so that education and training - and awareness is the other word that came out of this. Are we sort of concurring on this?

P1, P3, P5 & P6 (5.21) (nodding)

P9 (5.15) We need more communication, you know there is SAIA. They've got a periodical that comes out. So maybe in the periodicals there need to be articles on health and safety or maybe case studies.

P9 (5.33) Not designing, but they do discuss health and safety issues. Not so much designing, but that could possibly be raised, but that is a good mechanism. It is the only place really where everybody is together.

Rb (5.34) Yes, interesting.

P9 (5.35) Sorry - the other one is the CESA, it is some or the other engineering thing and they were also tied up with health and safety.

Rb (5.36) Is it Consulting Engineers or Civil Engineers?

P9 (5.37) Consulting Engineers – CESA

Rb (5.42) Okay, last touch on this page. On-going research is required to ensure development.

P12 (5.43) Ja (Colloquial yes – P11 and P10 nodding)

P9 (5.43) Yes, very definitely.

Selected cross-boundary responses from other structured questions may be worthy of consideration. Less formal mechanisms or mechanisms, which could feed 'formal' mechanisms include:

P7 (1.3) You must speak to building contractors as well … (Excerpt only) … they have what I suppose hard knock experience of what really happens.

P9 (1.72) Some of the more established contractors, not the little homebuilder / alteration guy, but someone like (company name withheld) for example - they must have a wealth of knowledge of what would constitute safe construction and I know I am taking Joe as an example. When (company name withheld) rolled their eyes many times when Joe came up with a particular idea, but tentatively he went around to their business and did it somehow, we don't know how he did it, but some of these more knowledgeable contractors have a world of knowledge.

P10 (1.73) I think you're touching on something there, we don't generally as designers take enough heed of knowledge from the contractor to consult with suitable construction industry people.

P6 (1.4) I think there is already a lot of studies that have been done in terms of the construction stage of health and safety … (Excerpt only).

P6 (1.13) There is already health and safety on construction sites. One needs to adopt that, use that as a basis and to assist with the design process. (P3 nods)

P7 (2.79) Ja, but there is nothing wrong with engaging with the contractor.

P2 (2.80) He can have a professional body or have a body that you can engage with that you can query problems and things like that. It could be a group of contractors.

P6 (4.9) I think we need to at this stage engage with bodies that are already in the H&S field - H&S experts. Although they are practically involved on the site itself in terms of the H&S to workers etc. They can also cross-pollinate with the profession to say these are the hazards encountered, in your design look for a, b and c, or make sure that you accommodate it. I think there could be cross-pollination there.

Ra (4.10) Ok.

P2 (4.11) So they engage in a much earlier process.

P6 (4.12) Ja, but they are also more experienced in what they do, because that is there job. So in terms of the design they can certainly give us pointers that say on this design stage these are the points you should look out for...

P10 (4.1) They need to have a basic design health and safety - construction health and safety background. So we have actually asked John to put a course together.

P10 (4.4) First one to me goes around experience and I would say that the average designer does not have the knowledge.

P9 (4.5) I would agree with that wholeheartedly.

P10 (4.8) You can’t buy experience and there needs to be and again it comes to your in-service training of some sort which is not available at the moment … (Excerpt only).

P9 (4.33) There must be far more emphasis on actual technical knowledge.

More ‘formal’ cross-boundary responses include:

P7 (9.58) Mmm - the designer. What piece of paper or whatever - or what things are we going to put in place to ensure that that guy – the designer - is able to do all of this stuff? I think we need to go back to our training. Training and awareness – where does it need to happen? – I’ll say it should happen at your institutions, your educational institutions - and also your CPD for the guys we were not been lucky enough to be trained in these institutions. What should they be covering in that? I think they need to be trained in the regulations – Construction Regulations. I don’t think they need to be trained to the extent that they can become professional safety officers, but it opens up a possibility for another field if they choose to change their fields. I think what also needs to go with that is examples of issues that they are going to encounter out there, so that they are aware of it at that stage already, and also what they see as the mandatory in terms of the act. What is actually required of them - what obligations will they have to deal with? I am going to call this rights and obligations of the mandatory. So those are the things about training and awareness and the things it needs to cover and then coming out of that we get to the point of the in-office situation, and this is where we come to our ‘model’ if you want to call it that.

P3 (9.70) There’s room for growth and I think if you combine that with this here into this process, before we even get to the review of the design, before you become the architect, you already got the training, you got the awareness. During the two years that you are doing your practical, you get exposed to it on sites and pick more up, and then someone who has done and has been involved in the training and awareness, can then put together your basic checklist and then that is made available through SACAP to all the professionals - which they can build upon if they want to. I think we’ll go a long way in preventing accidents.

Ra (9.71) Ok, just one question, your training and awareness, what sort of structure or model would that follow?

P3 (9.72) Well, for instance you could maybe have a subject at varsity. Those subjects could be ‘Construction Regulations and safety on sites’ or during the construction phase, or no, no, during the life of the building. So you have your current Construction Regulations which you guys really need to be made aware of. Examples of it - there is nothing that sticks more to your mind than a photograph of a guy having a leg ripped off by a crane, or something like that. And - what your rights and responsibilities are as an architect in terms of the act - as a manager and your duties to the client and obviously give these in terms of the act. NBR – I think it has to come in here - even if health and safety was not an issue, but it needs to come into varsities here. Then someone who is doing this - like a guy like you (gestures to the researcher) - should put something like this together and make that available to the profession.

P3 (9.91) Ja, (Colloquial 'yes') I think it all starts with the awareness and the training because that is where one of the biggest problems are at the moment.

Ra (9.92) So you need to take that awareness, take your training and plug it into the design process.

P3 (9.93) Yes.

P6 (9.135) I think it is awareness more than anything else at this stage.

Ra (9.136) Awareness and how to?

P6 (9.137) And how to – ja (Colloquial 'yes').

The mechanisms to provide requisite knowledge exposed by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but would architectural designers rise to the occasion?

5.2.6 Theme 6: Engaging architectural designers

This section embraces the sixth structured question being: 'What would engender architectural designers to engage in designing for construction health, safety, and ergonomics?'

Relevant responses to this question are included below:

P7 (6.1) It's exactly what we've spoken about - if you are convinced that it's worth it to save someone's life, then obviously you can engage with it.

Rb (6.9) Would architectural designers be inclined to want to save lives?

P12 (6.10) Of course yes. The answer has to be yes.

Ra (6.2) So saving lives might encourage people to engage in the process - it kind of talks to that lack of awareness that participant 3 spoke about. Would architectural designers want to take charge of the situation – be out there and say, let's fix this problem?

P6 (6.3) I think we first need to be aware that there is a problem - design related - before we actually encompass that problem, before we accommodate we should be aware that there is a problem …

P10 (6.14) They would certainly would want to drive the process, but they would need co-operation from the client.

P12 (6.15) Exactly

P10 (6.16) It comes back to where is the designer in this, and the role needs to be related to the principal agent role, because you need to have control over the other consultants to see that there is compliance. You can't take charge if you have no control over everybody else out there.

P12 (6.17) If you are only sub-consulting, in many instances, and you are not actually "chief" there is a problem.

P10 (6.18) You need to be in control of the process to be able to do that.

P9 (6.1) Increased fees would help a lot.

P12 (6.2) Thanks guys for saying that.

P9 (6.3) No, we're chatting and joking, but we were actually talking outside about this very topic. At the moment the pressure is on the architects to reduce their fees, because everyone is tendering against each other and the problem is the person who tenders the lowest fee, generally gets the job. That is the worst possible situation as the person who tenders the lowest fee does the least amount of work - he has to. So it opens it up a little bit.

P10 (6.4) I think hand in hand with this will have to come a change in call it the procurement of architectural services, because the responsibilities are increasing, and the liability is obviously increasing and as (P9) says if you cut the fees what are you cutting?

P9 (6.5) You can only cut your service.

P10 (6.6) That increases the risk that you have – you're not going through the whole process and again we come back to the SANS regulations and the requirement for the designer to sign off that the thing has been built according to - and whatever other implications come out of it. If we have, as we said earlier, a process of compliance somewhere that H&S has been taken into account that also will follow through.

P9 (6.7) I think what would increase buy-in, if it is the right word, would be a better understanding and I think to identify the need. If architects were more aware of the need to address health, safety, and ergonomic issues, I think they would voluntarily buy-in and become more involved.

A discussion on the need for specialists ensued. This is not included here, but is included in Section 5.5.10 'Additional themes arising from the focus groups'. Based on literature and the provisional studies, the facilitator probed in order to realign the discussions. The responses were concise:

Ra (6.25) (Excerpt only) … Do they (architectural designers) need to be encouraged?

P3 (6.26) At this stage, probably yes

P4 (6.27) Yes.

P10 (6.26) I think so (nodding from P10).

P9 (6.27) The health and safety aspects are considered by most architects as just another hassle when we are already in a hassled process.

P12 (6.28) Yes, very true, very true.

P9 (6.29) It is just another liability being fostered on us.

P10 (6.30)	Even if they consider them at all.
P9 (6.31)	So it is something that would need …
P12 (6.32)	They are quite good.
P10 (6.33)	They need to understand the implications why we should do it.
P9 (6.34)	They are nice people, generally (everyone laughs).
Ra (6.28)	Having a model and requisite knowledge in place will aid the process.
All (6.29)	Yes (much nodding).
P10 (6.36)	Ja (Colloquial 'yes').
P9 (6.36)	Yes, definitely (nodding all round).
Ra (6.30)	Taking ownership of the situation will assist encouragement.
P2 (6.31)	Responsibility?
Ra (6.32)	Ownership i.e. I want to do it, because I want to save lives?
P2 (6.33)	Ok
P3 (6.34)	Ja (Colloquial 'yes').
P8 (6.35)	… and need to save lives.
P12 (6.38)	Of course yes (P10 nods).
Ra (6.36)	A multi-stakeholder approach is necessary.
P3 (6.37)	Ja (Colloquial 'yes').
P4 (6.38)	Yes (some nods).
Rb (6.19)	Okay. Can architectural designers engage the process on their own?
P9 (6.20)	Probably not. It is teamwork – buildings get built by teamwork.
P10 (6.21)	I would like to add to that we need the client and we should have the contractor at the …

P12 (6.22) Ideally, ideally yes which is not always the case.

P10 (6.23) Or if it is subcontract work get a specialist subcontractor.

P12 (6.24) Yes.

Rb (6.25) Okay so the teamwork issue is what we are suggesting, the buy-in.

Rb (6.39) A multi-stakeholder approach is necessary.

P10 (6.40) Yes (participants nod).

Rb (6.41) That's the teamwork you were talking about.

Selected cross-boundary responses from other structured questions are included for consideration.

Accepting responsibility came to the fore:

P4 (3.29) I think that's important – maybe we should be. We need to accept that we need to take responsibility for these issues in the design stage … (Excerpt only).

P11 (3.58) The onus is on us to make sure that the contractor understands it…

P12 (3.59) So that he will understand that he will have high level windows and screen walls and all sorts of …

P10 (3.60) It also goes around your health and safety plan that you issue at tender stage. So you are identifying the risk. The problem comes in when you haven't identified a risk.

Rb (3.61) Who identifies it – the designer?

P10 (3.62) The designer.

Education, training and awareness could lead to engagement:

P3 (5.16) All the kind of stuff that the safety guys have experienced on site, that should be fed back into the education system. So the guys who are coming out of the university are already aware of what is expected and what to cover when they design.

P8 (5.17) They will have to make it a 15 year course (chuckles all round).

P3 (5.18) Ok, so once they walk out of university they are at least aware - not going to find out in the big wide world that you start your own practise after 2 years and you still don't know all these things and then the first project that you do the whole wagon hits the wheel and you're sitting with it, and you don't know what to do.

Knowledge and access to information could lead to engagement – and continued engagement:

P1 (7.18) I don't know if it answers the question, but I'd see that if there is this knowledge and this database, that you start specifying different materials or start utilising different construction techniques for certain elements, if you knew they mitigated a risk. So you'd start looking for pre-fabrication if you knew there is a risk like walls falling down for example. Then maybe new products would start coming on the market and you would specify them - like there's new greener products coming onto the market, you start specifying a greener product because there is more benefit. But that knowledge of why you're specifying it is known - if there is knowledge that whatever you're doing can mitigate risks on site, you'd start using it.

Ra (7.19) Based on knowledge - ok, you'd start using it. Well...

P1 (8.8) After a while you would become satisfied that what you specified causes no risk and you become...

Ra (8.9) So it is like a learning curve and you?

P1 (8.10) Once you get to a recipe that you know is fool-proof, it talks to a standard – and informs the next one.

P4 (9.34) In my mind one of the first things I would need is some sort of research or data resource so that I can start understanding the risk class or something for the priorities that one should focus on, so while designing, possibly statistically, what in this specific type of project - what one should bear in mind.

P6 (9.106) I think the whole process musn't become a cumbersome process, because we already got huge legislation on our tails and we're having to deal with all this energy efficiency etc, etc. Whatever it is must be user friendly - in doing that you will get the engagement of the architects far better.

Ra (9.107) User friendly?

P6 (9.108) Much better - the guys would want to work along with that, but if it is going to be a cumbersome effort then the guys are just going lose track.

The responses and discussions relevant to engaging architectural designers as exposed by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but the question arises as to what work improvements could be derived through such engagement?

5.2.7 Theme 7: Deriving outputs through using a model

This section embraces the seventh structured question being: 'In terms of the work performed by architectural designers, what would the improved outputs of using the model be?'

The facilitator set the scene with opening commentary. The response to this question was relatively concise and relevant responses are included below:

Ra (7.1) Of course we don't know the model yet, ok but we've got an idea of what we are talking about. Ok, we had inputs, we had suggestions for a framework, NBR or other, but what improved outputs could there be? What could come of using or designing for health, safety, and ergonomics?

P7 (7.2) Less fatalities on site I suppose

P3 (7.3) Maybe some new innovative design.

P10 (7.1) If you improve construction health and safety, hopefully you would also have better ergonomics - keep the safety side separate from the ease of work.

R (7.4) Just note the question there in terms of the work performed. What is generated by architects? Maybe we need to ask that question.

P5 (7.5) New approaches

P10 (7.6) If you are looking at the documentation that is produced, I would say less than 25% of the architectural profession produce adequate construction documentation. There is a lot of stuff out there at the moment that is effectively conceptual design and then they leave it to someone else to go make it work … (Excerpt only).

Ra (7.6) Ok, anything else? (silence) Let me ask … What documentation could reflect the benefits derived from it? - What do you produce?

P3 (7.7) You produce your design, your drawings, and specifications.

Ra (7.8) Design, drawings, specifications - can all construction hazards and risks be eliminated through the design process?

All (7.9) No

Ra (7.10) That’s a clear no – are you all in agreement with that?

P4 (7.11) Yes (nods all round).

P10 (7.10) Well it will be the specification and the procedure of work - which is your health and safety plan and your project implementation plan. You should be writing in terms of, what you were referring to (gestures to P11) - especially alterations. For any project - which most people don’t do.

Rb (7.11) Okay, so you need decent drawings, decent detailing and decent specifications to move in the right direction. Can all construction hazards and risks be eliminated through the design process?

P12 (7.12) No, it sounds stupid, but it is true.

P9 (7.13) Construction by nature is a risky business, let’s face it. If you hit a nail with a hammer you are going to hit yourself with it at some point.

P10 (7.14) You know when they did the dam in the 1930’s, we need to look at that in terms of the construction process and the whole thing where time and money drove the process and the effect it had on health and safety. The whole …

Rb (7.15) Was it positive time and money, or negative time and money?

P10 (7.16) Well they quoted for a fixed price, they had a few extras, but I mean it …

P9 (7.17) Didn’t some guys fall down the while the concrete was being poured?

P10 (7.18) Yes, and all sorts of things like drilling tunnels in the rock for the thing - the guys, because they would get like ‘speed bonuses’ they wouldn’t wait for the stuff to - the way that the American civil industry worked in that time, compared to what we would see today is horrendous – and the boss back in the office said ‘go faster, faster’.

Ra (7.12) What can designers do if they are aware of unresolved hazards and risks?

P3 (7.13) You mean at the design stage?

Ra (7.14) Yes, or when you finish the design before construction starts - what can you do if you are aware?

P6 (7.15) You need to point that out to the contractor.

P3 (7.16) Make the contractor aware of the unresolved risks.

Ra (7.17) Awareness – I think that was brought to the table earlier.

P10 (7.20) They should come up with a mitigation plan with the constructor.

P9 (7.21) As long as you identify the risks, I think the contractor can then address it.

P1 (7.18) I don’t know if it answers the question, but I’d see that if there is this knowledge and this database, that you start specifying different materials or start utilising different construction techniques for certain elements, if you knew they mitigated a risk. So you’d start looking for pre-fabrication if you knew there is a risk like walls falling down for example. Then maybe new products would start coming on the market and you would specify them - like there’s new greener products coming onto the market, you start specifying a greener product because there is more benefit. But that knowledge of why you're specifying it is known - if there is knowledge that whatever you're doing can mitigate risks on site, you'd start using it.

Ra (7.19) Based on knowledge - ok, you'd start using it. Well...

P1 (7.20) It is linked.

P10 (7.25) Yes, you must look at what is the most effective risk solution?

Rb (7.26) With the contractor. Any other ideas around unresolved hazards and risks?

P10 (7.27) It comes back to the client's understanding and accepting what risks there are and the impact on time and …

P12 (7.28) Expectations.

Ra (7.21) Is it an output performed by the work of architectural designers? The panel has told me that you produce drawings, you produce specifications - would those items reflect in there?

P1 (7.22) Yes, they would.

Ra (7.23) They would – ok anything else? (Silence: The facilitator probes for confirmation) There will be improved - ok based on this question - there will be improved design for construction H&S?

All (7.24) Yes (much nodding too).

P10 (7.31) Yes.

Ra (7.25) You think so – yes – OK, there will be improved H&S related information on building plans.

P4 & P7 (7.26) Yes

P10 (7.33) I wouldn't necessary say on the plans, but in the documentation, because it might be in the form of a specification or an execution plan, it might not necessarily be on the drawings.

Rb (7.34) Is there nothing you have done differently in the design?

P10 (7.35) You might have designed differently, but it wouldn't be obvious that it is different.

Rb (7.36) It wouldn't be obvious, but would it reflect on the drawings?

P12 (7.37) Ja (Colloquial yes – others nod).

P9 (7.38) Maybe in a subconscious way - there wouldn't be a note on the drawing.

Rb (7.39) Could you put a note on the drawing if there is a hazard or a risk that you are knowledgeable about?

P10 (7.40) No.

Rb (7.41) Not on the drawings.

P12 (7.42) Why not? Just a question - why wouldn't you do that?

P11 (7.43) I think a liability issue?

P10 (7.44) If there is a liability issue - are you going to put a note that the steel column is a danger? It is part of your health and safety spec – your report – your project plan.

P12 (7.45) No, no I am just posing a questing if you…

P10 (7.46) That is part of you H&S spec, your reported project plan - you are dealing with heavy steel members or high steel members - that is part of that. Your drawing is a technical drawing.

P9 (7.47) It could be up to the individual though - it could be a technical drawing, but it could say note this process carries dangers – see H&S plan for more detail.

Rb (7.48) Or a specification or it could refer to other…

P10 (7.49) The fact is you need a note at the bottom to say that everything on this drawing has an impact because that is a reality.

Ra (7.27) (A further probe) … There will be improved H&S related information in specifications.

P5 (7.28) Yes (some nodding).

P10 (7.57) Yes - should be not will be (participants nod).

Ra (7.29) Unresolved hazards and risks can be documented and distributed.

All (7.30) Yes (nodding all round).

Ra (7.31) Are we concurring?

All (7.32) Yes (much nodding).

P10 (7.59) Yes (nodding).

Selected cross-boundary responses from other structured questions are included for consideration.

On the point of notifying contractors of construction risks:

P1 (2.70) (Excerpt only) … I think the professional should identify risks. I think the other part should be that the contractor or someone resolving it and at least be made aware that you need to do this …

P10 (3.56) All the risks then get identified and get a method statement agreed by both parties.

P11 (3.58) The onus is on us to make sure that the contractor understands it…

To the contrary:

P1 (2.94) (Excerpt only) … The damage is done, you know if there was a risk and it was not identified you have passed the point of no return.

On the point of what documentation architectural designers produce:

Ra (2.101) Let's just consider documentation for a second, what documentation do you produce?

P7 (2.102) Well it becomes the documentation we've done in Stage 4, that is your documentation about your technical, your detailing, your technical spec writing and stuff like that.

Ra (2.104) Is spec writing design or isn't it?

P7 (2.105) That's up for debate. It depends on what you define as design.

Ra (2.106) Health, safety and ergonomics - in the SACAP design stages or stages of design? Health, safety and ergonomics - if I specify something that is …

P7 (2.107) I think in the design development stage, you might know what specs you wanted to write here, I am sure you have considered your materials while designing, you might not physically write it down but you might have considered it.

Ra (2.108) But is it part of the specifications, so it touches on Stage 4?

P7 (2.109) It depends what you consider design or not. Some people would see it as design of the building, others might say detail is design. Other people say spec writing is a design. Some people say landscapers are called architects. It's all about how you perceive it.

Ra (2.110) I am glad you brought it up. Is detailing part of design?

P5 (2.111) I would say so …

P6 (2.112) I would say so to a degree (general concurrence by nodding).

Ra (2.113) Is specification part of design?

P7 (2.114) It's part of the design … It's part of making the design work.

Ra (2.115) Ok, so for what it is worth, where the designer places the breakpoint in what design is and what documentation is, but it's all part of design – is this what you're saying - to an extent at least?

P1 (2.116) Yes (some nodding from participants).

On the point of considering H&S in specifications:

P12 (1.49) (Excerpt only) … then the specification and application methods if you can call it that - of things like floors, walls, ceilings, that kind of thing, then I think there is more scope of probably specifying or trying to design a better solution …

P12 (1.52) (Excerpt only) … You say that according to specifications you are not allowed to lay the carpet with that 'thing', until such time as the whole building has been evacuated or the doors are on, or the lights are in.

P10 (3.64) What we have done is we write a project specific one, you know if the client - there is the client spec and there is the project spec and this overwrites what is in the clients spec.

Rb (3.65) You may just be one of the few, that is why I am saying with my statements I am generalising, I am not pointing fingers.

The responses and discussions relevant to the improved work outputs as exposed by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but the question arises as to what becomes of the said work improvements?

5.2.8 Theme 8: Purpose of model outputs

This section embraces the eighth structured question being: 'What becomes of the range of outputs produced by architectural designers?'

The facilitator set the scene with opening commentary. The response to this question was relatively concise and relevant responses are included below:

Ra (8.1) We've produced all these drawings and specifications you've been telling me about - what do you do with them?

P10 (8.2) They should be part of the contract documentation.

P12 (8.3) They are actually – or not? They should be, ja (Colloquial 'yes').

P3 (8.2) We give it to the tenderers.

Ra (8.3) Mmm – tenderers?

P10 (8.5) The client and the contractor.

P3 (8.4)	And to the quantity surveyors for the bills of quantities.
Ra (8.5)	QS's for bills.
P1 (8.6)	Doesn't that start like talking to a standard?
Ra (8.7)	Which standard are you talking about?
P1 (8.8)	After a while you would become satisfied that what you specified causes no risk and you become...
Ra (8.9)	So it is like a learning curve and you?
P1 (8.10)	Once you get to a recipe that you know is fool-proof, it talks to a standard – and informs the next one.
Ra (8.11)	Talks to a standard is a good comment. Anything else?
	(silence)
Ra (8.12)	… I think you answered that to some extent, but can we just elaborate, who do they go to, plans and specifications - who do they go to?
P7 (8.13)	to a regulating authority who is responsible to regulate that industry, possibly to update current regulations for a series of projects, I'm guessing.
Ra (8.14)	Ok, authorities?
P8 (8.15)	Are you suggesting part of the municipal submission?
P7 (8.16)	Either that or part of National Building Regulations - to say that over time, from various architects, this system seems to work. So maybe we need to amend our original model to incorporate this.
Ra (8.17)	So it talks to the notion of standard or a level of operation?
P7 (8.18)	(nods)
Ra (8.19)	Ok - these tenderers – we're talking about who?
All (8.20)	Contractors.
Ra (8.21)	Contractors?

All (8.22) and sub-contractors (talking simultaneously).

Ra (8.23) So it is all the core people involving in the building industry, ok.

P6 (8.24) What they do with it, will be another issue.

Ra (8.25) Mmm …

P6 (8.26) What happens after you issue it to them - the implementation thereof on the ground - that is the next big question?

Ra (8.27) (Excerp only) … Can the information prove beneficial to future projects?

P4 (8.28) Very much so – Ja (some others nod).

P12 (8.7) Isn't that the purpose - It should be.

P9 (8.8) I would say yes, it will be.

Ra (8.29) Can this evolve into continuous H&S improvement on projects?

All (8.30) Yes (and nodding).

P10 (8.10) Definitely (nodding from participants).

The facilitator probes for reactions and confirmation:

Ra (8.31) Information should be distributed to the client and the entire project team.

All (8.32) Yes (and nodding).

P9 (8.14) If it was me it would be the entire project team (Participants nod).

P10 (8.15) They should be part of the process all the way through.

Ra (8.33) And we can add the authority in there – you brought it up. Early distribution and involvement of all stakeholders is essential.

P3 & P4 (8.34) Yes (P5 nods).

All (8.17) Yes (Nodding).

Ra (8.35) Continual operational improvement is possible in terms of design for construction health & safety.

P4 (8.36) Yes (nodding).

P10 & P11 (8.19) (Nodding).

Selected cross-boundary responses from other structured questions are included for consideration.

On the point of documentation:

P3 (2.36) (Excerpt only) … At the end of the day what it all boils down to is the designer is putting together a document that says to the contractor ...

P9 (7.54) As long as the contractor is made aware of a risk, whether it is in the bill of quantities, whether it is a special section of high risk work or something that is separately - as long as the...

P10 (7.55) It is the H&S plan (specification) it is supposed to be in there - which goes with the Bill of Quantities.

On the point of submitting plans to the local authority:

P3 (9.81) (Excerpt only) … so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

The responses and discussions relevant to what becomes of the improved work outputs as exposed by the FG discussions are synthesised with relevant literature and the provisional studies (see Chapter 6) in order to contribute to a provisional model. They have been acknowledged here, but the question arises as to whether the FG participants are able to envisage and 'assemble' a model?

5.2.9 Theme 9: Can participants 'assemble' a model?

This section embraces the ninth structured question being: 'Is there anything we may have missed, and is it possible to 'assemble' a model from the information gathered?'

The response to this question was immense and provided opportunity for the FG participants to synthesise the broad spectrum of discussions and to demonstrate their understanding of the topic – not that a true model could be expected.

The first part questions what may have been missed. Broad discussion ensued, but relevant commentary includes:

P10 (9.2) I'm sure we have – I don't know?

P9 (9.7) I mean if you wanted a 10m high wall, dammit you did a 10m high wall, you did not worry about the health and safety of actually constructing that element. You kind of left it to the contractor to resolve. I think you will understand if we miss anything, because 'all' architects I am going to suggest, 'all' architects are groping in the dark with this topic at this stage.

P3 (9.4) I think this is a new topic to a lot of us in terms of H&S in the design stage, so as a kick-off to that we are not sure if we missed anything. I think we each can think about it and maybe forth, afterwards we can come up with other things as well, but I think it is a good start off point.

Ra (9.5) Good start off point. Are you suggesting you might even have had your eyes opened to the situation?

P6 (9.6) Well, uhm... yes.

Ra (9.7) Have you been enlightened by the thought process if anything?

P4 (9.8) Yes, very much!

The second part of the question asked participants to sketch a model on the flipcharts provided. The facilitator set the scene by:

Ra (9.22) (Excerpt only) … what I would like to do if possible, is to apply our minds and thoughts as to what we've spoken about and how a model - just a rough idea or sketch on paper there - what could a possible model look like, and if we flip through the questions very quickly to remind ourselves:

- There were issues about key inputs, what goes into the model?
- What is a possible framework?
- Is there a process which can support designing for construction health, safety, and ergonomics?
- What knowledge would architectural designers need to have in order to engage the suggested process?
- What mechanisms could be put in place to provide requisite knowledge to architectural designers?
- What would engender architectural designers to engage in designing for construction health, safety and ergonomics?
- In terms of the work performed, what outputs would there be?
- What becomes of the range of outputs produced by architectural designers?

Lots of little elements which might or might not constitute the make-up of a model, but I think it has been given quite a bit of thought. Any suggestions - Who would like to drive the koki pen?

P1 (9.23) When you say a model are you looking for a diagram?

Ra (9.24) Just a diagrammatic outline of something which architectural designers could eventually use to - and it will always be only a proposal from research side, it doesn't mean it is going to happen - but a diagrammatical thing which architectural designers can use to design for construction health, safety, and ergonomics.

P9 (9.14) I've gone completely blank. I do not know what a model would look like … (Excerpt only).

The participants pondered and chatted among themselves for a while. Participant 1 came to the fore:

P1 (9.25) Ok, can I do the first one?

Ra (9.26) Yes.

P1 (9.27) (Moves to the flipchart) … We have to start the review of the design first (sketches a block with the word 'review' in it).

Ra (9.28) Review of the design?

P1 (9.30) Like an analytical review.

Ra (9.319) OK, first you are going to do the design and then the review has to come in here at some stage.

P1 (9.32) I don't know at what stage? Well, as early as possible, I'm guessing. I think we need some input here, I don't know if we are strong enough to know all the problems.

Ra (9.33) Ok, the idea is that at some point we need a review, and somehow we need to review the design. Just bear in mind that the model we are looking for might well include the review you are talking about, but it is also you are designing for health, safety, and ergonomics. Where are we bringing the 'designing' into the model? So design needs to come into the equation as well (P1 returns to his seat).

P4 (9.34) In my mind one of the first things I would need is some sort of research or data resource so that I can start understanding the risk class or something for the priorities that one should focus on, so while designing, possibly statistically, what in this specific type of project - what one should bear in mind.

Ra (9.35) Ok, so we need information to plug in, we need the knowledge and information. Should we write some key words up there? Knowledge and information - just bear that in mind (this was not written up).

Participant 7 took up the challenge and moved forward:

P7 (9.36) (Moves to the flipchart) I think when after all or certain things are in place, I am not talking necessarily about the actual process of health and safety and putting the regulation and that together, I am talking about the process of putting a building together.

Ra (9.37) Putting a building together through the design process?

P7 (9.38) Yes, so I think one would generally start with the architect, who is going to be a central figure to that. He is going to get it from above - he is going to get a brief from the client and he is going to get his own vision after getting that brief, and he will put his design together. With that goes research, we are talking about health and safety now. This is without a regulation - the regulation is kind of separate and the researcher would include his own experience from previous things. So this is design and vision after this has happened – in other words otherwise the client come to you as a ...

Ra (9.39) Just write client there (next to the arrow P7 drew) so that we know.

P7 (9.40) So you will have the client - obviously I won't have the whole thing right - everybody is feeding in bits of the process before you engage with anybody else, you take research, and part of research is your own experience it is not going through any regulation or whatever it is about your own experience not talking about the regulation or anything. In other words, you're identifying problems as part of the design process, and I'm talking specifically health and safety problems. With that, if it is in place is the law pertaining to health and safety that you got to incorporate with your research, it is part of your research. That might include the NBR as one whatever its going to be called if it is a separate SANS or whatever? From there he has gauged information now in a very broad sense, as part of inception, and from there he is going to as part of his design process be focussing obviously on health and safety, but this is where the health and safety expert if this person is not qualified with all the regulations and what goes with it, he's going to employ someone or he will get someone to come and assist him with that. So you will have H&S, your structural engineer, your QS in varying degrees - that is up to the architect at their discretion. What is the most important for them? Is the cost the most important? Does the cost go hand in hand with the health and safety spec? Is it just a ridiculous engineering issue, so again they all interact - I think it goes without saying. This is really Stages 1 to 3. I am going back to how I'm kind of used to an architectural practice where in other words, if I was working for an architect, I would be under his - I wouldn't even know about anything until about work Stage 3. I am talking about the difference between an architect and a technologist in an environment of a practice. So this - in broad terms, unless you are a technologist or an architect that specialised in this kind of a field, you won't necessarily be interacting with them at this stage. I am talking about the context of the office. So here is the architect is controlling it and he is chatting to people and he is coming up with the design. That's why for me anyway, and I could be horribly wrong, there is a very clear line between work Stages 1, 2, 3 and work Stage 4, as far as an architect's involvement. He still obviously oversees work Stage 4, but it is taken over by a documentation point of view, specifications etc. etc. You might have a different designer here assisting a senior tech or someone like that assisting an architect with the design, but in my opinion, the architect should always know what the technologist is doing as far as his detailing is concerned.

Ra (9.41) So you are talking about the nature of the actual practice.

P7 (9.42) Yes, ok maybe I am going off the point, but I am just saying from the entire process where is health and safety, where is this thing most likely to occur? It is in this phase and it is taken through and all I have here is as far as health and safety is now you are monitoring it to make sure that if you are documenting it, in other words drafting it yourself, it is kind of you're doing it yourself.

Ra (9.43) My question for you quickly is: Do your architectural technologists and senior architectural technologists ever design independently, or are they always under the architect?

P7 (9.44) The practise that I worked for, there were no partners that were technologists - I am just talking about what I am used to. I know things are changing, and I won't try to …

Ra (9.45) I am just trying to clarify the point.

P7 (9.46) Whether this is an architect or senior technologist or whoever the person who is taking on the client, the client has come to me, I am not an architect but I am fulfilling the role of the architect in the process. I'm just saying generally speaking, this is what happens.

Ra (9.47) So you are referring to what we have spoken about earlier where the health and safety design aspects can come in pretty early, in Stage 1 to 3 which is the SACAP work stages?

P7 (9.48) If it's going to be a major shareholder it needs to come in early - it depends how serious this is, if it is not that serious maybe it can come in further, but I hear you're talking about designing.

Ra (9.49) Early stages you say?

P7 (9.50) It's early stages yes, so Stage 4 is monitoring and change, in other words 'tweaks' as whoever was saying. We're not getting everything, so just now an engineer would say, you know what, that beam needs to be 600 not 300 or whatever it is. So if possible tweaks as health and safety, but it is more monitoring and that goes right to Stage 5, right through. The end process - work Stage 6 which could incorporate stuff like document findings, in other words you documented the project it has now being built - you've done your findings and now you are going to recycle it back into the industry from a point of view of updating that.

Ra (9.51) Ok, so we need to feed back to develop that continuous improvement?

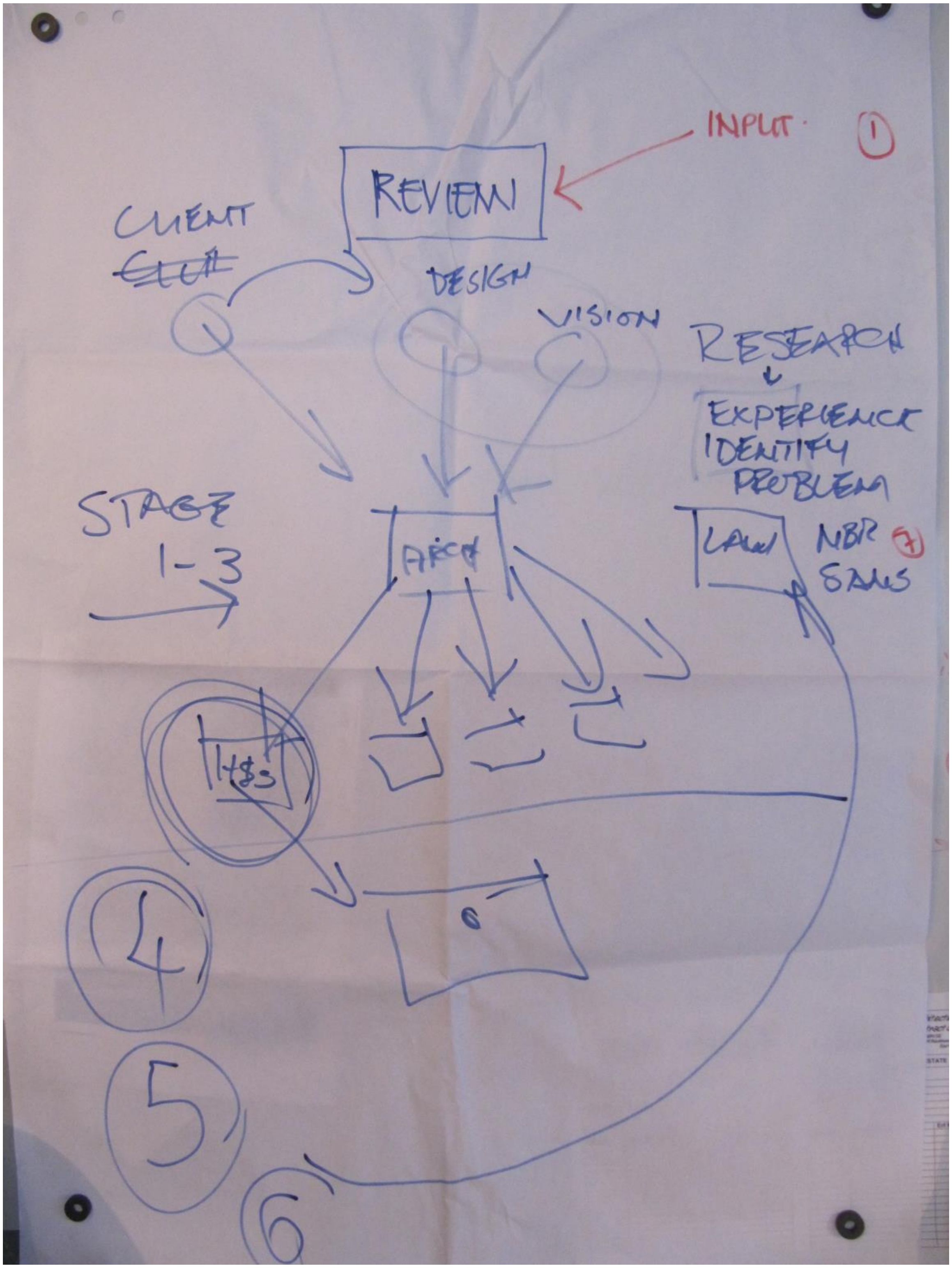
P7 (9.52) Yes, like I have now done a silly thing with the window, and someone has fallen off the roof.

Ra (9.53) Ok.

P7 (9.54) Whether that deals with how you want to formalise the model? (P7 steps down)

Ra (9.55) It's is all information toward it. Anybody else?

The essence of Participant 1 and Participant 7's input is encapsulated in the photograph overleaf.



Photograph 1: Participant 1 provided the 'review' input in the rectangle at the top, while Participant 7 provided the balance of the inputs for the diagram (the '1' and the '7' on the right were added as a reminder of which participants provided the input.

Participant 3 took up the challenge and moved forward:

P3 (9.56) (P3 approaches flipchart) Keep in mind what you see here. What you see here is obviously part of the process. Now we are looking at how we put some kind of document together to guide this guy.

Ra (9.57) To guide the designer?

P3 (9.58) Mmm - the designer. What piece of paper or whatever - or what things are we going to put in place to ensure that that guy – the designer - is able to do all of this stuff? I think we need to go back to our training. Training and awareness – where does it need to happen? – I'll say it should happen at your institutions, your educational institutions - and also your CPD for the guys we were not been lucky enough to be trained in these institutions. What should they be covering in that? I think they need to be trained in the regulations – Construction Regulations. I don't think they need to be trained to the extent that they can become professional safety officers, but it opens up a possibility for another field if they choose to change their fields. I think what also needs to go with that is examples of issues that they are going to encounter out there, so that they are aware of it at that stage already, and also what they see as the mandatory in terms of the act. What is actually required of them - what obligations will they have to deal with? I am going to call this rights and obligations of the mandatory. So those are the things about training and awareness and the things it needs to cover and then coming out of that we get to the point of the in-office situation, and this is where we come to our 'model' if you want to call it that.

Ra (9.59) How to design?

P3 (9.60) Yes. This is where we come to our checklist. In the checklist we have an issue of when do you check, ok, basically each work stage. That might mean you have to employ a specialist - maybe, maybe not? Then there is also an issue of - to show that you have in fact done that. The word that I hate, but unfortunately I can't get away from it is your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report. All this documentation gets added to your close-out report to your client. So far there are two issues - one is the 'training and awareness' and then your 'implementation model' - and maybe it doesn't have to be all that complicated especially if you're bringing in your specialists. So basically you put together a very simple documentation thing for your designer to follow. He doesn't need to be a specialist in H&S, but he needs to be aware and this is where it comes in. So common sense and the awareness that he has received at university will prevail while he is busy designing. When he is finished with work Stage 1, he calls in his structural engineer, and he calls in his specialist in health & safety.

Ra (9.61) And the dot at the arrow on the top of the (P3 puts finger on it) - yes that dot, is that your design?

P3 (9.62) What I am saying is, out of that comes this implementation.

Ra (9.63) Ok, so you've got education and you have a checklist?

P3 (9.64) Ja (Yes)

Ra (9.65) So the checklist - is that what you are looking at in the design process?

P3 (9.66) Yes. You're made aware when you are trained in this stage.

Ra (9.67) Give me some examples of what you might be checking?

P3 (9.68) Well, ummm, well heights of buildings. Maybe what should come in here, not just Construction Regulations, but also have to be NBR as well - very important, I think. It needs to come in here as well. Then from that training, a document needs to be put together highlighting issues that have come out of there, so the guy can always be aware of it when he is busy designing. That checklist doesn't have to be static, it can become bigger and bigger as things get added to it.

Ra (9.69) So there's room for growth?

P3 (9.70) There's room for growth and I think if you combine that with this here into this process, before we even get to the review of the design, before you become the architect, you've already got the training, you've got the awareness. During the two years that you are doing your practical, you get exposed to it on sites and pick more up, and then someone who has done and has been involved in the training and awareness, can then put together your basic checklist and then that is made available through SACAP to all the professionals - which they can build upon if they want to. I think we'll go a long way in preventing accidents.

Ra (9.71) Ok, just one question, your training and awareness, what sort of structure or model would that follow?

P3 (9.72) Well, for instance you could maybe have a subject at varsity. Those subjects could be ‘Construction Regulations and safety on sites’ or during the construction phase, or no, no, during the life of the building. So you have your current Construction Regulations which the guys really need to be made aware of. Examples of it - there is nothing that sticks more to your mind than a photograph of a guy having a leg ripped off by a crane, or something like that. And - what your rights and responsibilities are as an architect in terms of the act - as a manager and your duties to the client and obviously give these in terms of the act. NBR – I think it has to come in here - even if health and safety was not an issue, but it needs to come into varsities here. Then someone who is doing this - like a guy like you (gestures to the researcher) should put something like this together and make that available to the profession.

Ra (9.73) In the earlier discussion the NBR came out as a possible framework and both yourself and the previous speaker have spoken about the SACAP stages as well somewhere along the line?

P3 (9.74) That’s where you go back to this process (refers to flipchart) here - when do you check, which work stage. In each work stage you have to check - after each work stage you pick up your checklist and you go through.

Ra (9.75) You are talking about NBR, the arrow, does that relate to the checklist?

P3 (9.76) I would say ‘yes’, because what is in there needs to be in here.

P7 (9.77) Health and safety is part of it.

Ra (9.78) So that is part of the framework really, and we’re going to check accordingly. Ok- I’m understanding it now.

P3 (9.79) To link your processes and your NBR which is specific parts of the building, the process would be - we use a checklist at the end of each stage.

Ra (9.80) So parts of the building are important?

P3 (9.81) Yes, the parts (NBR) come in here, so when you are doing your work Stage 1, you’re almost finished with work Stage 1, of course you have been thinking about it while you doing the project, then you do your checklist and make sure that you have dealt with all the issues in work Stage 1, and each time you get to another work stage completion, you do the same thing again so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

Ra (9.82) Very interesting!

P3 (9.83) Then you have one checklist. You don't have a massive document - it might get quite big - I mean your NBR has got how many parts in it – at least 24?

Ra (9.84) So it is a checklist which you can look at after each work stage?

P3 (9.85) At each work stage – Ja (Yes), and then you are combining your processes with your items as well.

P7 (9.86) That checklist might be added in your office as your work experience allows you to check while you are busy.

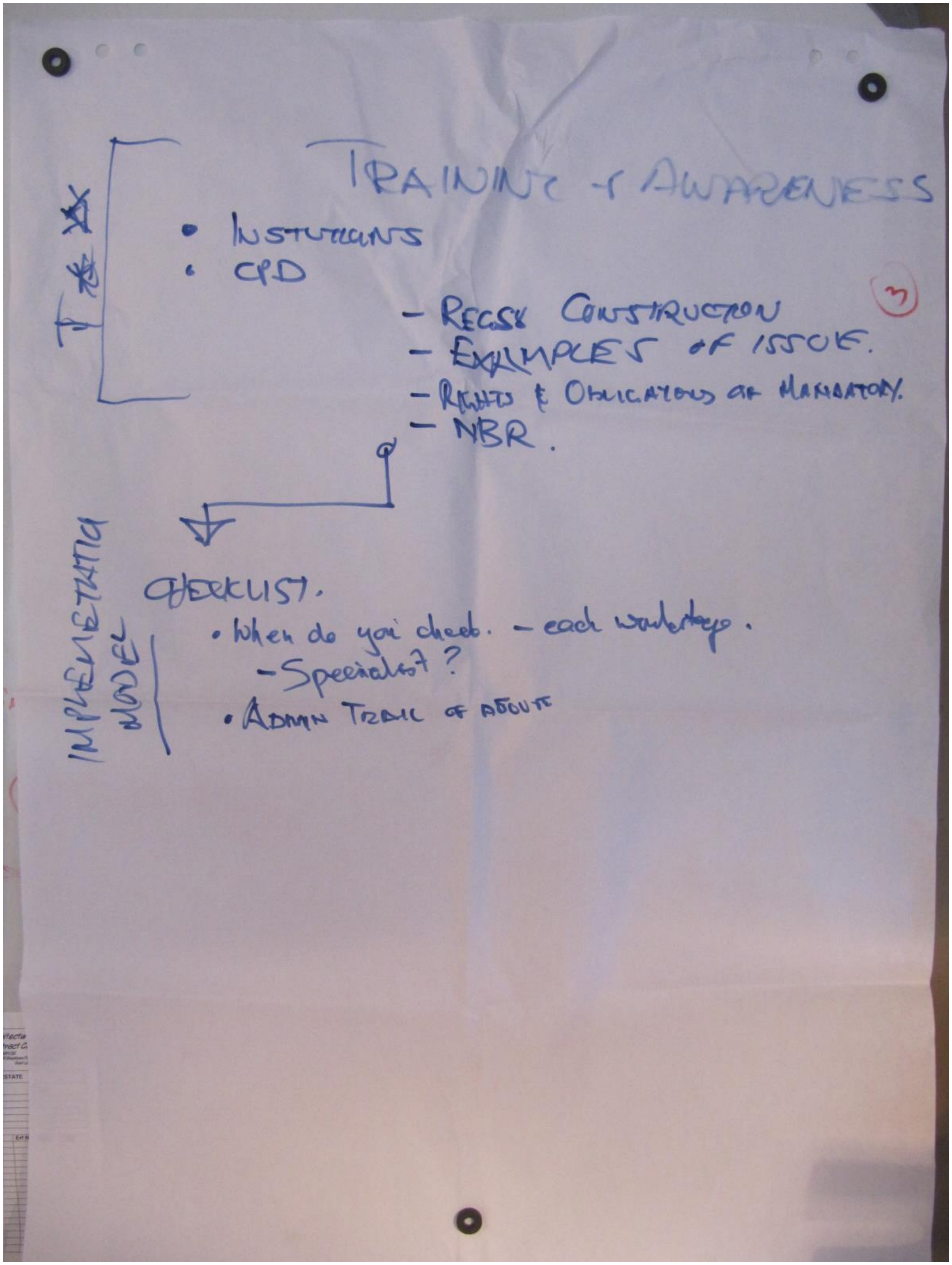
P3 (9.87) And then as you go through your checklist, you are going to say ok right at this stage I need my specialist in here.

Ra (9.88) In using it regularly you are going to improve your awareness that you were talking about at the top, so even in that there is a feedback cycle?

P3 (9.89) Yes (P3 returns to his seat).

Ra (9.90) Thank you. Ok, anybody else? Thank you.

The essence of Participant 3's input is encapsulated in the photograph overleaf.



Photograph 2: Participant 3 sketched the above diagram (the '3' on the right was added as a reminder of which participant provided the input).

Participant 10 took up the challenge and moved forward:

P10 (9.36) This is basically a workflow… (P10 starts sketching on the flipchart provided).

P10 (9.38) It's really more – just a process … (continues sketching. It is noted that verbal description is insufficient but the photograph overleaf demonstrates P10's thinking) … just taking it up to that stage at the moment. It is obviously once you have got to the point where you tend to reconstruct this …

Rb (9.39) So that is the process you suggest architects might use.

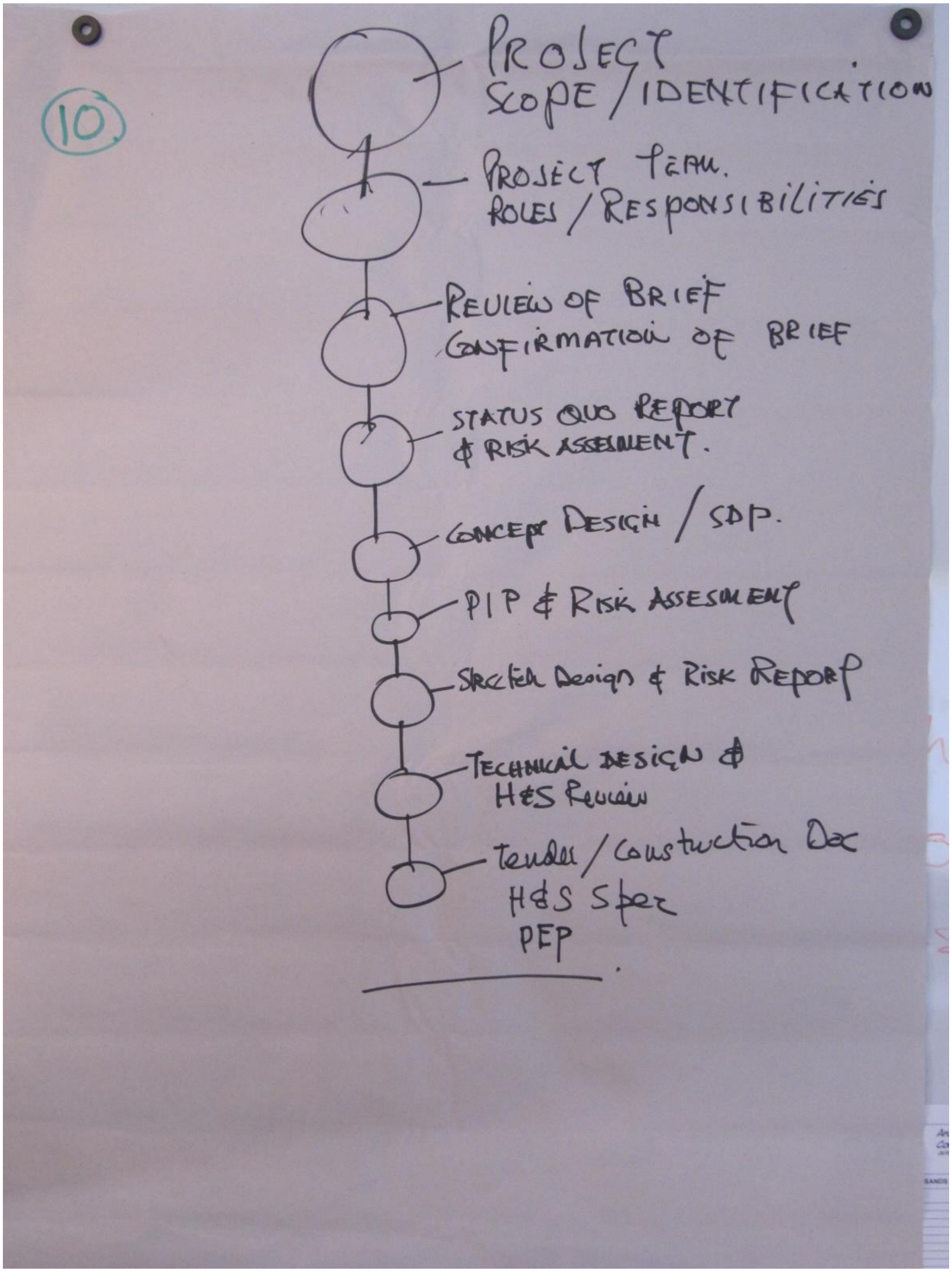
P10 (9.40) Up until that point, then one has to look at - from here on you are now getting your contractor coming on board and you are going to have to review those processes in like what he's bringing – a conventional tender process.

Rb (9.41) How do we get to the point where architects can do this?

P12 (9.42) Sorry, just a comment - the way I understand this it actually revolves around the designing of and the brief - that is the thing that is the middle - and how do we as designers who sit in the middle with the design and the brief actually co-ordinate and understand all these things. All these questions kind of feed into this thing so that you can get to a point where that design is actually sufficient and 'approved' in a health and safety for designing and an ergonomics thing. I look at it kind of differently - all these things kind of plug in, but it is actually the 'design' that is in question - that is what this thing is about.

Rb (9.43) Would you like to flip that over and present your way of thinking?

The essence of Participant 10's input is encapsulated in the photograph overleaf.



Photograph 3: Participant 10 sketched the above diagram (the ‘10’ on the left was added as a reminder of which participant provided the input).

Participant 12 accepted the invitation and moved forward:

P12 (9.44) I can do that, but it's not … (P12 steps up to the flip chart).

Rb (9.45) This is very 'free for all'.

P12 (9.46) Those things are crucial to the whole thing of getting somewhere.

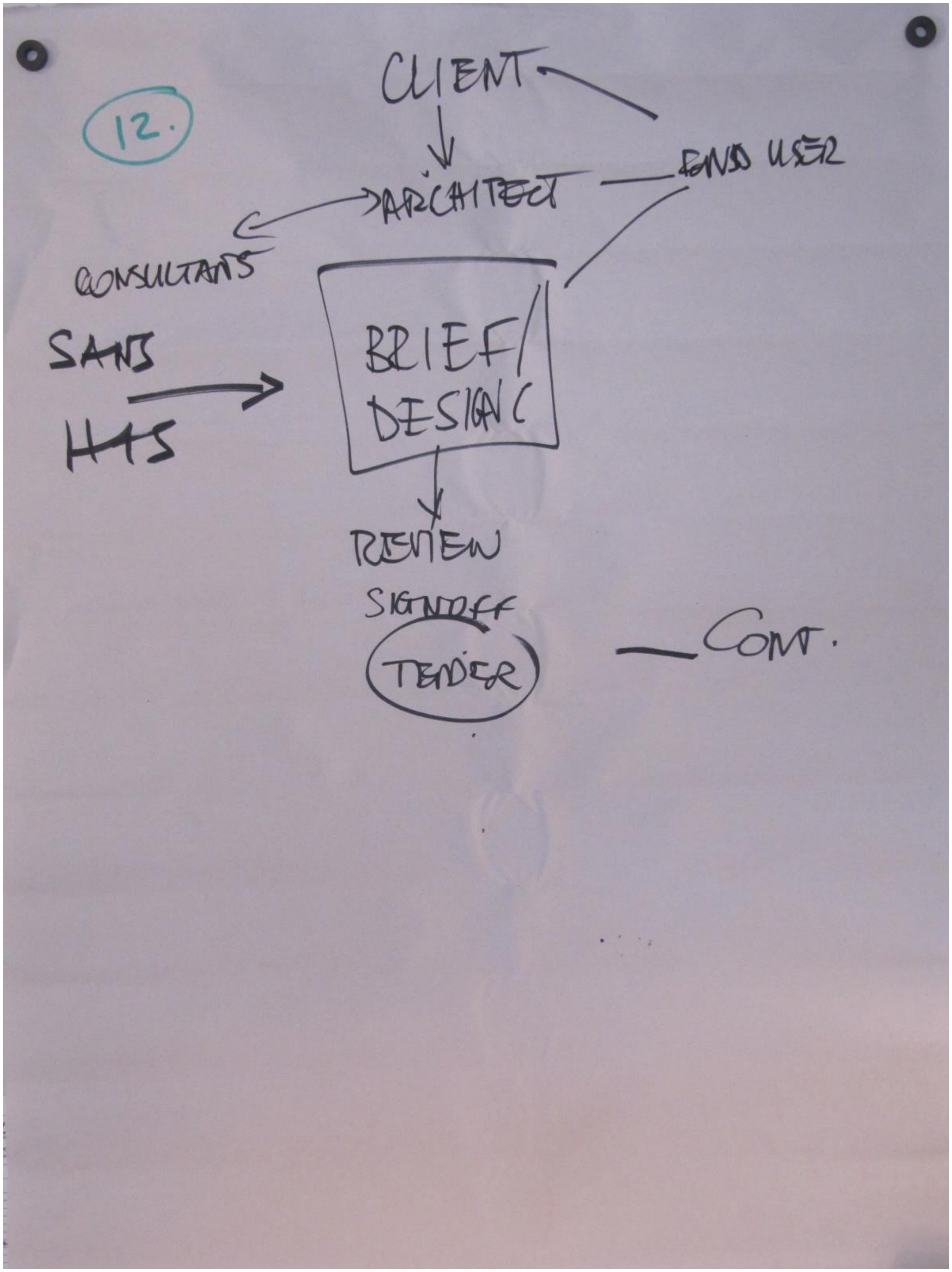
Rb (9.47) There are not real answers expected here. It's a think-tank - it's a think-tank.

P12 (9.48) We have a call it brief 'slash' (/) design. Then you have the client that sits on top obviously, he is initiating the whole thing. He is the bright spark. Obviously he comes to the architect and he would say ok Mr architect I would like to do something, but in order to do that obviously you have got your consultants, but these two - they talk to each other. In order to understand the design brief as well, the architect also needs to understand it whether the client and the end user is the same person as well. So obviously you have got some guy floating up there – end user. He talks there, there and he also influences that which actually creates the brief. Then you have got these things - SANS and all these health and safety things we have been talking about. Health and safety I would imagine would be systems and processes and all these kind of things. When this has been sorted out and everyone is happy with whatever that is and you go to let's say the 'review' - and all these other things P10 has mentioned - the project implementation plan, and all the technicalities of 'is this thing feasible?' Then you have got sign off and then you have our favourite person who is the contractor, who kind of jumps on board, because now you have the tender thing. With the review and with the contractor being awarded, obviously the consultant team must review with the contractor all these systems and things like that. Then you have got the monitoring and then you have got the on-site and all those things, but as I say we have all these things that actually point towards the design process. Then you have got the monitoring, administration, and then the final product with your outputs - whatever you want to call it. So all these points that P10 has put on, that is the way I see it, they kind of gel.

P10 (9.49) The way I see it, you are going through the process where you started from what you have got. Once you got that brief the first thing that you do is you are reviewing it so that you understand his requirements, then you are looking at the implications of the health and safety from everybody's point of view - and then once you move you 'review'. When you develop your design you go through the whole process again and then he is going to tell you that he actually wanted this and that, so for each of the steps that I have basically put there, it basically repeats the process until you come out…

P12 (9.50) I think for the purpose of what you are referring to is that the model of getting that thing sorted which is all that.

The essence of Participant 12's input is encapsulated in the photograph overleaf.



Photograph 4: Participant 12 sketched the above diagram (the ‘12’ on the left was added as a reminder of which participant provided the input).

No further participants offered to provide a discussion with a supporting diagram or sketch of what a potential model could comprise. Focus on assembling a model was lost and further discussions became more general in nature. Relevant aspects are encapsulated in the section to follow, which draws on the discussions of the focus groups and identifies additional relevant themes embedded in the data arising from the structured questions.

5.2.10 Additional themes arising from the focus groups

This section focusses on a range of additional themes arising from the data generated through the focus group discussions. Apart from the perception relative to contractor responsibility as mentioned in Section 5.5, these include: recognition of a multi-stakeholder approach; the issue of client responsibility; maintaining contractor responsibility; building types and project complexity; stifling architectural freedom, and construction in the context of South Africa.

a) Recognition of a multi-stakeholder approach

A range of statements suggest the need for a multi-stakeholder approach:

P7 (1.3) You must speak to building contractors as well … (Excerpt only) … they have what I suppose hard knock experience of what really happens.

P6 (1.29) I think health and safety has always been seen as a construction occurrence and I think we need to adopt it on the architectural side as well. It is everyone's responsibility at the end of the day.

P6 (2.32) You know I kind of question that too because in design, ok, you then would submit your design for approval, let say to BCM – should they not have a body in place as a separate department to check compliance before an accident occurs - obviously prevention is better than cure. Should there not be someone in their department that would say ok guys as we are checking your sewers, and this and that and that, so the department also checks the actual suitability for health and safety, so that when it gets to site and issued as a construction drawing it's already been passed a certain department. It’s not a blame thing, it’s an additional checkpoint to say it does comply - or address such and such a situation.

P6 (4.9) I think we need to at this stage engage with bodies that are already in the H&S field - H&S experts. Although they are practically involved on the site itself in terms of the H&S to workers etc. They can also cross-pollinate with the profession to say these are the hazards encountered, in your design look for a, b, and c, or make sure that you accommodate it. I think there could be cross-pollination there.

P8 (4.23) I mean if you look at the SACAP stages, as he said it is a process and the first stage is the appointment of consultants, whether it is a structural engineer or a H&S specialist, it encapsulates that, it doesn’t not encapsulate it.

P8 (6.23) It’s not the architect only that designs the building. It’s the team.

P3 (6.5) I think it is going to become a more and more of a specialised field and just like we engage structural engineers and those guys, we are probably end up engaging safety specialists. We might become aware of all of this through experience or whatever source of becoming aware might it either be through training, being made aware at university level or whatever the case. I think as an architect you’ve got enough on your plate to try and get your spatial relationships of your building to work for your client, and really structural stuff you leave for the structural engineer, electrical stuff you leave for the electrical guy and safety stuff, really nitty gritty safety stuff you would leave for your specialist. You should really be aware of these things, think about them while designing, but at the end of the day I don’t think an architect want to sit and take the full force, full brunt of responsibility. So I would like to see if guys are going to move towards engaging specialists.

P7 (6.6) They’re already out there.

Ra (6.7) They already out there?

P7 (6.8) You are just not forced to appoint them, but you are forced to appoint a structural engineer.

P3 (6.9) It might be worthwhile for us as professionals during work stage 1 while talking to your client, to make your client aware that you will be getting a safety specialist.

Ra (6.10) The people that are out there - are they designers or are they health and safety monitors?

P7 (6.11) They're health & safety monitors at this stage … (Excerpt only).

P3 (9.102) Let's say I was doing a highly complex hospital or whatever the case might be, certainly at work Stage 1 I would already advise my client that I need a specialist and get the specialist in before we start designing and say "now what are the kind of things that we have to look out for?" So when I am doing my concept design I start thinking about things and I would say to the guy: "Now you have a good look through here, do you see any problems we need to sort out before we are going any further?"

Ra (9.103) Ok

P3 (9.104) Whether or not there are very many safety specialists out there that are knowledgeable about health and safety problems in hospital design or any other kind of complex building design that's another issue. The ones that I have been seeing or dealing with are previous nurses or previous security agents that kind of thing, and it means they have attended a seminar and they've got a certificate that says that she qualifies, blah, blah, blah. So that is another thing that needs to be investigated at some stage.

P10 (1.5) (Excerpt only) … we need to look at the appropriate construction method and the appropriate input from the contractor and the worker …

P10 (1.5) I am also thinking – your client or the market you are designing for, has significant influence … (Excerpt only).

P10 (1.16) Well obviously the first thing you are looking at is what the client's requirements are or what are we designing … (Excerpt only).

P9 (1.72) Some of the more established contractors, not the little homebuilder / alteration guy, but someone like (company name withheld) for example - they must have a wealth of knowledge of what would constitute safe construction and I know I am taking Joe as an example. When (company name withheld) rolled their eyes many times when Joe came up with a particular idea, but tentatively he went around to their business and did it somehow, we don't know how he did it, but some of these more knowledgeable contractors have a world of knowledge.

P10 (1.73) I think you're touching on something there, we don't generally as designers take enough heed of knowledge from the contractor to consult with suitable construction industry people.

P11 (2.5) I think a lot of it's got to do with client requirements.

P10 (2.8) The other one which obviously has a major impact is the ability for the client to define his brief at the start of the project, and I think the big risk is when the client comes to you and he does not actually know what he wants, and you give the initial input and very often you get to the point of construction, and he says that is not what he actually wanted.

P12 (2.11) The other one that I also think is very important, we as designers get also input from other consultants … (Excerpt only).

P10 (2.14) Take a step back to the previous topic – your consultants, your professional team and how it is appointed or put together - the risk there becomes enormous, an ever increasing thing. Where the appointment is made by the client not based on competency or experience, the risk to the designer goes up like that. In a lot of these state issues where it has been appointed for other reasons, the designer has got no control over the competency of the other professions.

P10 (2.16) Where it is a team that gets selected, the team are comfortable and experienced to work together, otherwise you now have a conglomeration of various parties stuck together – that risk becomes.

P10 (2.25) It is a very important point - the review of the brief - is the client's brief realistic? … (Excerpt only).

P10 (3.17) There is opportunity for inclusion whether the client accepts that - is another story.

P12 (3.30) I think the word we are looking for is consultation with - not only ourselves, but also the client.

P10 (6.8) I think also the client – there needs to be an awareness and responsibility from the client so that they work with the architect and not against the architect, and that goes back to your procurement and your construction procedures, because that risk needs to be taken into account.

Rb (6.19) Okay. Can architectural designers engage the process on their own?

P9 (6.20) Probably not. It is teamwork – buildings get built by teamwork.

P10 (6.21) I would like to add that we need the client and we should have the contractor at the …

P12 (6.22) Ideally, ideally yes, which is not always the case.

P10 (6.23) Or if it is subcontract work, get a specialist subcontractor.

P12 (6.24) Yes

Rb (6.25) Okay so the teamwork issue is what we are suggesting, the buy-in.

P9 (7.54) As long as the contractor is made aware of a risk, whether it is in the bill of quantities, whether it is a special section of high risk work or something that is separately - as long as the...

P10 (7.55) It is the H&S plan it is supposed to be in there - which goes with the Bill of Quantities.

P10 (7.20) They should come up with a mitigation plan with the constructor.

P9 (7.21) As long as you identify the risks, I think the contractor can then address it.

P9 (8.14) If it was me it would be the entire project team (Participants nod).

P10 (8.15) They should be part of the process all the way through.

P12 (9.48) (Excerpt only) … he (the client) comes to the architect and he would say ok Mr architect I would like to do something, but in order to do that obviously you have got your consultants, but these two - they talk to each other. In order to understand the design brief as well, the architect also needs to understand it whether the client and the end user is the same person as well …

P10 (9.58) (Excerpt only) … there is a grey line between the principal agent and the architect or the designer, because in a lot of cases the principal agent or the manager is driving this process with the architect as a supplier at the end - it is not necessary the same person doing both, and so it becomes a team management exercise …

b) The issue of client responsibility

A range of responses reflect the issue of client responsibility in terms of the 2003 Construction Regulations:

P7 (2.37) But it isn't like that though. It is the client's responsibility to tell the contractor what the health and safety issues are.

P3 (2.38) Yes it is. My question is why it is the client's responsibility, what does he know about it?

P7 (2.39) I agree with you. I am just referring to the current regulation. I agree with you.

P3 (2.40) This is one of the gripes I have with the current regulations – to my mind it should not be in the client's hands. Put the aim in the client's hand to ensure that the contractor is doing what he is supposed to do. What does the client know? He relies upon his professional team to tell him yes the guy is putting his safety plan into place, but what do the professionals know about it? … (Excerpt only) … We will have a look at your plan, we will give it to the client, the client will say I know nothing about safety and sign it off, unless he is employing a safety officer who knows all these things to sign it off on behalf of the client. Otherwise the client is taking a massive risk.

P3 (5.14) Yes (P4 nods) One of the biggest problems I have with the law is the whole issue of the client being responsible. The issue with the mandatory, which puts the onus back on us as professionals. It's taking people who are not knowledgeable and making them responsible. That's just not on.

P3 (9.149) The only part that still worries me though is I've struggled with it ever since the law came out, the issue of the client being responsible. I have a great problem with that because the client is not knowledgeable. They should really change the law.

P10 (1.31) No, the problem is to date we have not had a health and safety consultant that actually understands the problems in building construction. Yes, we have the workers, and if you read the thing the client has to have that now during the design stage.

P10 (2.53) That's right. They're also telling the client that he has a responsibility.

P12 (2.54) and he doesn't understand either.

c) Maintaining contractor responsibility

Besides the perceptions of responsibility expressed in Section 5.5, specific responses were directed at not taking current H&S responsibility away from contractors:

P 6 (2.142) I think what he is saying is a very good point there. As professionals on the architectural side, this is what we studied for, this is what we're trained to do, this is what we do on a daily basis, ok it is good to bring in the health and safety side, but I think if you compare a contractor and the training he received over the years, he has also got certain knowledge in that field - now as an architectural body you are now going to spec for him - ok there are a couple of dangers to it - you spec for him, the contractor what to do and what not to do in terms of health and safety. Ok he's been doing it for years, it's almost like - you are taking that responsibility away from him, I know he has still got it, but you are specifying it and I don't think we are actually going to be in a position that we can spec it, because that's not our training.

Ra (2.143) It is not our training - ok.

P6 (2.144) We are not qualified to do that. That's his work and now you're taking his responsibility away from him. For argument sake we went on to an excavation just now of 5 m high, so now we say we must now spec shoring and how to shore etc. etc. - he's been doing it for 30 years.

Ra (2.145) Is there a shortfall in our training?

P6 (2.146) No, I think it is not our responsibility. Our responsibility to a degree I think, but each body covers a certain aspect; in other words the contractor puts measures in place. I know I said, and it is almost contradictory to my statement earlier about everyone's responsibility, but I think it's got to be looked at in certain depths. Do we take ultimate responsibility in which the contractor would say ok I'm going to use your specs in terms of shoring, but he's been doing it for 30 years, but you are specifying what I must do?

Ra (2.147) Does it maybe tie in with (P1's) comment about all we have to do in certain situations is recognise a risk and notify the contractor of the risk. He wasn't suggesting the design …

P6 (2.148) Yes, I would agree.

P6 (2.152) That's correct, so there might be something you overlook, which should also be brought to his attention, about high winds and putting up scaffolding and all sorts of things - you might not highlight that. So it also comes down to your own personal knowledge in your field so you're treading on the professional contractor and you are trying to dictate his terms. But it is good to highlight certain areas, but it's not limited to. It might be your perception that it is a dangerous field so you bring it to his attention, but there might be something that you overlook which is equally important, but I don't think we need to write those specs.

P6 (9.19) I think one's also got to look at this in context - in other words you have your contractor that you have already set up, who has by regulation got to have health & safety in place. He is aware of it and he knows of the do's and don'ts and he knows that over 3m high he has to have special precautions or that scaffolding got to be reinforced to a certain degree at certain height, he knows that, so we must not take that responsibility away from him. We must not in our specs have to say if that wall is so high you have to do x, y, and z, because it is already encompassed in his responsibility.

P3 (9.121) I think we need to differentiate between the contractor's responsibility because we don't want to take his responsibility away, but it needs to be in the checklist so that the professional be aware of what the contractor should be responsible for.

P3 (9.145) Well what I am trying to illustrate is, when things happen they happen very quickly - if things go wrong they go wrong very quickly - there is no warning it is going to happen and obviously one can't think of everything, we are not going to cover everything and there are issues on the site which are the contractor's responsibility. Your responsibility as the professional is to design it in such a way to minimise the possibility of things going wrong without any warning.

P10 (3.50) I think what you got to do is you got to have a health and safety review, don't forget he has to provide a plan and he has to identify at that point are there risks and if he points out there is a risk in the way the design and construct has been requested, if he points that out to you don't respond to it, then I seek that there is…

P12 (3.51) Of course yes, then there is most definitely …

P10 (3.52) … there is a problem, but if he doesn't point it out it becomes a grey area, and again it has to be looked at in terms of what is accepted practice – if what you are designing is within the accepted practice it is very difficult to be able to say - but if it is no that it is an unsafe practice - then it is a problem. The contractor as part of his responsibility should be reviewing what you ask him to construct.

P10 (9.64) I just wonder where do you draw the line between the design or designers here? Call it a consultant team risk and a contractor risk, and to give you an example – the construction of a multi-storey building - so you are working on the second floor and they are going to cast the concrete on the third floor deck. The contractor has his subcontractor working in that area and somebody is working above you…

P10 (9.66) No, but whose responsibility is it? Yes, if you see something you are legally bound to take action - but in the first place I would imagine that it is a contractor's responsibility to make sure that when he is carrying out the hazardous or risky operation here that there is nobody working underneath.

d) Building types and project complexity

Some responses ponder issues of building types and project complexity:

P7 (1.9) (Excerpt only) … the model should obviously be researched and amended as per project …

P1 (2.139) (Excerpt only) … I don't profess to know if I was doing a large scale plan, I am thinking non-domestic now, I wouldn't know how to …

P7 (3.41) Also overseas there are more complicated buildings being built in the first world countries - that is more available than here. I think the complexity high rise etc. has possibly got to do with the high mortality or injury here.

P6 (3.42)	And then again on the same topic, should we not be identifying in terms of frameworks what particular projects need more spotlight placed on health and safety than others - ok - it is just a question?
Ra (3.43)	Mmm - you’re talking building types.
P1 (3.58)	The responsible person should sign it off – and then – maybe that goes to complexities. Maybe domestic we can sign off, but multi-storey maybe we don’t, and an expert comes in.
P4 (9.34)	(Excerpt only) … what in this specific type of project - what one should bear in mind.
P4 (9.97)	Maybe I just have a comment. The way SACAP - we were referring to SACAP stages maybe that grid they put out with project complexity, when one starts creating a checklist you wouldn’t have an all-encompassing checklist, so maybe use the low, medium, high complexity project classification or so as a basis for different projects. Obviously when you hit the higher complexity, we start bringing consultants in - a checklist itself is not as valid any more, but at least it gives you that point by point check.
P3 (9.98)	You might not even have a checklist - as an architect, you might not have a checklist for a high complexity building, because you are going to bring in your specialist, and the specialist will guide you as far as concern, let them check your design stages. I see that checklist as a basic checklist otherwise it is going to be too cumbersome again.
P10 (1.3)	The construction industry is broad based, so you go from domestic, to institutional, to industrial, to commercial, to high rise, and then to specialist projects. Each of them, to my mind, have totally different requirements in terms of project design.
Rb (1.4)	You are absolutely correct when it comes to the specifics of different building types … (Excerpt only).
P10 (1.44)	It comes back to the kind of structure that is fine, legally in a city centre site where you only going that way (gestures upward) you might be going down first, so then you obviously have shoring, piling, all those things related with the below ground basements and things. Otherwise your restricted site in any of the

city centres where you are working over public areas, and the restrictions what do you design in and is it your responsibility to do it - and on my side I think yes – hoardings and things - we need to specify it.

P10 (3.7) Again – what are you wanting to consider? When you look at the ergonomics and all the rest, what are we looking at? How are the guys going to build it? So right up front we are making a decision as to the kind of structure we will use.

Rb (3.8) So once again it is building type?

P10 (3.9) It's building type – or not building type, but construction type.

e) Stifling architectural freedom

Some responses question the stifling of architectural freedom:

P7 (6.17) I don't think it will ever get to a point like an architectural professional will allow a - let's call it a subsidiary consultant to dictate to them to a degree how their building must - certainly they'll want it to comply, but I don't think any of us would ever allow someone to dictate to us how a building should operate, and we will have to try and find some way of a happy medium. So to say that it is the - my concern is that it becomes a be all and end all on how to design a building, we are really forced to face our directions and - it ties our hands to a certain point.

P7 (6.19) I don't say it's going to kill architecture, because one architect's ideas might be curtailed by certain restrictions.

Ra (6.20) Mmm … and they wouldn't want it curtailed.

P9 (3.78) (Excerpt only) … but to review the design - and I think it is a choice of words, because architects are terribly touchy about their designs.

Some responses indicate that regulations, or a model, should not stifle design:

P7 (9.13) Hence this thing of being a guideline not a regulation - is what you can and can't do on site, so if your H&S stuff is above board and all good then you can build whatever you want.

Ra (9.14) Yeah, we're not saying somebody can't build at a certain height, we're saying: is there something in the design mechanism?

P7 (9.15) but they won't say you can't build?

Ra (9.16) No, I can't imagine anything like that.

P1 (9.17) It's failed then if it says something like that - it is not bad design it is bad implementation. We never had bad design – it is not common sense.

f) Construction in the context of South Africa

Some responses express construction in the context of South Africa.

Concern is expressed about the construction labour force:

P6 (3.40) (Excerpt only) … we are dealing with a very different population group here in terms of our workers and our labour force as what England are dealing with, and I think there would be a vast majority, percentage wise, of accidents on sites in South Africa or Africa put it that way, which would be more negligence related as opposed to design related.

P10 (1.5) (Excerpt only) … I know we have this in the government sector, this whole labour intensive thing. There is a limit how practically and technically it can be applied and you have divergent political paths. Now either you are going to design into the political structure, or you are designing to achieve a goal and produce a structure that meets a specific need …

P10 (1.12) Of course if you think - if you put it into perspective where the contractor goes and hires people straight out of the community. He puts people on site with absolutely no training and a lot of these programs ask for training on site. That number 1 goes against every health and safety guideline in the industry. So what I am saying is, how do we package this thing, because if we are working to a model that is the ideal model, and it is what we would like to see it and how it should work it is fine, but how do you tackle the other side of the thing where the model and whatever is happening out there is not ideal, the people you are dealing with they wouldn't even know about safety, and this goes back to what I was telling the guys beforehand, we sit in SA at the moment with a supply chain management system that has lost all focus. Does it talk to the need of the industry or of producing the end result? It is caught up in all sorts of other issues and those issues very often go totally against the regulations.

P10 (1.36) There are also a hundred and plenty unreported accidents – those not serious enough to be reported. Most of the accidents that happen on the site are not caused by designers. Most of them are caused by negligence from the workers. A lack of knowledge … (Excerpt only).

P10 (1.58) Yes and no. Why I am saying no is generally we are dealing with a workforce that is not adequately trained … and again I come back to a statement we made earlier - we build with a labour force that is not qualified to build. … (Excerpt only).

P10 (9.8) (Excerpt only) … They are largely outside your control, so the contractor even there has reduced control because we have a lot of subcontracting, we have a lot of labour only contracts, we have a lot of inexperienced or partly trained people working on site and you are not in a position from a design point of view, to say no those people can't be part of the process. So your risk factor goes up both from a quality point of view and production point of view and a safety point of view, because inexperienced people on site they have it again it goes through your safety training - has the contractor got adequate safety procedures? It is no point having a manual, but are they complying with it? Are his guys - forget about the boots and the helmets - are they working properly? You get a guy up on the roof, 3, 4 stories up and he has got his safety belt hooked onto his belt and it's not hooked onto anything else - or it is hooked onto his mate who is not hooked on? So there are all sorts of risks which make it very difficult for the designer to mitigate.

P10 (9.10) (Excerpt only) … most of our experienced workforce have gone north, so every time a big job comes up they scramble and get guys from all over and put a team together. Jobs finished and they may keep two or three guys, it is not a case of the contractor having a large permanent workforce, it is all temporary and so your level of competence, your level of experience is far below one would expect or desire and that is a risk which is very difficult to design around. You are aware of it, but you are not in control of it.

Concern is expressed relative to time constraints:

P10 (1.75) (Excerpt only) … again we've been talking about a design aspect we haven't touched on at all, you mentioned the program - you ask them to build the thing in six months, then you tell them to build the same thing in three months - that's a whole different thing. Speed becomes everything.

P9 (1.76) With speed comes accidents.

P10 (1.77) Or cutting corners.

Rb (1.78) Just on that you are putting that compressed time onto the builder, what about compressed time in the design process?

P10 (1.79) There is a corporation just north of PE who are putting out tenders on a design and supply basis which is actually an architectural competition - now you are asking people to do input with no reward. So immediately it has an impact on the quality what goes in. There are very few architectural practises that can afford to put a full service at no cost – no fee. The other problem is that the conditions put by the client, their expectations, their timeframe and this has come up in a number of projects that have been happening in the current time where the budget – they must spend the money by next month. We are going to appoint that guy on the 1st of this month - hang on, on the 30th of this month we still have to appoint him, the other dates haven't moved – unrealistic time expectations must be number 1 on the list of hazards.

P12 (1.80) I fully agree with you, I think that is our biggest problem, probably.

P10 (7.18) Yes, and all sorts of things like drilling tunnels in the rock for the thing - the guys, because they would get like 'speed bonuses' they wouldn't wait for the stuff to - the way that the American civil industry worked in that time, compared to what we would see today is horrendous – and the boss back in the office said 'go faster, faster'.

5.3 SUMMARY

This chapter focussed on presenting the data obtained through AR using two FGs. The early sections touched on the 'Buffalo City' and the 'Nelson Mandela' FGs, as being representative of South Africa.

The structured questions emanating from Chapter 4 are deemed to have been successful in soliciting an immense volume of qualitative data which was included as a range of themes due to cross-boundary responses within the structured questions. A range of additional themes not directly related to the structured questions were located within the responses, and are included as data due to their relevance. The underlying perception of contractor responsibility also came to the fore.

The qualitative data gathered and divulged here is explored in Chapter 6 to follow, which serves to interpret the data in terms of related literature and the provisional studies undertaken, and ultimately toward development of the included provisional model.

6. INTERPRETATION AND A PROVISIONAL MODEL

6.1 FOREWORD

This chapter explores the vast volume of qualitative data divulged by the FG participants as presented in the Chapter 5 themes, and synthesises the data in terms of related literature and the provisional studies. It achieves this by bracketing appropriate themes into model components, and gradually translates the outcomes graphically into a provisional model. The process realises more than just a model, and embraces a 'core model' embedded within a greater 'process model'.

The underlying perception that construction health, safety, and ergonomics is the contractor's responsibility was detected in the FG discussions. This is briefly touched on here as it does not contribute positively as a development theme and has therefore not 'earned' its own section.

With the traditional forces of cost, quality, and time driving construction, construction health, safety, and ergonomics is left to contractors and other site professionals outside of the design realm and has little influence on mitigating risk, leading to a high incidence of ill health, injury and death (Mroszczyk, 2005; Smallwood, 2006; Schneider, 2006). This notion was supported by the first provisional study (Appendix 1 and section 4.2.1) which determined, *inter alia*, that architectural designers insufficiently engage in HIRAs while designing, as they have not been adequately prepared for this in design education, while the second provisional study (Appendix 2 and Section 4.2.2) also touched on the perception with data including "It doesn't really matter as the risks and dangers are the contractor's responsibility", and "It is not so much design as management of site procedure." Relative to the main study, the following selected participant response optimises the underlying perception:

P3 (2.36) … at the end of the day what it all boils down to is that the designer is putting together a document that says to the contractor, when you are finished on the site Mr Contractor, this is what the building should look like. How you get it there with safety measures that need to be put in place to get it there, is your job Mr Contractor.

Not to dwell on this underlying perception, what follows brackets appropriate themes into six essential model components and simultaneously evolves the model. Firstly, the 'key inputs' (Theme 1) are considered in terms of the type of information which can contribute toward developing and sustaining a model. Secondly, the 'core model' comprises a model framework (Theme 2), a working process (Theme 3) and requisite knowledge (Theme 4). Thirdly, the 'mechanisms' considers the provision of requisite knowledge (Theme 5) and engaging architectural designers (Theme 6). Fourthly, the 'key outputs' (Theme 7) entertains beneficial documentation derived from designing for construction health, safety, and ergonomics. Fifthly, the 'dissemination' embraces the purpose or destination of the model outputs (Theme 8). Sixthly, a 'continuous information feedback loop' is incorporated to ensure continued development and sustainability of the model and its ultimate intention.

The question of whether participants could 'assemble' a model (Theme 9) and the 'additional themes' arising from the FGs is incorporated into the aforementioned six essential model components and the embedded themes. The writings in many ways mimic the data in that it is structured to demonstrate how the participants progressively moved from vague beginnings to more confident discussions to constructive endings. The chapter concludes with a 'summary and presentation of the provisional model'.

6.2 THE KEY INPUTS

This model component draws primarily on Theme 1 and realises a range of resources identified as suitable 'key inputs'. An initial sense of vagueness prevailed among FG participants. This was demonstrated by the initial data in Chapter 5, where vague questions and general discussions took place as participants pondered the topic in an attempt to find direction. What follows is broken into sub-sections for ease of reference and includes: relevant literature; causes of accidents; information on hazards and risks; international approaches and models; design recommendations, and recent studies and on-going research and development. Due to vague beginnings, some aspects included are as a direct result of prompting or questioning by the facilitator, based on related literature and the preliminary studies.

6.2.1 Relevant literature

There is a vast array of relevant international and local literature directed at construction H&S. Elaboration has not been included here as it is included in chapter 2 'The survey of related literature', but a broad overview is provided here.

This includes international statistical data demonstrating a high incidence of illness, injury and death (Weitz and Luxenberg, 2010; Penny, 2007; Bureau of Labour Statistics – US Department of Labour, 2007 & 2008; Pritchard, 2009; Innes, 2009; HSE 2010a & 2010b; Safe Work Australia, 2010). Similarly, local literature includes devastating statistics relative to the construction industry (Compensation Commissioner, 1999; COID, 1999; cidb, 2009). It also includes the more traditional interrelationship of cost, quality, and schedule toward measurement of project success, and the notion of H&S being the contractor's responsibility (Szymberski, 1997; Mroszczyk, 2005; Schneider, 2006; Smallwood, 2006a) and the need for DfH&S as expounded by Hinze (2005), Toole and Gambatese (2006), and Toole *et al*. (2006).

Despite such calls, The Constitution of the Republic of South Africa (Republic of South Africa, 1996; GCIS, 1998), underpinned by the OH&S Act No. 85 (Republic of South Africa, 1993), the Construction Regulations (Republic of South Africa, 2003), the proposed amendments to the Construction Regulations, and the SACAP (2008) expectation of ethics and integrity has had little effect on architectural designers engaging in designing for construction H&S in South Africa. While Cameron *et al*. (2005) promote effective planning toward a reduction of construction risks, the UK's Gateway model (HSE, 2004) and the Australian CHAIR model provide structured approaches toward reducing construction hazards and risks. Numerous recommendations for safer design, generally in the form of lists have been collated by researchers and authors such as Gambatese (1997), Weinstein (2005), and Behm (2005).

The appropriateness of design education remains questionable due to the lack of experience and ability of architectural designers relative to designing for construction H&S, and the need to optimise relevant tertiary education programmes and CPD courses is essential (Cowley *et al*., 2000; Toole and Gambatese, 2006 and 2008; Smallwood 2006 and 2006a; Schulte *et al*., 2008).

This broad overview merely sets the scene for relevant extant and future literature to be considered as a key input. It is not considered comprehensive here.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence to the statement of ‘Consideration of local and international literature would prove beneficial to developing a guiding model suitable for use in the context of South Africa’ was met with a mean score (MS) of 3.73, which is above the midpoint score of 3.00 suggesting it’s suitability as a key input.

Being the first question, the initial FG data largely related to broader considerations which are included later. Based on literature and the provisional studies, the facilitator probed:

Ra (1.12) Ok, is there any relevant literature out there that can guide us?

The response was brief but relevant:

P6 (1.13) There is already health and safety on construction sites. One needs to adopt that, use that as a basis and to assist with the design process (P3 nods).

Literature demonstrated a broad range of issues relative to construction H&S. The fourth provisional study demonstrated that relevant literature would prove beneficial as a key input. Although the FG data is brief, applicability of relevant extant or future literature to any research or other topic is of utmost value. It is therefore argued that ‘relevant literature’ must constitute a key input.

6.2.2 Causes of accidents

Haslam *et al*. (2005) reference Kletz (2001) and highlight the multi-causal range of factors which lead to construction accidents. These include the proximal factors and the distal factors with the latter implicating design, with Gibb *et al*. (2006) proffering poor design and planning decisions leading to 'active failures'.

The main causes of accidents worldwide are not unlike those occurring in South Africa, and include 'falls onto different levels', 'motor vehicle accidents', 'struck by', 'inhalation, absorption and ingestion', and 'WMSD's or body stressing' (Haslam *et al*., 2005; Penny, 2007; Bureau of Labour Statistics – US Department of Labour, 2008; cidb, 2009, Innes, 2009; Safe Work Australia, 2010, HSE, 2010b).

Behm (2006) proposes that at least one third of accidents can be mitigated through safer design, while the HSE (2003) demonstrates the figure to be approximately 50%.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence with the statement of 'Architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics' resulted in a MS of 4.07, which is well above the midpoint score of 3.00 strongly suggesting it's suitability as a key input.

Relative to the FG data, and based on literature and the provisional studies, the facilitator probed as to whether the 'causes of accidents' could serve as a key input.

Initial responses were brief, but relevant:

P6 (1.17) Oh yes!

P9 (1.35) Yes, I said here (making own notes) reported incidents. I think that needs to be reported to the Department of Labour or something. Court cases?

Other data is less direct, but integrates examples relative to causes of accidents:

P10 (1.44) It comes back to the kind of structure that is fine, legally in a city centre site where you only going that way (gestures upward), you might be going down first, so then you obviously have shoring, piling, all those things related with the below ground basements and things. Otherwise your restricted site in any of the city centres where you are working over public areas, and the restrictions what do you design in and is it your responsibility to do it - and on my side I think yes – hoardings and things - we need to specify it.

P12 (1.49) I mean I think we've been thinking about going up or down or left or right and windows and that sort of things, but I think what one should think about is not only how to build the building, but you should also think of the building or whatever type of structure it is being broken down into different components. Yes, if you go up it is hazardous, but once the structure is up then the specification and application methods if you can call it that - of things like floors, walls, ceilings, that kind of thing, then I think there is more scope of probably specifying or trying to design a better solution, so that the guy doesn't stand on a little 'koekerige leertjie' (spindly ladder) to get up there so that maybe the installation goes in whilst the scaffolding is up - looking at the floor structure for example. So maybe that is the other way of looking at it, not just bringing it up, but when the building is there. I think there is more scope actually getting that. That way we can probably say listen the guy is not going to lay the carpet until such time as the walls are painted or something like that.

P12 (1.52) I think the line is probably where if you know that this carpet or the glue that they use for example is going to get completely stuffed up - the guys are going to float more toward the ceiling than down on the floor. You say that according to specifications you are not allowed to lay the carpet with that 'thing' until such time as the whole building has been evacuated or the doors are on or the lights are in.

P10 (1.55) We have an example at the hospital a couple of years ago when the chap had to work overtime and he had to do the toilets and do the change room, the supervisor came past everything is lekker - he goes to grab his supper downstairs - the guy laying the vinyl has got the glue tin open, his mate comes in (shows action of lighting a cigarette) – explosion, and the guy lands in ICU. Now that is not a design aspect that you mustn't do this - and no smoking - that is a construction thing so there is this line. We need to make the guys aware of the hazards but we are not the contractor.

Literature demonstrated a broad range of causes of accidents and suggests that accidents can be mitigated by up to 50% through appropriate design. The fourth provisional study demonstrated that architectural designers need to understand causes of accidents in order to design for construction H&S. The FG data supports the need and integrates examples relative to causes of accidents. It is therefore argued that the 'causes of accidents' constitutes a key input.

6.2.3 Information on hazards and risks

Considering inhalation, absorption, and ingestion are construction health hazards and risks, falls onto different levels, MVAs, and struck by accidents are safety hazards and risks, and WMSDs or 'body stressing' are construction ergonomics hazards and risks, and any interrelationship between them (Haslam *et al*., 2005; Penny, 2007; Bureau of Labour Statistics – US Department of Labour, 2008; cidb, 2009, Innes, 2009; Safe Work Australia, 2010, HSE, 2010b), and the likelihood that up to 50% can be mitigated through appropriate design (HSE, 2003; Behm, 2006; Toole and Gambatese, 2006), then surely information on hazards and risks is important.

Relative to health hazards and risks, Cowley *et al*. (2000) advocate Bender and Hadley (1994) suggesting that hazardous material risks should be managed through all stages and suggest that manufacturers of hazardous chemicals to improve hazard information on packaging, thus making 'upstream target groups', being designers, more aware of product hazards and risks. They further advocate The Consultancy Company (1997) suggesting that if H&S hazards and risks are assessed it is usually too late to intervene, while Smallwood (2006 and 2007) professes that construction H&S hazards and risks, inclusive of ergonomics, can be addressed through improved architectural education and training.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence with the statement of 'Architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics' realised a MS of 3.53, which is above the midpoint score of 3.00 suggesting it's suitability as a key input.

Relative to the FG data, and based on literature and the provisional studies, the facilitator probed as to whether 'information on hazards and risks' could serve as a key input.

Responses were brief but relevant:

P3 (1.19) Oh yes, they can contribute.

P10 (1.40 Your hazards, especially with chemicals and use of flammable materials or other hazardous materials. I mean one needs to understand that and the working conditions that go with it … (Excerpt only).

Additional cross-boundary data provided additional support relevant to hazards and risks. This however pointed more in the direction of HIRAs, which are considered more specific than broad 'information on hazards and risks' and is included later as part of the 'design knowledge window' (Section 6.3.3) in order to avoid repetition.

Literature demonstrated a range of information relative to hazards and risks, while the fourth provisional study demonstrated that architectural designers would need to identify hazards and undertake risk assessments in order to design for construction H&S. Although this is focussed on more specifically in the 'design knowledge window' it is argued that the broader range of 'information on hazards and risks' constitutes a key input.

6.2.4 International approaches and models

The CDM Regulations of 1994 and amended 2007, offer valuable insights toward the protection of construction personnel and the public and provide for multi-stakeholder duties (Neil, 1994; Hetherington, 1995; CDM, 2007), and ultimately gave rise to the Gateway model which identifies five sequential project phases requiring effective planning, namely the concept, feasibility, design, construction, and maintenance phases (HSE, 2004a; Cameron *et al*., 2005). This provides a "... structured, systematic, logical, rigorous and transparent ..." (HSE, 2004a, x) manner and offers a means of assessing designers' and contractors' work, which includes performance assessments at given intervals throughout the mentioned phases and provides a range of useful support tools.

Similarly, the Australian CHAIR model aimed at promoting a multi-stakeholder approach toward a reduction of construction H&S hazards and risks linked to design by giving designers the "... opportunity to sit down, pause and reflect on possible problems" (WorkCover NSW, 2001, 4). The CHAIR conforms to the 'principles of safe design' (Australian Safety and Compensation Council, 2006), and the 'hierarchy of control' (Australian Safety and Compensation Council, 2006), and prescribes 'safe design', as listed by Alwani-Starr in 1996 (WorkCover NSW, 2001, 6). It makes use of generic 'guidewords', and sub-prompts relating to each element of the design and serves to stimulate discussions (WorkCover NSW, 2001).

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence to the statement of 'Consideration of suitable international models would prove beneficial to developing a guiding model suitable for use in the context of South Africa' realised a MS of 3.53, which is above the midpoint score of 3.00, suggesting it's suitability as a key input.

Relative to the FG data, and based on literature and the provisional studies, the facilitator probed as to whether 'relevant international models' could serve as a key input.

Responses were brief but relevant:

P4 (1.22) Yes (nods from numerous participants).

P9 (1.57) It certainly could. For instance, if there's an Aussie model, then I think it could be applied.

P10 (1.58) Yes and no. Why I am saying no is generally we are dealing with a workforce that is not adequately trained. So any international model has to be adapted … (Excerpt only) … So whatever model we are doing has to be broadened …

P9 (1.60) Of course yes.

Relevant to Participant 1 (who worked in the UK for some time) raising the point of the CDM Regulations of which other participants lacked awareness the following statement lends support to international relevance:

P7 (2.21) It was mentioned, not the specific document. It was mentioned - something from another country, but it must be adaptable for SA.

Literature included international approaches and models such as the UK's CDM Regulations and the Gateway model, and the Australian CHAIR model. The fourth provisional study demonstrated that consideration of suitable international models would prove beneficial to developing a guiding model suitable for use in the context of South Africa. While FG data was brief, it was certainly relevant. It is therefore argued that 'international approaches and models' constitute a key input.

6.2.5 Design recommendations

Behm (2006) advocates previous design recommendations made by Gambatese and Weinstein, and provides a list of 'new design recommendations'. Similarly, Mroszczyk (2005) makes examples of design recommendations originating from Weinstein (2005), Gambatese (1997), and Behm (2006), and splits these into suggestions and the purpose of the suggestions. Given the original sources, similarities to Behm (2006) are evident. The lists are not repeated here in order to avoid repetition.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence to the statement of 'Consideration of existing design recommendations would prove beneficial to developing a guiding model suitable for use in the context of South Africa' realised a MS of 3.79, which is above the midpoint score of 3.00, suggesting its suitability as a key input.

Relative to the FG data, and based on literature and the provisional studies, the facilitator probed as to whether 'design recommendations' could serve as a key input.

Responses were brief but relevant:

P10 (1.65) Just clarify that - when you say design recommendations?

Rb (1.66) Yes, if there are other researchers or other practices in other countries who have made recommendations for design practices - if I can put it that way - could design recommendations - in other words recommendations to resolve health and safety issues and risks through the design process.

P10 (1.67 Probably yes - again one needs to look at what is the environment in which that design recommendation has been made against our environment.

Literature included a range of design recommendations. The fourth provisional study (Appendix 4 and Section 4.2.4) demonstrated that consideration of existing design recommendations would prove beneficial to developing a guiding model suitable for use in the context of South Africa. Although FG data was brief, it was certainly supportive. It is therefore argued that 'design recommendations' constitutes a key input.

6.2.6 Recent studies and on-going research and development

While 'recent studies', as wording, was not directly interrogated in terms of the review of the literature, Leedy and Ormrod (2010) suggest such a review as essential to place chosen research problems in perspective by drawing on the knowledge of those who have already 'journeyed into the unknown' and have recorded their findings. Many sources of information used in the review of the literature and other contexts of this study have stemmed from 'recent studies', while the body of knowledge itself is based on 'on-going research'.

Relevant to this research, the second provisional study (Appendix 2 and Section 4.2.2) raised the point of research and new ideas by suggesting that 'It's a new field ... not widely explored. We need research and new ideas …'

The other provisional studies did not directly question 'recent studies and on-going research and development'. It is however clear that the provisional studies provided tremendous insight and ultimately facilitated the development of the structured questions used in the main study, thus suggesting that they are deemed suitable as key inputs in terms of recent studies and on-going research and development.

Relative to the FG data, and based on literature and the provisional studies, the facilitator probed as to whether ‘recent studies’ could serve as a key input.

Responses were brief but relevant:

P3 (1.15) Yes, they would.

P9 (1.22) I am not aware of any recent studies, but if there are any they would serve as role models.

The facilitator also probed as to whether ‘on-going research and development’ could serve as a key input. Responses were relevant:

P6 (1.24) Yes, I think that’s important.

P10 (1.85) I think very much so. I think also what goes hand in hand with that is to get co-operation from the architects to feed back on the outcomes of projects - especially when you have unusual projects or high hazard projects.

Rb (1.86) So the feedback will actually get noted and looked into and pumped back into whatever is happening?

P10 (1.87) Yes, if you are coming up with finding specific problems that would affect others.

Included here is the notion of a research or data resource as a contribution to key inputs came to the fore:

P4 (9.34) (Excerpt only) In my mind one of the first things I would need is some sort of research or data resource so that I can start understanding the risk class or something for the priorities that one should focus on …

P7 (9.38) (Excerpt only) … With that goes research, we are talking about health and safety now.

P9 (2.22) Yes there is, there would be case studies or previous examples. Quite recently I was asked to put together a brief for a fire station and I went to two books that have design criteria for fire stations. So that and also got two documents off the internet, both American unfortunately, but there are documents out there on how to design this…

P10 (2.23) There is a lot of information out there - it is obvious to see what is relevant to our conditions in terms of the planning input.

P12 (2.24) But by default architects should actually when they get a brief of any sort they should sit and review what has been asked for and actually look at those things. You get my idea – look at precedents – American or whatever.

Relevant literature on the topic is research based and has contributed to the knowledge base over time. The four provisional studies constitute research and proved instrumental to the success of the main study. The applicability of recent studies and on-going research and development and making that data available as a resource for architectural designers was included in the FG data. It is therefore argued that 'recent studies and on-going research and development', notwithstanding a research data base, constitutes a key input.

6.2.7 Summary and graphic representation

This section synthesised relevant literature, the provisional studies and the FG data relative to the identification of suitable 'key inputs'. Being the first structured question a sense of vagueness prevailed among participants thus requiring the need for the inclusion of probes based on related literature and the preliminary studies.

In closing the first structured question, the facilitator summarised and probed as to whether the range of discussed issues could all serve as key inputs.

Responses were brief but relevant:

P4 (1.31) Ja (Colloquial for ‘yes’).

P9 (1.98) Yes, all of those most definitely can contribute.

It is therefore argued that ‘relevant literature, causes of accidents, information on hazards and risks, international approaches and models, design recommendations, and recent studies and on-going research and development’ all constitute key inputs.

The key inputs are included in graphic format as a contribution toward the greater model.

Diagram 1: The key inputs

KEY INPUTS
Relevant literature; Causes of accidents; Information on hazards and risks; International approaches and models; Design recommendations; Recent studies and on-going research and development

↓

?

The question arises as to what their purpose is, or into what they are being devoted?

6.3 THE CORE MODEL

This central model component draws primarily on themes 2, 3 and 4 and realises a framework for the core model, a working process within the framework, and identifies the range of requisite knowledge architectural designers require in order to engage the process. The data demonstrates how confidence grew among the FG participants as they became more acquainted and comfortable with the topic. Synthesised with literature and the provisional studies, what follows is broken into sub-sections under the following headings: 'the model framework'; the 'design opportunity window'; the 'design knowledge window', and the 'summary and presentation of the core model'.

6.3.1 The model framework

Based on literature in the independent sections to follow, the third provisional study (see Appendix 3 and Section 4.2.3) attempted 'to establish a framework toward development of a guiding approach or model, suitable for use by architectural designers in South Africa, to mitigate construction hazards and risks'. In doing so, it sought inter alia to 'establish if there was any particular documentation used by architectural designers to which a possible model could be attached or associated with' and considered a range of documentation for this purpose. These included: the National Building Regulations (NBR); Bills of Quantities (BoQs); Work Breakdown Structures (WBSs), and Preambles for Construction Trades. It questioned whether any other documentation was used, and considered all possibilities relative to the SACAP 'architectural work stages' in a matrix format of questioning without the realisation that the SACAP stages could actually constitute part of the model framework.

Although the fourth provisional study (Appendix 4 and Section 4.2.4) was primarily targeting model inputs, it overlapped with, and drew on specific aspects of the third provisional study (Appendix 3 and Section 4.2.3) and provided a statement of 'a guiding model should have a framework which is familiar to architectural designers and offers ease of use'. The resultant MS of 4.33, which is well above the midpoint score of 3.00, suggesting its importance. It also, *inter alia*, questioned the range of documentation used by architectural designers – keeping familiarity in mind.

The third provisional study (Appendix 3 and Section 4.2.3) leaned heavily toward the NBR as framework for the model, while the matrix method of questioning implicated the SACAP ‘architectural work stages’. Relevant aspects of the fourth provisional study support these notions and more directly recognise the importance of the latter. What follows, considers both relative to other possible documentation, and ultimately realises ‘the cross-reference matrix as model framework’.

a) Application of the National Building Regulations (NBR)

Some literature relative to construction H&S considered a range of building components and associated trades (Smallwood, 2006b; Gangolells *et al*., 2010; Safe Work Australia, 2010), which are in line with the 26 parts of South Africa’s NBR (Republic of South Africa, 2010). The NBR embraces the Bill of Rights incorporated into the Constitution of the Republic of South Africa and serves to ensure safe, healthy buildings, with specific concern for building occupants (Republic of South Africa, 2010), however with less mention or regard for construction workers.

While a broader explanation of each NBR part is included in the review of the literature, the parts of the NBR are included here as being similar to the range of building components and associated trades as expressed above. These include: Part A: Administration; Part B: Structural design; Part C: Dimensions; Part D: Public safety; Part E: Demolition; Part F: Site operations; Part G: Excavations; Part H: Foundations; Part J: Floors; Part K: Walls; Part L: Roofs; Part M: Stairways; Part N: Glazing; Part O: Lighting and ventilation; Part P: Drainage; Part Q: Non-water-borne means of sanitary disposal; Part R: Storm-water disposal; Part S: Facilities for persons with disabilities; Part T: Fire protection; Part U: Refuse disposal; Part V: Space Heating; Part W: Fire installation, and Part X: Environmental sustainability, with its first sub-part, Part XA: Energy efficiency in buildings (Republic of South Africa, 2010), while (Lemmer, 2011) suggests that parts to follow will most likely include Part XB: Water efficiency in buildings, and Part XC: Recycling of building materials.

Toward establishment of a model framework, the third provisional study (Appendix 3 and Section 4.2.3) considered a range of documentation. This included firstly documentation 'used by' architectural designers, and secondly documentation suitable for 'attachment' of a model. It considered all possibilities relative to the SACAP 'stages of design' in a matrix format.

In the 'used by' category, project specific BoQs and project specific Preambles for Construction Trades are not available for the first three SACAP architectural work stages, meaning that they are not effective for consideration throughout the design process. Relative to the remainder of documentation types, the NBR is preferred relative to WBSs in all six stages of design. With respect to the open-ended possibility, it is noted that 'no other documentation was recommended by any of the respondents'. A summary of NBR and WBS MSs relative to 'attachment' is provided in the table below:

Table 13: Degree of documentation consideration or usage relative to the stages of the design process

Documentation	**SACAP architectural work stages**					
	Stage 1 : Inception	Stage 2: Concept and viability	Stage 3 : Design development	Stage 4 : Documentation and procurement	Stage 5 : Construction	Stage 6 : Close out
National Building Regulations (NBR)	2.83	3.00	4.50	3.83	3.75	2.92
Work Breakdown Structure (WBS)	1.75	1.83	1.92	1.67	1.75	1.42

In the 'attachment' category, project specific BoQs and project specific Preambles for Construction Trades are also not available for the first 3 SACAP stages of design, meaning that they are also not effective for consideration throughout the design process. Relative to the remainder of documentation types, the NBR is preferred relative to WBSs in all six stages of design. With respect to the open-ended possibility, it is noted that 'no other documentation was recommended by any of the respondents'. A summary of the NBR and WBS MSs relative to 'attachment of a guiding approach or model' is provided in the table below:

Table 14: Degree of concurrence relative to attachment of a guiding approach or model

Documentation	SACAP architectural work stages					
	Stage 1 : Inception	Stage 2: Concept and viability	Stage 3 : Design development	Stage 4 : Documentation and procurement	Stage 5 : Construction	Stage 6 : Close out
National Building Regulations (NBR)	2.58	3.08	4.00	3.83	3.75	2.92
Work Breakdown Structure (WBS)	0.75	0.75	1.08	1.33	1.17	1.25

In terms of the documentation explored in the third provisional study, the NBR prevails as the most commonly used by architectural designers during the design process, and it also prevails as the most suitable for attachment of a guiding approach or model, notwithstanding the matrix form of questioning relative to the SACAP architectural work stages.

Based on literature and drawing heavily on the third provisional study in terms of the model framework, the fourth provisional study (Appendix 4 and Section 4.2.4) once again considered, *inter alia*, whether 'a guiding model should have a framework which is familiar to architectural designers and offers ease of use'. This resulted in a MS of 4.33, which is well above the midpoint score of 3.00, suggesting its importance. The study also considered the range of documentation as before, being the NBR, BoQs, WBSs and Preambles for Construction Trades. This time around it also included the SACAP architectural work stages, which previously formed basis for the matrix format of questioning.

The MSs relative to the updated range of documentation downplay WBS (2.33), Preambles for Construction Trades (2.47), and BoQs (2.53) against the midpoint score of 3.00. The NBR retains popularity with a MS of 4.00, while the SACAP architectural work stage dominates with a MS of 4.20. When considered against the average score of 3.00, the NBR and the SACAP architectural work stages cannot be ignored as serving toward the model framework.

The fourth provisional study (Appendix 4 and Section 4.2.4) also included some qualitative aspects. To the question of ‘Do you have any comments or questions regarding a possible framework for a guiding model?’ one response included ‘Good idea to relate it to SANS 10400 (NBR)’.

Toward the model framework, what follows explores the FG data in terms of the NBR, while reserving discussions on the SACAP architectural work stages for the next section.

The FG data initially raised the question of a ‘tick box’ which is more aptly included later as a sub-section of the model. The notion of an ‘assessment matrix’ was also included and forms part of the model framework further on. Data samples which epitomise the situation are included here. The data started to lean toward the NBR breakdown (without mention) with the following statement:

P3 (2.3) I think that framework needs to be broken down into smaller bites. If you are going to give a guy a document that is massive, there is no way that he is going to have the time to look at it. He is going to be aware that it is there, but if you give a framework that is broken down into bite sizes – things to think about at the design stages, things to think about the working stage, things to think about when the contractors on site, that you can refer to. I think that’s going to be a lot more useful than some massive document. That’s why you will find there are probably a lot of guys that aren’t even looking at the Construction Regulations right now. It is just too cumbersome.

The notion of the NBR as framework became evident in the data:

P6 (2.11) Your Building Regulations (NBR) stipulates a lot of safety stuff about your trench widths and heights of your handrails, those issues related to health and safety.

Ra (2.12) So Building Regulations (NBR) are considered during the design process?

P7 (2.13) Your municipal bylaws as well, not that they'll override them (NBR) - there might be certain bylaws that you'll have to abide with as well.

P9 (2.39) I think in a certain way, the NBR set out guidelines, otherwise how would we know a wall needs to be 6m long without a support, you wouldn't know about it, unless there is a regulation set about it.

P10 (2.40) Your local town planning regulations, they have a huge impact on your design.

P9 (2.41) Yes, I think primarily the NBR and some of the bylaws.

P12 (2.42) Yes, I think National Building Regulations, but then the other problem is some of the local authority people do interpret things differently as well.

P6 (2.22) I don't think we need to re-invent the wheel. We should just possibly use what we can and adapt. Not adapt but modify it to suit.

Cross-boundary data reflected building elements or components as included in the NBR:

P3 (2.55) I think it could be, if we take for example if we take any one of the parts – the part on walls for example - if they are brought in a section in the part - when it comes to safety in terms of the construction of the walls, which is all in there in terms of designing a structure and things like that. If you think about what happens if they are building the wall, what do you have to design that they can in fact build it safely safety? Maybe these things need to come into each sections, so I would say...

The data included architectural designers understanding of the NBR parts or framework:

P4 (2.63) (Nods) We already understand the framework.

The facilitator probed for more data relative to the NBR reflecting an ideal framework for a model. Data included:

P10 (2.65) If you just look at the headings, yes. When you look at the NBR - if you just look at the index it'll cover the points.

Rb (2.66) The breakdown of the parts?

P10 (2.67) Yes, but don't look at what is in it - they just serve to confuse the issue because one of the greatest problems with that is the parts don't talk to each other.

Rb (2.68) So the parts could form a framework?

P12 (2.69) It could probably, but I would not use that on it's own.

Literature relates the technical elements of buildings similar to the parts of the NBR. The third provisional study suggested the NBR as a possible framework. The fourth provisional study supported the third relative to the NBR and highlighted the importance of the SACAP architectural work stages. The FG data clearly reflects the NBR as constituting a model framework, or at least part thereof. The section which follows, being the SACAP architectural work stages, entertains further notions of a model framework.

It is therefore argued that the NBR must constitute a major element of the model framework, but not the model framework in its entirety. Vast scope exists for the inclusion of the SACAP architectural work stages.

b) The SACAP architectural work stages

The Architectural Professions Act, No. 44 of 2000 ensures that all architectural designers are registered with the SACAP, and makes it an offence to conduct architectural business if not registered (SACAP, 2008). While the SACAP does not emphasise designing for construction H&S it expects members to carry out duties with integrity (SACAP, 2008) – surely encapsulating designing for construction H&S, but not.

The SACAP provides registered members with gazetted guidance (Republic of South Africa, 2010b) on a range of aspects, which includes six 'architectural work stages'

(Republic of South Africa, 2010b). While broader explanation of these is included in the review of the literature, they include: Stage 1: Inception; Stage 2: Concept and viability; Stage 3: Design development; Stage 4: Documentation and procurement; Stage 5: Construction; and Stage 6: Close out (Republic of South Africa, 2010; Goldswain and Smallwood, 2012).

The six SACAP architectural stages of work (Republic of South Africa, 2010b) embrace a typical project from start to completion and assist architectural designers in their work.

Included in the prior NBR discussion and relative to the third provisional study was the matrix form of questioning relative to the SACAP architectural work stages. Although the 'stages' did not form part of the line of questioning its importance was recognised and included in the fourth provisional study (Appendix 4 and Section 4.2.4). The full range of MSs in relation to documentation is not repeated here as it was included in the prior NBR discussion. Not to downplay the NBR with a MS of 4.00, which is well above the average of 3.00, the importance of the SACAP stages of design is demonstrated by a higher MS of 4.20. In short, the provisional studies propose the NBR and the SACAP architectural work stages as both constituting major possible elements of the model framework.

As stated earlier, a 'tick box' and 'assessment matrix' formed part of the FG data, which will be revealed later. Data samples relative to the SACAP architectural work stages are included in what follows. In order to solicit data based on the provisional studies the facilitator probed and an immediate response brought SACAP to the fore:

Rb (2.26) Is there a professional body which guides architectural designers?

P9 (2.27) There is a compulsory body which is SACAP and to practice as an architect in South Africa you have to be registered with SACAP in whatever category … (Excerpt only).

The discussion veered back to the NBR (not displayed here). The facilitator provided a probing statement relative to the SACAP architectural work stages reflecting an ideal framework for a model. Data included a debate as to what constitutes design, of which the aspects aligned themselves with the SACAP architectural work stages:

P3 (2.84) Ja, it can.

Ra (2.85) It can?

P6 (2.86) Just read that (statement) again.

Ra (2.87) The SACAP stages of work reflects an ideal framework for the model.

P7 (2.88) Ja, I agree with that.

Ra (2.89) Which goes back to the question of does the professional body guide the design process? So if we are agreeing with the SACAP stages of work, are they providing some guidance in the design process? If you are agreeing with this statement then it talks to the previous question about the professional body, but anyway the statement on the table is 'the SACAP stages of work reflect an ideal framework for the model'. Can we think about that for a moment?

P10 (2.85) The stages of work – that is like the summary, what happens within those stages and what are the implications. It does define the cycles up until occupation of building.

P12 (2.86) But it does not actually help us. That actually only serves so that the client understands how we claim fees and how the things actually come together. It's really theoretical. I don't think so.

P9 (2.87) I did write earlier when you were talking, I said here concept design, cost estimate, program, and risk assessment. So I thought possibly a risk assessment report could be built into the SACAP work stage. For example Stage 2 would be preliminary design, so you would produce a preliminary design, preliminary cost estimate, preliminary programme and a risk assessment report - which is not there at the moment.

Rb (2.88) So you are considering these risks in the early design stages?

P10 (2.93) right before anything further happens…

Rb (2.94) concept and feasibility

P10 (2.95) it is part of the feasibility…

Rb (2.96) … which is Stage 1 of the SACAP.

P1 (2.90) No, can I say no, there is only one stage and that is the design stage, because its inception, its design, it's not detail design...

Ra (2.91) Is detail design not design?

P1 (2.92) If you're thinking about design why can't we see detail design as technical design, not design.

P4 (2.93) That's in Stage 1 to 3 and 4 is documentation …

P1 (2.94) Stage 4 is municipal submission, which is documentation but it's not design it's handover and completion and other stuff. The damage is done, you know if there was a risk and it was not identified you have passed the point of no return.

Ra (2.95) Passed the point of no return … Ok, we're busy building - what happens if a variation order comes into play?

P1 (2.96) Ok, but then you go back to stage one, you go back to first principles, but you are on site.

Ra (2.97) So we can consider construction, health, safety and ergonomics through the SACAP work stages but particularly early stages. Is that what you suggest?

P7 (2.98) I think for the majority, the bulk of it is Ok. If a V.O. comes along we assess it as part of the overall design which goes back to the beginning.

Ra (2.99) So early consideration, stage 1, 2, 3, are we saying if we talk to the problem early in the process, you're possibly making bigger impact and see it through from there, or what are we …?

P7 (2.100) It is your design - your first few stages - it is not documentation for construction health and safety. It is design.

Ra (2.101) Let's just consider documentation for a second, what documentation do you produce?

P7 (2.102) Well it becomes the documentation we've done in stage 4, that is your documentation about your technical, your detailing, your technical spec writing and stuff like that.

Ra (2.104) Is spec writing design or isn't it?

P7 (2.105) That's up for debate. It depends on what you define as design.

Ra (2.106) Health, safety and ergonomics - in the SACAP design stages or stages of design? Health, safety and ergonomics - if I specify something that is …

P7 (2.107) I think in the design development stage, you might know what specs you wanted to write here, I am sure you have considered your materials while designing, you might not physically write it down but you might have considered it.

Ra (2.108) But is it part of the specifications, so it touches on stage 4?

P7 (2.109) It depends what you consider design or not. Some people would see it as design of the building, others might say detail is design. Other people say spec writing is a design. Some people say landscapers are called architects. It's all about how you perceive it.

Ra (2.110) I am glad you brought it up. Is detailing part of design?

P5 (2.111) I would say so …

P6 (2.112) I would say so to a degree (general concurrence by nodding).

Ra (2.113) Is specification part of design?

P7 (2.114) It's part of the design … It's part of making the design work.

Ra (2.115) Ok, so for what it is worth, where the designer places the breakpoint in what design is and what documentation is, but it's all part of design – is this what you're saying - to an extent at least?

P1 (2.116) Yes (nodding from participants).

The SACAP literature provided a backdrop as to the established architectural work stages. While the third provisional study suggested the NBR as framework, this fitted within the SACAP architectural work stages questioning matrix. This realisation forged the relevant line of questioning for the fourth provisional study which supported the NBR and ultimately demonstrated the importance of the SACAP architectural work stages toward the model framework. The FG data clearly earlier reflected the NBR as constituting a model framework, or at least part thereof, while the data relative to the SACAP architectural work stages is also leans heavily toward the latter.

It is therefore argued that the SACAP architectural work stages must also constitute a major element of the model framework, but not necessarily in its entirety. The question arises as to the integration of the two.

c) *The cross-reference matrix as ‘model framework’*

The earlier section ‘a’ supported the NBR as model framework and the prior section ‘b’ supported the SACAP architectural work stages as model framework. The support was proffered by the third and fourth provisional studies as well as by the FG data.

The matrix method of questioning used in the third provisional study provided a possible mechanism for integration of the NBR and its parts, and the SACAP architectural work stages. The notion of a matrix was forthcoming early in the FG data:

P10 (2.3) Could it not be a tick box check list of some sort, where you have highlighted all the key issues and things - or some sort of assessment matrix, and if it’s showing high risk then it’s something you flag to take further.

The facilitator probed relative to integration of the two. Some doubt was given, however the discussion incorporated possibility:

Ra (2.117) Ok … so we have made two statements here. We’ve made a statement that the NBR forms a bit of a framework and we made a statement that the SACAP stages of work forms part of a workable framework. Which one do we lean to?

P7 (2.118) I’m still inclined to go with the National Building Regulations.

P4 (2.119) Ja, so would I.

Ra (2.120) Or can we integrate them?

P10 (2.103) I want to see - need how they see that happens, because as I say the NBR generally deal with technical issues.

Rb (2.104) Technical issues - do the technical issues get considered during different work stages?

P10 (2.105) Yes, but they might be considered over and over again. Most of them come into the early phase and then you get into the technical phase. I can't see that you can take the NBR and split them up into stages.

P12 (2.106) I can't see that happen, no …

P10 (2.107) At each stage you have to look at them or certain aspects of them.

P7 (2.121) Maybe, with difficulty.

P3 (2.122) If you think of it, you're trying to put a document together for a framework - the two of them are not really going to gel. The one is talking about parts of a building and the other one is talking about the processes.

Ra (2.123) The one is talking about the parts and the other about the processes - design processes is that what you are saying?

P3 (2.124) Yes.

Ra (2.125) So at what stages of SACAP design do you consider the NBR?

P3 (2.126) Basically all the way through.

Ra (2.127) All of them?

P3 (2.128) Ja ... your initial design concept you're not really thinking building regulations, you're thinking special relationships and things like that. As you start developing your design you start looking at that ... and as you go further into documentation stage, your detailed design and your specifications you'll look more and more at them (regulations).

Ra (2.129) So at various stages of SACAP you will consider the NBR.

P3 (2.130) Maybe not so much during work Stage 1, maybe more in work Stage 2 on.

FG data initially suggested difficulty with integration and the facilitator summarised the concern:

Ra (2.153) (Excerpt only) … Ok, so just generally the NBR reflects an ideal framework and the SACAP stages of work reflects and ideal framework and it might be difficult to integrate them. Is that a summary of what you're saying?

P4 (2.154) Yes (numerous nods).

The importance of the SACAP architectural work stages re-emerged relative to a discussion on 'H&S experts'. Data samples include:

P6 (4.12) Ja, but they are also more experienced in what they do, because that is there job. So in terms of the design they can certainly give us pointers that say on this design stage these are the points you should look out for...

P2 (4.13) But generally they only come in at contract stage...

P6 (4.14) Yes, I know, yes, they know already what the problems are...

P2 (4.15) They should be more involved in the Stages 1, 2 and 3.

P7 (4.19) So it is up the architectural person whether he engages with the H&S guy at stage 1 or 2 or at what point. If you go to Stage 3, and you haven't got him in yet, and he comes and let's call it 'bugs' your design, because you haven't considered H&S regulations - then it'll be a bit silly.

Ra (4.20) You are talking about site, you're talking about structure, you're talking about design stages, I am seeing a continual link between the design stages and the SACAP - I mean the SACAP design stages and the NBR components?

P7 (4.21) If you're talking about design – then we've got to – got to consider it.

Data gathered later in the FG proceedings confirmed the link between the NBR and the SACAP architectural work stages:

P7 (9.40) (Excerpt only) … That might include the NBR as one whatever its going to be called if it is a separate SANS or whatever? From there he has gauged information now in a very broad sense, as part of inception, and from there he is going to as part of his design process be focussing obviously on health and safety … This is really Stages 1 to 3 … there is a very clear line between work Stages 1, 2, 3 and work Stage 4 … documentation … specifications etc…

Ra (9.47) So you are referring to what we have spoken about earlier where the health and safety design aspects can come in pretty early, in Stage 1 to 3 which are the SACAP work stages?

P7 (9.48) If it's (H&S) going to be a major shareholder it needs to come in early - it depends how serious this is, if it is not that serious maybe it can come in further, but I hear you're talking about designing.

Ra (9.49) Early stages you say?

P7 (9.50) It's early stages yes, so in Stage 4 is monitoring and change, in other words 'tweaks' as whoever was saying. We're not getting everything, so just now an engineer would say, you know what, that beam needs to be 600 not 300 or whatever it is. So if possible tweaks as health and safety but it is more monitoring and that goes right to Stage 5, right through. The end process - work Stage 6 which could incorporate stuff like document findings, in other words you documented the project it is now being built - you've done your findings and now you are going to recycle it back into the industry from a point of view of updating that.

P7 (9.58) (Excerpt only) … we get to the point of the in-office situation, and this is where we come to our 'model' if you want to call it that.

Ra (9.59) How to design?

P3 (9.60) Yes. This is where we come to our checklist. In the checklist we have an issue of when do you check, ok, basically each work stage … your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report …

Finally, data relative to focus group respondents attempting to sketch a model includes the integration process:

Ra (9.73) In the earlier discussion the NBR came out as a possible framework and both yourself and the previous speaker have spoken about the SACAP stages as well somewhere along the line?

P3 (9.74) That's where you go back to this process (refers to flipchart) here - when do you check, which work stage? In each work stage you have to check - after each work stage you pick up your checklist and you go through.

Ra (9.75) You are talking about NBR, the arrow, does that relate to the checklist?

P3 (9.76) I would say 'yes', because what is in there needs to be in here.

P7 (9.77) Health and safety is part of it.

Ra (9.78) So that is part of the framework really, we're going to check accordingly. Ok- I'm understanding it now.

P3 (9.79) To link your processes and your NBR which is specific parts of the building, the process would be - we use a checklist at the end of each stage.

Ra (9.80) So parts of the building are important?

P3 (9.81) Yes, the parts come in here, so when you are doing your work Stage 1, you're almost finished with work Stage 1, of course you have been thinking about it while you doing the project, then you do your checklist and make sure that you have dealt with all the issues in work Stage 1, and each time you get to another work stage completion, you do the same thing again so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

Ra (9.82) Very interesting!

P3 (9.83) Then you have one checklist. You don’t have a massive document - it might get quite big - I mean your NBR has got how many parts in it – at least 24.

Ra (9.84) So it is a checklist which you can look at after each work stage?

P3 (9.85) At each work stage – Ja (Colloquial ‘yes’), and then you are combining your processes with your items as well.

Given the questioning matrix for the third provisional study, the importance of the NBR and its parts and the importance of the SACAP architectural work stages as exposed by the fourth provisional study, the possibility of integrating the two was raised. The FG data offered concern, but eventually realised how the NBR and its parts and the SACAP architectural work stages mesh.

It is therefore argued that the NBR and its parts and the SACAP architectural work stages both constitute major elements toward the model framework and that integration of the two is necessary.

After careful consideration and thumbnail sketching, the researcher proposes that the many parts of the NBR (Parts A – X) form a vertical ‘y-axis’ of the model framework, and that the SACAP architectural work stages (1 – 6) form a horizontal ‘x-axis’ of the model framework. The concept is not to form a repeat of the NBR, but to use the ‘headings’ or ‘breakdown’ of the parts as guidance. This notion was also incorporated in the FG data:

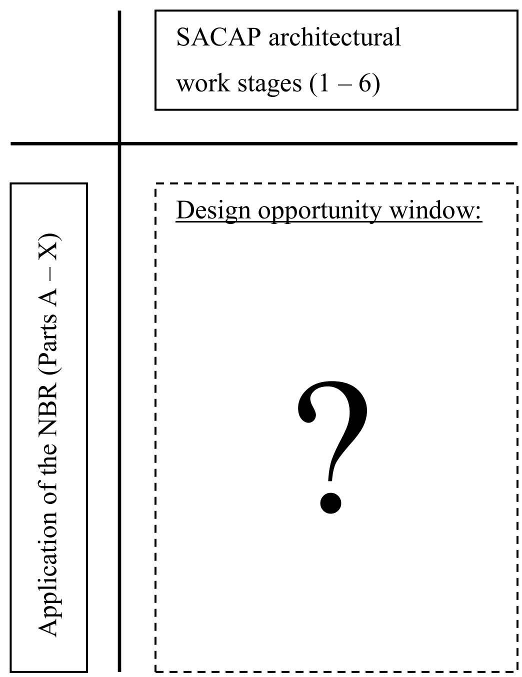
P10 (2.65) If you just look at the headings, yes. When you look at the NBR - if you just look at the index it’ll cover the points.

Rb (2.66) The breakdown of the parts?

P10 (2.67) Yes, but don’t look at what is in it - they just serve to confuse the issue because one of the greatest problems with that is the parts don’t talk to each other.

Stemming from the interaction of the NBR parts and the SACAP architectural work stages as model framework, a vast range of interactive points of intersection become the real opportunity for designing for construction H&S. In the light of opportunity, the researcher has termed this the 'design opportunity window'. This is depicted below within the two axes of the model as model framework.

Diagram 2: Provisional 'model framework' incorporating the 'design opportunity window'



The question arises as to what opportunities exist within the 'design opportunity window' for architectural designers to design for construction H&S?

6.3.2 The 'design opportunity window'

With the model framework giving rise to the 'design opportunity window', the question arises as to what should be incorporated into the window, which architectural designers can consider during the design process in terms of designing for H&S. Generally, this relies on Theme 3 'The search for a working process'. Relevant literature, and more specifically relevant international approaches and models', among other considerations, as well as the preliminary studies, provided much backdrop toward developing and 'populating' the design opportunity window.

While some sub-sections of the 'design opportunity window' were not directly interrogated in the provisional studies, the statement of 'a guiding approach or model would assist architectural designers in the process of designing for construction health, safety, and ergonomics' was incorporated into the third provisional study (Appendix 3 and Section 4.2.3). The response realised a MS of 4.25 which is well above the midpoint score of 3.00.

A similar statement being 'A guiding model should include a process which architectural designers can follow in order to design for construction health, safety, and ergonomics' was incorporated into the fourth provisional study (Appendix 4 and Section 4.2.4). The response attracted a MS of 3.60 which is above the average of 3.00, thus indicating possible need for inclusion of a design process.

What follows provides a process, but recognises that design is cyclic and suggests that the design process cannot be static.

a) Design options and design selection

If poor design and planning decisions lead to 'active failures' (Haslam *et al*., 2005), then surely better consideration of optimum alternatives can proactively ensure project success (Hinze, 2005; Toole and Gambatese, 2006). Following extensive research, Behm (2006) concluded that up to one third of construction accidents could have been avoided if better design options were implemented, while the HSE (2003) proposed that safer design options could have mitigated up to 50% of accidents.

While the CDM Regulations (Neil, 1994; Hetherington, 1995; CDM, 2007) and the South African Construction Regulations (Republic of South Africa, 2010a) attempt to ensure that architectural designers consider construction H&S in exercising their design options, the UKs Gateway model (HSE, 2004a) and the Australian CHAIR model (WorkCover

NSW, 2001) actually provide opportunity for architectural designers, *inter alia*, to review their chosen designs toward establishing the optimum option and selection.

Design options and design selection were not specifically incorporated into the provisional studies, yet consider a choice of options and eventual selection as normal to every task we undertake in life – certainly in the design process. The second provisional (see Appendix 2 and Section 4.2.2) study, however did question inclusion of H&S into the design process. Selected data suggests that 'It should be part of integral thinking ... part of design and documentation', and 'The fundamentals of health and safety should be discussed, even at university, and should be monitored and recorded'.

Broader FG data arising from the second theme, 'the search for a model framework', raised the question as to what actually constitutes design? This is considered relevant here, although partly repetitive, and data includes:

Ra (2.99) So early consideration, Stage 1, 2, 3, are we saying if we talk to the problem early in the process, you're possibly making bigger impact and see it through from there, or what are we …?

P7 (2.100) It is your design - your first few stages - it is not documentation for construction health and safety. It is design.

Ra (2.101) Let's just consider documentation for a second, what documentation do you produce?

P7 (2.102) Well it becomes the documentation we've done in Stage 4, that is your documentation about your technical, your detailing, your technical spec writing and stuff like that.

Ra (2.104) Is spec writing design or isn't it?

P7 (2.105) That's up for debate. It depends on what you define as design.

Ra (2.106) Health, safety and ergonomics - in the SACAP design stages or stages of design? Health, safety and ergonomics - if I specify something that is …

P7 (2.107) I think in the design development stage, you might know what specs you wanted to write here, I am sure you have considered your materials while designing, you might not physically write it down but you might have considered it.

Ra (2.108) But is it part of the specifications, so it touches on Stage 4?

P7 (2.109) It depends what you consider design or not. Some people would see it as design of the building, others might say detail is design. Other people say spec writing is a design. Some people say landscapers are called architects. It's all about how you perceive it.

Ra (2.110) I am glad you brought it up. Is detailing part of design?

P5 (2.111) I would say so …

P6 (2.112) I would say so to a degree (general concurrence by nodding).

Ra (2.113) Is specification part of design?

P7 (2.114) It's part of the design … It's part of making the design work.

Ra (2.115) Ok, so for what it is worth, where the designer places the breakpoint in what design is and what documentation is, but it's all part of design – is this what you're saying - to an extent at least?

P1 (2.116) Yes (nodding from participants).

Although some debate around what constitutes design took place, it is important as the eventual consensus was that design, detailing, and specifications all form part of design to some degree. These are all encompassed, *inter alia*, in the SACAP architectural work stages (Republic of South Africa, 2010b).

In the search for a working process (Theme 3), FG data initially promotes ideas outside of the design realm. The facilitator probed and the selected data comprises:

Ra (3.3) In terms of process, I am thinking from a design aspect - can I maybe ask a question - a probing question: Do architectural designers attempt to finalise the status of their designs at each stage of the design process before progressing? Each stage now for example your SACAP stages as mentioned before.

P3 (3.4) I find it very difficult - there is no cut-off point. It is backwards and forwards processes until you get to the final. You can't say I have now finished Stage 1, I can carry on to Stage 2. The ideal of course would be to say I am finished with work Stage 1, work Stage 2, now it is the final stage of development, call it if you want to preliminary working drawings if you want to.

P10 (3.3) You go back, it is a constant review.

Rb (3.4) During this constant review situation, is there opportunity for inclusion of health, safety and ergonomics considerations?

P12 (3.5) Of course yes.

Rb (3.6) Any suggestions as to how?

P10 (3.7) Again – what are you wanting to consider? When you look at the ergonomics and all the rest, what are we looking at - how are the guys going to build it? So right up front we are making a decision as to the kind of structure we will use.

Rb (3.8) So once again it is building type?

P10 (3.9) It's building type – or not building type but construction type.

P9 (3.10) The question is – Is there a process to support safety in design. At the moment is there a process? The answer to that is probably at the moment – No.

P7 (3.6) I think it's automatically there in varying degrees. I did a house once where I specified a large pane of glass. I didn't consider how the hell they'd get it to the first floor. So yes, the next time I design a house I'll consider how and chat to the contractor. I think sometimes you work through the stages and other times you work to your own initiative.

Design is suggested to include design, detailing and specification, *inter alia*, and is included in the SACAP architectural work stages. In the search for a working process (Theme 3), the data suggests that design, as research, is cyclic or helical in nature. Comments such as "… there is no cut-off point. It is backwards and forwards processes until you get to the final" (P3, 3.4) and "You go back, it is a constant review" (P10, 3.3) epitomise this. Data suggests that "The ideal of course would be to say I'm finished with work Stage 1, work Stage 2, now it's the final stage of development …" (P3, 3.4). Data also suggests a current lack of process, and as to 'how' is suggested to be subject to the kind of structure, the building type, and / or the type of construction. Although it is likely that the ideal eludes us, the literature and the researcher proffers that during the design process architectural designers consider a range of design options, and ultimately select a specific design. It is therefore advocated that 'design options' and 'design selection' be independently included in the design opportunity window despite the cyclic or helical nature of design. The literature and the focus of this research would then imagine that architectural designers consider construction H&S while considering design options and undertaking design selection, and throughout the SACAP architectural work stages.

b) H&S reviews

Relative to design, Hinze (2005) promotes construction H&S through continual operational improvement, and Toole and Gambatese (2006) claim that designs should be "... reviewed to ensure it can be constructed safe(l)y, as well as meet cost, schedule and quality goals."

The UK's Gateway model in complete form for larger projects includes opportunity for 'performance assessments' (reviews) at given intervals (Gateways) throughout five sequential project phases being the concept, feasibility, design, construction and maintenance phases (HSE, 2004a; Cameron *et al*., 2005). In collapsed form for smaller projects, the Gateway model allows for 'Consolidated Gateway Reviews' toward ensuring construction H&S consideration (HSE, 2004a).

The Australian CHAIR model provides architectural designers, among others, the "... opportunity to sit down, pause and reflect on possible problems" (WorkCover NSW, 2001, 4), being the opportunity to conduct H&S reviews through three specific phases. H&S reviews are openly included in the name CHAIR, with the 'R' itself meaning 'review' (WorkCover NSW, 2001).

The third provisional study (Appendix 3 and Section 4.2.3) incorporated a statement that 'It would be beneficial to have an approach or model which includes a mechanism for interim assessments during the various stages of the design process', which realised a MS of 3.50, which is above the midpoint of 3.00, thus indicating likely inclusion of H&S reviews.

The facilitator probed as to whether there is opportunity to scrutinise or review designs in terms of construction health, safety, and ergonomics as part of the design process and FG data included:

P2 (3.8)	Are you referring to like a checklist?
Ra (3.9)	Mmmm - it might include a checklist if one exists, or existed at some point, but from a designer point of view could anybody sit down and say ok I've done my design to a certain stage, is it possible to sit down and look at my design and ask myself health, safety and ergonomic questions?
P3 (3.10)	I think it is very possible to do it.
Ra (3.12)	So do we concur that there is opportunity to sit down and scrutinize our designs as we progress - when and how could we do that?
P6 (3.13)	Is it not something we're already doing – is it not part of the design process? It is not like kind of we have to like say now health and safety has to come into it - Is it not part of the overall design process?
Ra (3.14)	Mmm - It should be, it is not being done, but it should be.
P7 (3.15)	It depends on the extent to which you want it to be done.

P12 (3.15) If the designer can refine the design and say there might be better processes or whatever the case might be to achieve the goal, one needs the knowledge. So those kind of things in the mechanism whether via consultation, whether the client says we must use that guide or that process whatever the case is, so I am jumping now, but that is the kind of thing to support the design. They do feed in. Design is very much an animal which you are dealing with, which is not a fixed thing.

Rb (3.16) So just to cut back to where we were, there is opportunity for inclusion once…

P10 (3.17) There is opportunity for inclusion - whether the client accepts that is another story.

P9 (3.19) Yes of course, and I think a lot of this happens subconsciously to the architect because it is part of the design process. I would say probably in 99.9% of the cases, elements of health and safety are solved not by design but by technical aspects of construction… (excerpt only).

P10 (3.50) I think what you got to do is you got to have a health and safety review … (excerpt only).

The third provisional study supported the literature in the context of South Africa by pointing in the direction of H&S reviews. The FG data suggests that it is possible to scrutinise or review designs, and subject to acquiring knowledge designs can be refined to achieve the goal. On the topic of scrutinising designs, the notion of a checklist (included later) was once again brought to the fore, which can be used as a measure to check designs relative H&S inclusion. It is therefore argued that 'H&S reviews' form a vital element of the design opportunity window.

c) H&S checklists

The Gateway model (HSE, 2004a) includes a range of expectancies created throughout the various phases and creates a roadmap which can quite easily be perceived as a 'checklist' which designers can follow. Further to that, it includes a range of support tools in the form of a 'tool box' which facilitates general project planning and integrates construction H&S planning. Many of these are in the form of documentation frameworks and guides which assist designers and managers, among others, and can also be perceived as 'checklists' toward improved project planning and implementation while including construction H&S considerations.

The Australian CHAIR model (WorkCover NSW, 2001) includes three specific CHAIR sittings which include a range of 'guidewords', *inter alia*, in order to promote discussion toward identification of hazards and risks among the stake-holders, and also allows for development of additional guidewords in order to emphasise other issues that may exist. These guidewords once again can be construed as a 'checklist', however WorkCover NSW (2001) caution that too many guidewords may turn the sitting into an arduous checklist and negate the 'brainstorming' efforts. This caution is noted.

The second provisional study (Appendix 2 and Section 4.2.2) data raised the point of 'checking' by suggesting that '... methodology should check and double check your decisions as you proceed'.

The third provisional study (Appendix 3 and Section 4.2.3) included the statement of 'architectural designers would like a model, which provides a series of checklists which can be used during the design process', which realised a MS of 4.33, which is well above the midpoint of 3.00.

The fourth provisional study (Appendix 4 and Section 4.2.4) included the statement of 'a guiding model should include checklists and allow opportunity for design notes in order to assist the process, which realised a MS of 4.07, which is once again well above the midpoint. The support for 'H&S checklists' therefore reflects the literature.

Not surprisingly, the notion of a 'checklist' was included in numerous sections of the FG data and is finally included here as a 'tool' for use in the design opportunity window. Some initial data included:

P1 (1.5)		Are you looking for a deliverable as an input?

Ra (1.6)		Mmmm – a deliverable – in other words?

P1 (1.7) Some sort of tracking document - like a checklist type of thing.

P10 (1.83) It is almost a tick box that you need to say - and flag them as a hazard from 1 to 5 or something.

P7 (1.9) Maybe the thing of how do you compile a checklist and who compiles it? If you look at the model that is across the board applicable to any project, then that model should be researched if it is a gazetted document for example. That means the model should obviously be researched and amended as per project - how do you form that model which you speak to kind of to get that model right. Who are the role players in other words?

More detailed selected data relevant to the framework includes:

P7 (3.11) I am thinking about a checklist, if you have it as an addition to it. Like people specialising in SANS 204 (NBR) - if they can check your drawings for example, it might be a good idea if they check it from a specialist point of view to see if you have the finer details right. There might be somebody in your office or a specialist out there which can do it as part of the process. I am kind of reading through it, meeting him once a month and then we can go through the health and safety issues as much as you need someone or a professional specialist in the SANS Regulations, as much as you find you can have specialists in anything - you may have a mechanical engineer who can become part of your process before you put that Stage 4.1 together as part of your final drawings, now can we go back to where is it pertinent or more pertinent in the first 3 stages. By the time you get to the structure of the building I think it can be part of the process, part of the design. You need to possibly know it yourself very well, or if you’re a bit rusty on it you find someone who knows more than you - if there is a document to follow – a document or framework.

Further selected data suggests a relationship between checklists and design reviews:

P10 (2.3) Could it not be a tick box check list of some sort, where you have highlighted all the key issues and things - or some sort of assessment matrix, and if it's showing high risk then it's something you flag to take further.

P10 (2.45) To come back to having some matrix or tick-box - you need to take cognisance of all these things, are you compliant, if you are not there is a process that you have to apply. It is really putting together a list of all the things that effect, or could affect the issue, and then it's a thing – are you within the parameter or do you have a circumstance that needs you to take additional precautions.

P3 (9.74) That's where you go back to this process (refers to flipchart) here - when do you check, which work stage. In each work stage you have to check - after each work stage you pick up your checklist and you go through.

Ra (9.75) You are talking about NBR, the arrow, does that relate to the checklist?

P3 (9.76) I would say 'yes', because what is in there needs to be in here.

P7 (9.77) Health and safety is part of it.

Ra (9.78) So that is part of the framework really, and we're going to check accordingly. Ok- I'm understanding it now.

P3 (9.79) To link your processes and your NBR which is specific parts of the building, the process would be - we use a checklist at the end of each stage.

Ra (9.80) So parts of the building are important?

P3 (9.81) Yes, the parts (NBR) come in here, so when you are doing your work Stage 1, you're almost finished with work Stage 1, of course you have been thinking about it while you doing the project, then you do your checklist and make sure that you have dealt with all the issues in work Stage 1, and each time you get to another work stage completion, you do the same thing again so that by the time you get to construction drawings hopefully you have sorted out all the possible problems and then I would say you should probably do the same thing here before you submit.

Ra (9.82) Very interesting!

P3 (9.83) Then you have one checklist. You don't have a massive document - it might get quite big - I mean your NBR has got how many parts in it – at least 24.

Ra (9.84) So it is a checklist which you can look at after each work stage?

P3 (9.85) At each work stage – Ja (Yes), and then you are combining your processes with your items as well.

P7 (9.86) That checklist might be added in your office as your work experience allows you to check while you are busy.

P3 (9.87) And then as you go through your checklist, you are going to say ok right at this stage I need my specialist in here.

Following literature and noting the caution relative to the CHAIR model, provisional studies 3 and 4 both strongly supported the need for H&S checklists. FG data regularly referred to the notion of a checklist, however this often appeared to be 'misplaced' and is best included as a 'tool' for use in the design process. The data not only considers a checklist, but insinuates a matrix that reflects the NBR parts throughout the SACAP architectural work stages and the need to check at each stage. It is therefore argued that 'H&S checklists' form a vital element of the design opportunity window.

d) H&S data records

The review of the literature in entirety, and the more specific aspects such as the statistics would not have been possible without accurate records being kept. Similarly, Behms' (2006) analysis of 450 construction accident reports, and the HSEs' (2003) construction accident study of 100 cases would not have been possible without accurate data records.

The Gateway model (HSE, 2004a) expects all construction documentation to be continually developed and records kept for inclusion in a project H&S file. It maintains that historic data from comparable projects, brainstorming and checklists can be used to assist in the identification of construction hazards and risks, should be categorised and captured in a suitable document or table. Record keeping, for example the H&S files, is considered paramount if designers and others can expect to be defendable in legal situations (HSE, 2004a).

Data from the second provisional study (Appendix 2 and Section 4.2.2) included the need for keeping records by recognising that 'The fundamentals of H&S should be discussed, even at university, and should be monitored and recorded'.

The fourth provisional study (Appendix 4 and section 4.2.4) included the statement of 'a guiding model should include checklists and allow opportunity for design notes in order to assist the process, which realised a MS of 4.07, which is well above the average. The 'design notes' could or should ultimately be kept with project records and could therefore be considered as 'H&S data records'. The support for 'H&S data records' therefore reflects the literature.

FG data included consideration of relevant documentation in the form of reports or maintaining records. Selected data includes:

P9 (3.45) If there was an HSE assessment report as part of your report to the client - or if it forms part of the submission to the local authority – or if the local authority had a tick-box of things you've complied with like NBR and …

P10 (3.50) I think what you got to do is you got to have a health and safety review, don't forget he has to provide a plan and he has to identify at that point are there risks and if he points out there is a risk in the way the design and construct has been requested, if he points that out to you don't respond to it, then I seek that there is…

P12 (3.51) Of course yes, then there is most definitely …

Some data considered records relative to dealing with contractors, bearing in mind that they are not often appointed prior to the design process:

P9 (3.53) Possibly then there needs to be - as part of our contract administration - almost like an agreement. Then I go back to this, I like this tick-box thing, but if you sit down as architect and contractor, the contractor goes through all these things and he signed to say that he has reviewed it and that there are no risks.

P10 (3.60) It also goes around your health and safety plan that you issue at tender stage. So you are identifying the risk. The problem comes in when you haven't identified a risk.

Rb (3.61) Who identifies it – the designer?

P10 (3.62) The designer.

FG data implies that administration (such as H&S data records) could prove invaluable from a legal protection viewpoint:

P1 (2.26) That's my other question. Say you were to be judged as being negligent in terms of health and safety or construction design, or designing for manufacture on site, who would that person be and how would they audit you? What terms of reference could they use as you went past this stage and didn't do x, y, and z? How could they prove that you didn't do x, y, z for instance?

Ra (2.27) Well they are not going to say - I do not know who that person would be, the 'policeman' whoever he is? Could he not say, show me your documentation to prove that you considered it?

P1 (2.28) I'm kind of asking you the question, but I don't have the answer.

P12 (3.57) If there is an incident and I think there is a lot of these guys what they do is they assume they know everything - the contractors as well - that they can build anything anyhow in anyway and then if something does happen, it is easy for them to say okay it is the architect's fault or whatever the case is. What I am trying to say is the review – us making sure that the contractor understands the building and how it is going to be constructed.

P11 (3.58) The onus is on us to make sure that the contractor understands it…

P9 (3.63) Right there is a major problem, because the health and safety specifications that we are putting out, I suspect if it landed up in a court of law we would fall seriously short, because we are not qualified. From the municipality side we've got a standard health and safety specification to literally put out irrespective of, and I think if that comes to a court of law you are going to have serious problems.

P10 (3.88) Recording H&S decisions made. There may well be external factors that fed the choices made - let's say in a construction method. You may be making a choice that has a higher risk, because of other factors. It needs to be recorded 'why' and then how you mitigate the risk.

P3 (9.60) (Excerpt only) … Then there is also an issue of - to show that you have in fact done that. The word that I hate but unfortunately I can't get away from it is your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report. All this documentation gets added to your close-out report to your client.

Literature and the preliminary studies reflected the need for design notes or better still H&S data records. FG data speaks of assessment reports, pointing out risk and contract documentation, and leads to a 'health and safety plan that you issue at tender stage'. These all comprise forms of administration and record keeping, thus it is argued that 'H&S data records' form a vital element of the 'design opportunity window'.

e) Variation orders (VOs)

Toole and Gambatese (2006) suggest that reducing hazards and risks can be achieved during the design process by conducting reviews of the design at various stages, which encapsulates variations or changes from the original design. Hendrickson (2008) suggests that the planning and design of any facility should consider the entire project life-cycle, and states that "… changes of design plan are not uncommon", while these also affect changes in operations which exacerbate construction hazards and risks (HSE, 2004b).

The Gateway model acknowledges changes to design and includes a 'design change control' tool in its 'toolbox'. It is used to implement construction H&S consideration, among other, into any design changes which may occur, usually under pressure, on a construction project. Change management reviews should consider overall status of change on the construction and H&S fronts, among others. It is suggested that more specific risk reviews should take place when changes occur (HSE, 2004a).

The CHAIR model (WorkCover NSW, 2001) relates to all construction phases, and considers the application of guidewords as prompts relative to construction elements under consideration, implying that changes to construction elements should also be reviewed in terms of designing for construction H&S.

VOs[3] were not directly interrogated in the provisional studies however it is argued that these regularly form part of the design and construction process. A statement of 'a guiding model should include a process which architectural designers can follow in order to design for construction health, safety, and ergonomics' was provided in the fourth provisional study (Appendix 4 and section 4.2.4). This realised a MS of 3.60, which is above the midpoint of 3.00, and theoretically incorporates VOs.

The notion of VOs was briefly entertained in the FG data as it constitutes part of the broader design process. Within a broader discussion, the facilitator probed and data included:

Ra (2.95)	Passed the point of no return … Ok, we're busy building - what happens if a variation order comes into play?
P1 (2.96)	Ok, but then you go back to stage one, you go back to first principles, but you are on site.
Ra (2.97)	So we can consider construction, health, safety and ergonomics through the SACAP work stages but particularly early stages. Is that what you suggest?

[3] Variation orders or VOs are commonly used terminologies for design changes in South Africa and stems from a range of contract documentation. The later 'validation of the model' brings this to the fore.

P7 (2.98) I think for the majority, the bulk of it is Ok. If a V.O. comes along we assess it as part of the overall design which goes back to the beginning.

Following on the earlier data, the facilitator probed and data included:

Ra (3.54) H&S should be considered when variation orders occur?

P4 & P7 (3.55) Yes (with nods all round).

P10 (3.92) Definitely yes.

P9 (3.93) I think so. Is there such a thing as a VO (quips – laughs all round)?

While literature suggests that design changes need to take construction H&S into account, the provisional studies did not entertain the notion, however it is argued that these regularly form part of the design and construction process, thus requiring them to be considered in terms of safer design. FG data concurs that 'H&S should be considered when VOs occur', thus it is argued that 'variation orders' form a vital element of the 'design opportunity window'.

f) Sign-off or revisit

Numerous researchers and authors have contended that designing for construction H&S can be enhanced by conducting construction H&S reviews at the various stages of design (Toole *et al*., 2006; Toole and Gambatese, 2006; Behm, 2006; HSE, 2003), while Behm (2006) proclaims that it entails the "consideration of construction site safety in the preparation of plans and specifications for construction projects." Earlier suggestions of accurate record keeping and H&S project files were deemed beneficial (HSE, 2004a; WorkCover NSW, 2001). It is assumed that all these reviews, plans, specifications, and other accurate records are checked and signed off prior to distribution or filing.

The HSE (2004a) furthers this in its aim at improving general project planning and integrating construction H&S planning, and expects the project team to sign-off all review related items prior to confidently progressing (HSE, 2004a). The CHAIR model expects construction elements to be considered relevant to construction H&S and further expects accurate record keeping. Once again the signing off of records is proffered.

In South Africa, The Architectural Professions Act, No. 44 of 2000 ensures that all architectural designers are registered with the SACAP, which expects all registered persons to competently carry out their duties with integrity (SACAP, 2008). While SACAP does not emphasise designing for construction H&S, it was earlier mentioned that the carrying out of duties with integrity would surely encapsulate this. Relevant to signing off the work, architectural work stage 5 'Construction' expects assessment of progress and issuing of practical completion certificates, and architectural work Stage 6 'Close out' expects fulfilment of the project and subsequent final completion certification (SACAP, 2008). Although designing for construction H&S appears to be a lesser priority to the SACAP, such certification would suggest the 'finality' of inclusion of H&S consideration in terms of the design and construction processes if the said integrity was truly in place.

Sign-off was not included in the provisional studies however based on literature the notion was included in the FG proceedings. The facilitator probed as to opportunity to sign off the designs or revisit the process as part of ensuring designing for construction H&S commitment. Data included:

P2 (3.57) The responsible person can sign it off.

P1 (3.58) The responsible person should sign it off – and then – maybe that goes to complexities. Maybe domestic we can sign off, but multi-storey maybe we don't, and an expert comes in.

P10 (3.95) The problem with signing off is you are signing off your documentation or your process, you can't sign off what the contractor is going to do.

Rb (3.96) Yes, we are talking about the design process here.

P10 (3.97) Okay – ja (Colloquial 'yes') - and I think the checking of drawings by the Project Architect or the responsible architect especially where you are using technicians or people who are not PR Arch's - there is a whole responsibility thing depending on the project and the ability of what that person can sign off in terms of the SACAP regulations. So on a complicated building you can't have the technician sign off and check the drawing. It is a quality control thing even if you don't have ISO there is an internal quality control process thing that is linked to this.

FG data supports literature and other insinuations and insists that there is opportunity for parties responsible for design to sign off the work as an internal quality control process in order to ensure commitment to safer design. It is therefore argued that the opportunity to 'sign-off or revisit' forms a vital element of the 'design opportunity window'. Exactly when such opportunity or opportunities to sign-off arise was not interrogated by the focus groups. This is addressed in the 'summary and graphic representation' to follow.

g) Summary and graphic representation

Theme 3 'The search for a working process' exposed a range of vital elements for consideration within the design opportunity window. Many of these emanate from literature, and are supported by the provisional studies and the FG data. These include: design options; design selection; H&S reviews; H&S checklists; H&S data records; variation orders, and 'sign-off or revisit' opportunities.

In closing the theme with the FGs, some direct probing was included as a quick check. The data emanating therefrom included:

Ra (3.37) Just a couple of statements, I am not going to dwell on them. You can react as you wish - Architectural designers should consider H&S in their design options.

P10 (3.66) Yes (participants nod).

Ra (3.46) The design selection should reflect consideration of H&S. Taking your options, does your design - your chosen design out of those options - should it reflect that you have considered H&S?

P10 (3.68) Well any of them should reflect.

Ra (3.48) Mmm - There should be opportunity for design reviews?

P4 & P5 (3.49) Yes (with nods all round).

P10 (3.70) Where?

Rb (3.71) In the design process.

P12 (3.72) By the designer.

Ra (3.50) H&S checklists would facilitate the process?

P9 (3.82) Absolutely.

P10 (3.83) Yes (Participants nodding)

P7 (3.51) Yes, an easy question. Craig Goldswain to compile (chuckles all round).

Ra (3.52) H&S record keeping would facilitate the process?

P4 & P7 (3.53) Yes (with nods all round).

P9 (3.85) Yes, I think it would.

P10 (3.86) You mean through the design process?

Rb (3.87) Yes.

P10 (3.88) Recording H&S decisions made. There may well be external factors that fed the choices made - let's say in a construction method. You may be making a choice that has a higher risk, because of other factors. It needs to be recorded 'why' and then how you mitigate the risk.

Rb (3.89) Recorded and responded to – that's what you are saying?

P10 (3.90) Yes.

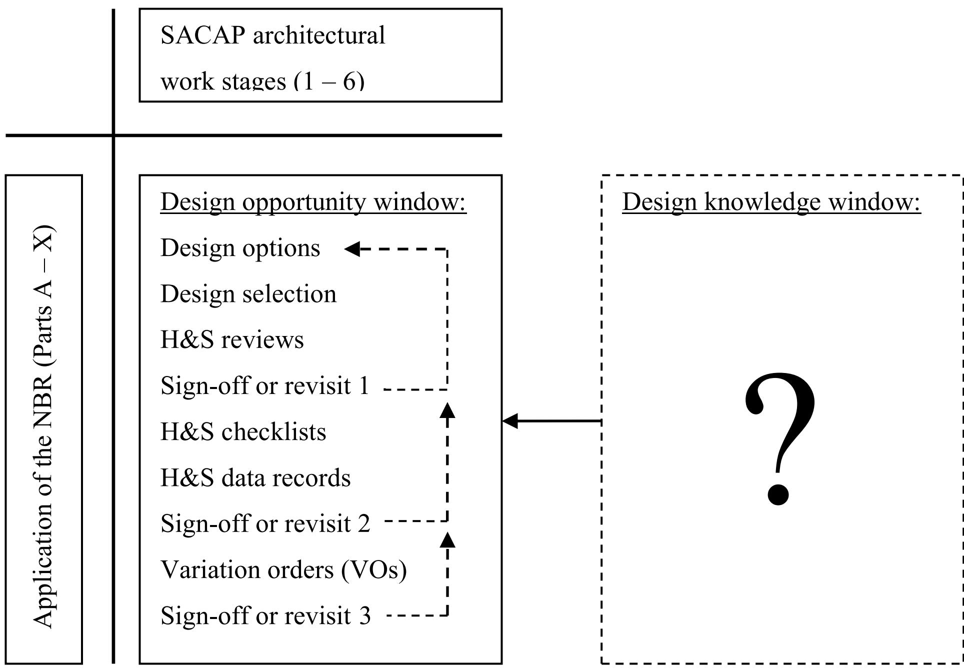
Exactly when to 'sign-off' was unfortunately not entertained by the FGs. Literature has included the cyclic notion of design and numerous opportunities where construction H&S and other related design reviews can take place and appropriate records can be signed off as in the case of the Gateway model (HSE, 2004a) and also the proffered opportunities. The researcher interrogated the research undertaken, and attempted to view the situation as objectively and logically as possible toward development of the provisional model. Although included here, the provisional model was later put forward to the FG members and is included in Chapter 7 'Validation and refinement of the model'.

In attempting to use both objectivity and logic, it must be remembered that what follows should be considered within the framework and throughout the SACAP architectural work stages. It is firstly suggested that signing off on a range of 'design options' bears little fruit as a specific 'design selection' would still need to follow, assuming that H&S considerations were used throughout and that 'H&S checklists' and 'H&S records' were included and maintained. Secondly, once a specific design has been selected it would prove expedient to conduct 'H&S reviews'. If designer satisfaction in terms of safer design is achieved at this point it may well be a worthy opportunity to 'sign-off or revisit' the situation. The 'H&S checklists' (as tools) and 'H&S data records' may well serve toward the said sign-off, but 'sign-off or revisiting' of such checklists and data records would further affirm the designers' commitment to safer design. VOs, which may only occur much later – even during construction – should be subjected to a full design and documentation process including full consideration for safer design, and 'sign-off or revisit' opportunities should be included once again. Although architectural designers may use their own initiative or discretion and adapt their practices as to when to sign-off, in terms of the model the researcher has proposed three specific opportunities.

While design remains cyclic or helical in nature, it postulated that the 'design opportunity window' comprises: design options; design selection; H&S reviews; sign-off or revisit 1; H&S checklists; H&S data records; sign-off or revisit 2; variation orders, and sign-off or revisit 3.

With this in place, the question becomes that of an appropriate knowledge base, in order to enable architectural designers to actively engage the design opportunity window. This has given rise to what the researcher terms the 'design knowledge window', which is depicted below together with the model framework and the populated design opportunity window.

Diagram 3: Provisional 'model framework' with the populated 'design opportunity window' and the vacant 'design knowledge window'



Due to the cyclic or helical nature of design, the format of the 'design opportunity window' cannot accurately be foretold and it is anticipated that individual architectural designers will interpret and adapt it to their own expectations. What follows explores the 'design knowledge window'.

6.3.3 The 'design knowledge window'

The 'design opportunity window' cannot be actively engaged without an adequate knowledge of designing for construction H&S. The question arises as to what architectural designers need to know, meaning what should be, or needs to be, incorporated into the ‘design knowledge window’, which will give architectural designers an adequate knowledge of designing for construction H&S in order that they can make optimum use of the ‘design opportunity window’? As earlier FG data suggested:

P12 (3.15) If the designer can refine the design and say there might be better processes or whatever the case might be to achieve the goal, one needs the knowledge … (excerpt only).

The survey of related literature including that of international models and the preliminary studies has exposed a range of contributory factors deemed suitable to populate the design knowledge window. To some degree, these reflect the ‘key inputs’ but are included from a different perspective – that of architectural designer knowledge.

The fourth provisional study (Appendix 4 and Section 4.2.4) included some qualitative aspects. In response to the question of ‘Do you have any comments or questions regarding a possible framework for a guiding model?’ one response included ‘Exposure of professionals to necessity of a model would highlight shortcomings in knowledge’.

Generally, this section relies on Theme 4 ‘The search for requisite knowledge’. Relevant literature, among other considerations, provided much backdrop toward developing and ‘populating’ the design knowledge window.

a) Construction processes

Construction processes infer the use and type of technology which influences construction performance and the ability to achieve the range of strategic objectives (Chang and Lee, 2004). It becomes essential for all stakeholders, including architectural designers, to recognise the design and construction relationship, what Hendrickson (2008) perceives as an ‘integrated system’, while Chang and Lee (2004) raise concern that most studies address construction management issues and ignore the construction technology realm. These need to come together to ensure the aforesaid ‘integrated system’.

The South African Construction Regulations strive to ensure a multi-stakeholder responsibility for construction H&S. Clients, designers and quantity surveyors, as well as the principal contractor must all accept responsibility for construction H&S. Designers are required to, *inter alia*, provide the client with relevant design information which has an effect on cost, inform the contractor of likely construction risks, provide a geo-science technical report, advise on methods and sequence of construction, and modify the design where construction risks are apparent (Republic of South Africa, 2003; Smallwood and Haupt, 2005). It is proffered that in order to achieve these expectations architectural designers would need an adequate knowledge of construction processes.

The second provisional study (Appendix 2 and Section 4.2.2) data raised the point of construction processes and education by suggesting that 'Training should include on site experience ... and … mentorship is lacking', and 'Architects should have hands on knowledge of what the contractor encounters'.

Similarly, the fourth provisional study (Appendix 4 and Section 4.2.4) included some qualitative data. Relative to construction processes, one response suggested that 'Designers and architectural practitioners should be actively exposed to the physical construction process of projects to ensure a practical understanding of the erection and construction process and constraints'.

The FG data exposed the need for architectural designers to realise how construction happens, including the construction methods used which affect choices and decision making:

P10 (3.88) Recording H&S decisions made. There may well be external factors that fed the choices made - let's say in a construction method. You may be making a choice that has a higher risk, because of other factors. It needs to be recorded 'why' and then how you mitigate the risk.

Some data, while discussing education, highlights the need for technical understanding and understanding of construction processes:

P10 (4.6) Because we are pushing out people from university in an exceedingly fast rate, who - a lot of them are entering the market without ever being in an office. They have been doing their course with having done no practical during the course and during their holiday work, they have done nothing. Tech is even worse and you are putting these people out there and especially your Technicians are suddenly designers now, where previously they were technicians. They do not understand the process, they do not understand the construction process, they are not taught building construction *per se* anymore.

P10 (4.8) You can't buy experience and there needs to be and again it comes to your in-service training of some sort which is not available at the moment. There needs to be an understanding that this is part of the designer or architect's roll. Probably 10% of the architects understand the need or process – to everybody else, it is a whoa! I don't want to be involved.

P10 (4.12) They need to understand the construction process.

P10 (4.27) I think everyone needs to understand the construction process. We are sitting at the moment with a situation, we have a huge part of the industry that doesn't - they have no idea how that is going to turn into a building. You can't design and design safely if you don't understand the construction process.

P9 (4.33) There must be far more emphasis on actual technical knowledge.

The literature suggests that construction processes, integrating technologies, ultimately influences construction performance. The second and fourth provisional studies both proffered architectural designers as needing to understand construction processes, while the FG data reinforced the need. It is therefore argued that 'construction processes' must form a vital element of the 'design knowledge window'.

b) Construction programming

While the construction process integrates technologies, the real issue is "… the implementation of a design envisioned by architects and engineers … performed with a variety of precedence and other relationships among different tasks." (Hendrickson, 2008) Hendrickson (2008) suggests that the planning and design of any facility should consider the entire project life-cycle, and while designers and contractors attempt to introduce time and cost saving techniques into construction, designs should be reviewed to ensure constructability to minimise negative impact (Toole and Gambatese, 2006; Hendrickson, 2008).

Hendrickson (2008) and Lester (2007) promote a range of fundamental scheduling tools or techniques to achieve optimum sequencing and timing of construction activities, while the HSE (2004b) includes a hierarchy of influences with causal connotations in their 'influence networks'. Considering cost and resources serves to demonstrate the interrelationship of construction activities toward achieving project success, yet Cameron *et al*. (2005) caution that project success should arise without construction site risks presenting negative experiences.

Relative to South Africa, the Construction Regulations expected designers to advise on methods and sequence of construction (Republic of South Africa, 2003; Smallwood and Haupt, 2005), among others, which cannot happen without a knowledge of construction programming.

The second provisional study (Appendix 2 and Section 4.2.2) raised the point of construction programming by suggesting that 'some sort of methodology is crucial ... a method or awareness of the building programme'.

The FG data brought the need for programme knowledge to the fore:

P12 (1.49) (Excerpt only) … So maybe that is the other way of looking at it, not just bringing it up but when the building is there. I think there is more scope actually getting that. That way we can probably say listen the guy is not going to lay the carpet until such time as the walls are painted or something like that.

P11 (1.50) You should have a program...

P10 (1.51) You see, that's what I am saying where is that line?

P12 (1.52) I think the line is probably where if you know that this carpet or the glue that they use for example is going to get completely stuffed up - the guys are going to float more toward the ceiling than down on the floor. You say that according to specifications you are not allowed to lay the carpet with that 'thing' until such time as the whole building has been evacuated or the doors are on or the lights are in.

The literature suggests that adequate planning and programming can achieve project success without the negative H&S experiences. The second provisional study touched on '… a method or awareness of the building programme', and the FG data demonstrated the need to understand the sequencing or programming of construction activities. It is therefore argued that 'construction programming' forms a vital element of the 'design knowledge window'.

c) Contextual H&S

Relative to the design knowledge window, architectural designers should have a broad understanding of the circumstances and the environment within which 'designing for construction health, safety, and ergonomics' occurs.

Literature provides a vast expanse of appropriate information which architectural designers can engage toward an improved contextual understanding of construction H&S. Some appropriate literature is included in Chapter 2 'review of related literature' while a quick overview is demonstrated in Section 6.2.1 'relevant literature' to set the scene. These are not included here in order to avoid repetition, however its importance cannot be overlooked. In reality, the general 'contextual H&S' tends to overlap with the majority of this thesis and the four provisional studies – and vice versa.

The FG data exposed a range of possible requisite knowledge as included in the sections to follow, but in terms of 'contextual H&S':

P 4 (4.1) I think first off, a full understanding of the relevant information that is already there.

P10 (4.1) They need to have a basic design health and safety - construction health and safety background … (Excerpt only).

P10 (4.4) First one to me goes around experience and I would say that the average designer does not have the knowledge.

P9 (4.5) I would agree with that wholeheartedly.

P10 (4.8) You can't buy experience and there needs to be and again it comes to your in-service training of some sort which is not available at the moment. There needs to be an understanding that this is part of the designer or architect's role. Probably 10% of the Architects understand the need or process - to everybody else, it is a whoa! I don't want to be involved.

P10 (4.12) They need to understand the construction process.

P9 (4.13) But you need the context as in the need for it.

Rb (4.14) Yes.

P9 (4.15) We need to understand - why is it necessary?

Rb (4.16) The need for it and maybe a little about the background for it and the impact it's got on society - and that …

P9 (4.17) Then yes, then definitely yes.

The broad range of appropriate literature, which is not repeated here, is considered suitable toward providing architectural designers with an appropriate contextual knowledge, notwithstanding overlaps with the sections to follow. The four provisional studies used contextual literature toward placing the study in the context of South Africa. It is therefore argued that 'contextual H&S' forms a vital element of the 'design knowledge window'.

d) Causes of accidents

This section is included here relative to the 'design knowledge window', however was also included previously in the 'key inputs'. In order to avoid repetition, literary reference is deliberately kept brief but is touched on as a reminder.

Haslam *et al*. (2005) referenced Kletz (2001) promoting the multi-causal range of proximal and distal factors which lead to 'active failures' (Gibb *et al*., 2006).

The main causes of accidents worldwide, including South Africa, includes 'falls onto different levels', 'MVAs', 'struck by', 'inhalation, absorption and ingestion', and 'WMSD's or body stressing' (Haslam *et al*., 2005; Penny, 2007; Bureau of Labour Statistics – US Department of Labour, 2008; cidb, 2009, Innes, 2009; Safe Work Australia, 2010, HSE, 2010b).

Behm (2006) proposes that at least one third of accidents can be mitigated through safer design, while the HSE (2003) demonstrated up to 50%.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence relative to the statement of 'Architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics' resulted in a MS of 4.07, which is well above the midpoint score of 3.00, strongly suggesting it's suitability as essential to the design knowledge window.

While FG data discusses risks within section 'c' to follow, it appeared to consider the 'causes of accidents' as risk. The two are most certainly intertwined. Some of the data relative to causes are expressed through example, remembering that exposure to risk can lead to or 'cause' an accident:

P1 (2.72) If it is design, but there could be instances in the design process that you have to cater for - for climatic conditions or whatever. Designing at a place with high wind speeds and you have a façade system, so how do you get that up. So there is, I think it is identification of risks and it you have tried to mitigate once you create a system, I tried this system, that system and we can't get away from it you need this, because that satisfies XA for example you need this type of glass, and it is a big sheet of glass and it is heavy and it's double glazed, and I have to have it for that so it gives you health and safety risks.

P7 (3.6) (Excerpt only) I did a house once where I specified a large pane of glass. I didn't consider how the hell they'd get it to the first floor. So yes, the next time I design a house I'll consider how and chat to the contractor. I think sometimes you work through the stages and other times you work to your own initiative.

P10 (7.18) Yes, and all sorts of things like drilling tunnels in the rock for the thing - the guys, because they would get like 'speed bonuses' they wouldn't wait for the stuff to - the way that the American civil industry worked in that time, compared to what we would see today is horrendous – and the boss back in the office said 'go faster, faster'.

P9 (9.7) I mean if you wanted a 10m high wall, dammit you did a 10m high wall, you did not worry about the health and safety of actually constructing that element. You kind of left it to the contractor to resolve. I think you will understand if we miss anything, because 'all' architects I am going to suggest, 'all' architects are groping in the dark with this topic at this stage.

More direct probing queried whether architectural designers need to understand the causes of accidents. FG data was brief but affirmed the notion:

P3 & P4 (4.25) Yes, as before (nods all round).

P10 (4.19) Yes (nods all round)

A range of appropriate literature relative to CoAs, although kept brief here, can be linked to the notion that exposure to risk ultimately causes accidents. The fourth provisional study gestured that 'Architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics'. FG data examples are directed more toward risk, while such risks can become causes of accidents. More directly, data demonstrated that architectural designers need to understand the causes of accidents. It is therefore argued that ‘causes of accidents’ forms a vital element of the ‘design knowledge window’.

e) Hazard Identification and Risk Assessments (HIRAs)

This section is included here relative to the ‘design knowledge window’ however it is more directed at HIRAs than the more general ‘information on hazards and risks’ included in the ‘key inputs’.

WorkSafe Victoria (2005) provide explanations of ‘hazard identification’ and ‘risk assessments’, but also simplified the terminology – ‘find it’, ‘assess it’, and ‘fix it’. Gangolells *et al*. (2010) promote the need for proactive hazard identification and subsequent elimination, while Pipe Line Safety (2000) proposed assessment thereof in terms of ‘probability of occurrence’ and ‘severity of consequence’, and foster awareness and training toward mitigation. Carter and Smith (2006) conclude that control measures cannot be implemented in the case where hazards and risks are not identified and that a lack of information sharing and a lack of standard procedure exacerbate construction hazards and risks and propose accurate method statements as a means of dealing with the issue. While the HSE (1998) suggests HIRAs to be a careful examination of what is included in ‘work’. HIRAs are included in the name of CHAIR itself, with the ‘HA’ meaning ‘Hazard Assessment’ (WorkCover NSW, 2001).

The first provisional study (Appendix 1 and Section 4.2.1) established that relative to South Africa, architectural designers do not adequately conduct HIRAs, and the statement of ‘architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics’ was provided in the fourth provisional study (Appendix 4 and section 4.2.4). The response realised a MS of 3.53, which is above the midpoint score of 3.00.

The FG data exposed the need for hazard identification and risk assessment, as a contribution to the design knowledge window:

P1 (2.70) (Excerpt only) … so there is an inherent risk of digging down trenches 3, 4, 5m down and say people - it has to be hand dug for whatever geomorphic reason and we have to have personnel down below ground level. I think the professional should identify risks …

P12 (2.11) (Excerpt only) … just before you have a tender - say for example the engineer tells you – do you know what, we thought we can do that but you know what we need 50 million skyhooks now to achieve that goal. That throws the whole thing out. You know what I mean?

P10 (2.12) I agree, I have just been there.

P12 (2.13) Well I am busy with it that is why I am so irritated because there's the thing don't tell me now there is a pipe running there now after three months. That influences the design … (Excerpt only).

P10 (3.60) It also goes around your health and safety plan that you issue at tender stage. So you are identifying the risk. The problem comes in when you haven't identified a risk.

Rb (3.61) Who identifies it – the designer?

P10 (3.62) The designer.

P1 (4.3) I don't think we are the experts in what risks are out there.

Ra (4.4) You don't know the risks out there?

P1 (4.5) What are the major risks on sites, what are the major hazards, what should we be mitigating against?

Ra (4.6) So you need to understand the risks and hazards involved - is that right?

P1 & P3 (4.7) (Both participants nod).

Ra (4.8) Ok.

Rb (4.20) (Probing statement) … Architectural designers need to be able to identify hazards and undertake risk assessments.

P9 & P10 (4.21) Yes (nods all round).

Rb (7.19) It was suggested that all hazards and risks cannot be eliminated, but what can designers do if they are aware of unresolved hazards and risks?

P10 (7.20) They should come up with a mitigation plan with the constructor.

P9 (7.21) As long as you identify the risks, I think the contractor can then address it.

Literature suggests that hazards and risks can be eliminated through HIRAs, while the provisional studies demonstrate the need within the architectural profession of South Africa. FG data demonstrated that architectural designers need to understand HIRAs in order to mitigate accidents. It is therefore argued that 'HIRAs' forms a vital element of the design knowledge window.

f) Project type and complexity

Numerous researchers have contended that 'falls from height' contributes significantly to injuries and fatalities (Haslam *et al*., 2005; Penny, 2007; Bureau of Labour Statistics – US Department of Labour, 2008; cidb, 2009, Innes, 2009; Safe Work Australia, 2010, HSE, 2010b), while Gangolells *et al*. (2010) consider residential buildings which includes, *inter alia*, single storey dwellings relative to HIRAs. This variety of study alone suggests that 'project type and complexity' plays an important role.

'Design recommendations' infer a range of project types and related complexities such as those provided by Behm (2006) drawing on Gambatese and Weinstein: design domed, rather than flat, skylights with shatterproof glass or add strengthening wires; design guardrail protection around skylights; review the condition and integrity of the existing structure and indicate any known hazards or deficiencies on the contract drawings; orientate the project layout or grade the site accordingly to minimise the amount of work on steep sites; for pre-cast concrete members, provide inserts or other devices to attach fall protection lines; minimise the amount of night work, and consider using prefabricated stairways which can be erected as one assembly.

Behm's (2006) 'new design recommendations' include: design appropriate and permanent fall protection systems for residential roofs to be used for construction and maintenance purposes.; design appropriate and permanent fall protection systems for commercial roofs to be used for construction and maintenance purposes; consider permanent anchorage points, lifeline attachments, and / or holes in the perimeter for guardrail attachment, and design wood framed walls to be no more than 8 feet high, when higher walls are specified, provide a warning to the constructors to not lift these higher walls manually.

While project type and complexity needs to be taken into account, qualitative commentary included in provisional study 2 (Appendix 2 and Section 4.2.2) reminds designers of the need to 'Take note that any construction site can be hazardous depending on the behaviour of the constructors on site', and that 'Building at 1m can be as dangerous as at 20m …' It also insinuates project type and complexity with commentary such as 'Besides that the design may be challenging and unconventional …', and that 'there is always a way to carry out works safely, but it is costly for unconventional projects'.

FG data relative to 'additional themes' clearly indicates that 'project type and complexity plays a role in the design process, including the safer design aspirations:

P7 (1.9) (Excerpt only) … the model should obviously be researched and amended as per project …

P1 (2.139) (Excerpt only) … I don't profess to know if I was doing a large scale plan, I am thinking non-domestic now, I wouldn't know how to …

P7 (3.41) Also overseas there are more complicated buildings being built in the first world countries - that is more available than here. I think the complexity high rise etc. has possibly got to do with the high mortality or injury here.

P6 (3.42) And then again on the same topic, should we not be identifying in terms of frameworks what particular projects need more spotlight placed on health and safety than others - ok - it is just a question?

Ra (3.43) Mmm - you're talking building types.

P1 (3.58) The responsible person should sign it off – and then – maybe that goes to complexities. Maybe domestic we can sign off, but multi-storey maybe we don't, and an expert comes in.

P4 (9.34) (Excerpt only) … what in this specific type of project - what one should bear in mind.

P4 (9.97) Maybe I just have a comment. The way SACAP - we were referring to SACAP stages maybe that grid they put out with project complexity, when one start creating a checklist you wouldn't have an all-encompassing checklist, so maybe use the low, medium, high complexity project classification or so as a basis for different projects. Obviously when you hit the higher complexity we start bringing consultants in - a checklist itself is not as valid any more, but at least it gives you that point by point check.

P3 (9.98) You might not even have a checklist - as an architect, you might not have a checklist for a high complexity building, because you are going to bring in your specialist, and the specialist will guide you as far as concern, let them check your design stages. I see that checklist as a basic checklist otherwise it is going to be too cumbersome again.

P10 (1.3) The construction industry is broad based, so you go from domestic, to institutional, to industrial, to commercial, to high rise, and then to specialist projects. Each of them, to my mind, have totally different requirements in terms of project design.

Rb (1.4) You are absolutely correct when it comes to the specifics of different building types … (Excerpt only).

P10 (1.44) It comes back to the kind of structure that is fine, legally in a city centre site where you only going that way (gestures upward) you might be going down first, so then you obviously have shoring, piling, all those things related with the below ground basements and things. Otherwise your restricted site in any of the city centres where you are working over public areas, and the restrictions what do you design in and is it your responsibility to do it - and on my side I think yes – hoardings and things - we need to specify it.

P10 (3.7)	Again – what are you wanting to consider? When you look at the ergonomics and all the rest, what are we looking at - how are the guys going to build it, so right up front we are making a decision as to the kind of structure we will use.
Rb (3.8)	So once again it is building type?
P10 (3.9)	It's building type – or not building type but construction type.

Literature, including a range of design recommendations, is suited to different project types and complexities. The provisional studies caution that any construction situation can be dangerous and include project type and complexity within the notions of 'unconventional' construction. FG data relative to 'additional themes' clearly indicates that project types and complexity plays a role in the design process, including the safer design aspirations. It is therefore proffered that 'project types and complexity' forms a vital element of the design knowledge window.

g) Design recommendations

Design recommendations featured as one of the 'key inputs', and the 'lists' provided by Behm (2006), advocating the contributions of various design recommendations made by Gambatese, and Mroszczyk (2005) acknowledges that the contributions of Gambatese and Weinstein have purpose, and the importance has been demonstrated through examples being used in various sections of this document. Further elaboration will not be made here to avoid repetition.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence with the statement of 'Consideration of existing design recommendations would prove beneficial to developing a guiding model suitable for use in the context of South Africa' resulted in a MS of 3.79, which is above the midpoint score of 3.00, suggesting it's suitability in terms of the design knowledge window.

Based on literature and the provisional studies, the facilitator probed as to whether a knowledge of 'design recommendations' could assist architectural designers to practice safer design. The FG data is brief and to the point:

P10 (1.65) Just clarify that - when you say design recommendations?

Rb (1.66) Yes, if there are other researchers or other practices in other countries who have made recommendations for design practices - if I can put it that way - could design recommendations - in other words recommendations to resolve health and safety issues and risks through the design process.

P10 (1.67) Probably yes - again one needs to look at what is the environment in which that design recommendation has been made against our environment.

Literature included a useful range of design recommendations toward mitigation of construction hazards and risks, and ultimately accidents. The fourth provisional study supported the inclusion of design recommendations, and the FG data demonstrated that architectural designers need to have knowledge of design recommendations in order to mitigate construction accidents. It is therefore argued that 'design recommendations' forms a vital element of the design knowledge window.

h) Lifecycles of Buildings

The provisional studies did not question H&S in relation to the 'lifecycles of buildings' *per se*, however included it as part of the review of the literature by advocating Cameron *et al*. (2005) who discussed the Gateway approach and identified 'concept, feasibility, design, construction, and maintenance as phases' (Appendix 1). Hendrickson (2008) suggests that the planning and design of any facility should consider the entire project life-cycle due to individuality of projects, site peculiarities, future anticipations, and changes to design among other. The Australian CHAIR model includes life-cycles of buildings or structures as it encourages "… stakeholders to come together to reduce construction, maintenance, repair and demolition safety risks associated with design." (WorkCover NSW, 2001: 1)

Relative to 'lifecycles of buildings', specific 'design recommendations' include life-cycle phases for example "…design a parapet to be 42 inches tall. A parapet of this height will provide immediate guardrail protection and eliminate the need to construct a guardrail during construction or future roof maintenance" as provided by Behm (2006) drawing on the earlier works of Gambatese and Weinstein.

FG data relative to 'additional themes' clearly indicates that 'lifecycles of buildings' needs to be considered during the design process, including the healthier and safer design aspirations. Data includes:

P10 (2.80)	The framework will have to look at the life cycle of the building not just the design and construct phase.
Rb (2.81)	... and the life cycle constitutes?
P12 (2.82)	I would very much say the client …
P10 (2.83)	From concept to final demolition. There a lot of buildings that go through three, four cycles in their lifespan, and it's becoming more complex.
Ra (4.31)	Architectural designers need to understand the lifecycles of buildings?
P7 (4.32)	In other words how do you repair it in 30 years' time?
P3 (4.33)	and how do you get rid of it in 30 years' time?
Ra (4.34)	How do you get rid of it – we're talking demolition?
P3 (4.35)	Yes.
P10 (4.25)	Yes (nods all round).
Rb (4.26)	You see these are not new comments, you brought a lot of them to the fore.
P10 (4.27)	I think everyone needs to understand the construction process. We are sitting at the moment with a situation, we have a huge part of the industry that doesn't - they have no idea how that is going to turn into a building. You can't design, and design safely if you don't understand the construction process.

P9 (4.29) That is not being emphasised sufficiently even at university level. I considered myself fairly practical when I had finished varsity, because I had worked for a year and a half for Architects fulltime as well as all my holidays, barring one, while I studied, and the first job that I got to do as a qualified architect, not registered, qualified – I could not do it.

P10 (4.30) I'll give you an example – we had, a couple years ago, a lady who came from UPE, a bright girl, she was asked to go and do a little old house plan and submit it – she could not even understand the basics of what was needed to submit a plan for a small thing. There is no training anywhere in the system to equip them to go and practice – it's all theoretical - everything that used to be in the courses …

P9 (4.31) I agree.

P10 (4.32) When I studied up in Johannesburg, part of our thing we had to go and build a structure, I think we built little shelters at a sports ground. I know here in PE they used to do it - they actually made the architectural students go hands-on and build something somewhere.

P9 (4.33) There must be far more emphasis on actual technical knowledge.

P10 (4.34) That has gone totally out of the thing. The Tech guys are even worse, because it is all on paper these days, it is not even paper anymore – it's a computer exercise.

Ra (4.36) Ok, so it is not only construction, we're talking about repairs or maintenance and demolition.

So, In general if architectural designers knew something about these things, it would help in the design process. Is that what we are talking about?

P3 (4.37) Ja (numerous nods)

Literature offers the need for architectural designers to consider the 'lifecycles of buildings' during the design process. This was also included in the review of the literature relative to the first provisional study. The FG data relative to 'lifecycles of buildings' clearly indicates that this must contribute to the design process. It is therefore proffered that 'lifecycles of buildings' forms a vital element of the design knowledge window.

i) Summary and presentation of the core model

This section considered a range of vital elements for consideration within the design knowledge window. These emanate from literature, are supported by the provisional studies and the FG data, and include the need for architectural designers to have a sound knowledge of: construction processes; construction programming; contextual H&S; causes of accidents; HIRAs; project type and complexity; design recommendations, and lifecycles of buildings.

During the FG sittings, the facilitator also attempted to summarise:

Ra (4.24) Ok, a couple of statements here … Architectural designers need to understand the causes of accidents.

P3 & P4 (4.25) Yes, as before (nods all round).

P10 (4.19) Yes (nods all round).

Ra (4.26) Ok - they need to be able to identify hazards and undertake risk assessments.

We're talking about hazards and risks - would it be beneficial if architectural designers could identify hazards and risk assessments?

P3, P5 &P7 (4.27) Yes (nods all round)

P9 & P10 (4.21) Yes (nods all round).

P4 (4.28) I think that comes back to education.

Ra (4.29) Ok, it comes back to education - right - Architectural designers need to be aware of any existing design recommendations to aid the process?

P3, P4, P5 &P7 (4.30) Yes (nods all round).

P9 & P 10 (4.23) Yes (nods all round).

Ra (4.31) Architectural designers need to understand the lifecycles of buildings?

P7 (4.32) In other words how do you repair it in 30 years' time?

P3 (4.33) and how do you get rid of it in 30 years' time?

Ra (4.34) How do you get rid of it – we're talking demolition?

P3 (4.35) Yes.

P10 (4.25) Yes (nods all round).

Rb (4.26) You see these are not new comments, you brought a lot of them to the fore.

P10 (4.27) I think everyone need to understand the construction process. We are sitting at the moment with a situation, we have a huge part of the industry that doesn't - they have no idea how that is going to turn into a building. You can't design and design safely if you don't understand the construction process.

P9 (4.29) That is not being emphasised sufficiently even at university level. I considered myself fairly practical when I had finished varsity, because I had worked for a year and a half for Architects fulltime, as well as all my holidays, barring one, while I studied and the first job that I got to do as a qualified architect, not registered, qualified – I could not do it.

P10 (4.30) I'll give you an example – we had, a couple years ago, a lady who came from UPE, a bright girl, she was asked to go and do a little old house plan and submit it – she could not even understand the basics of what was needed to submit a plan for a small thing. There is no training anywhere in the system to equip them to go and practice – it's all theoretical - everything that used to be in the courses …

P9 (4.31) I agree.

P10 (4.32) When I studied up in Johannesburg part of our thing we had to go and build a structure, I think we build little shelters at a sports ground. I know here in PE they used to do it - they actually made the architectural students go hands-on and build something somewhere.

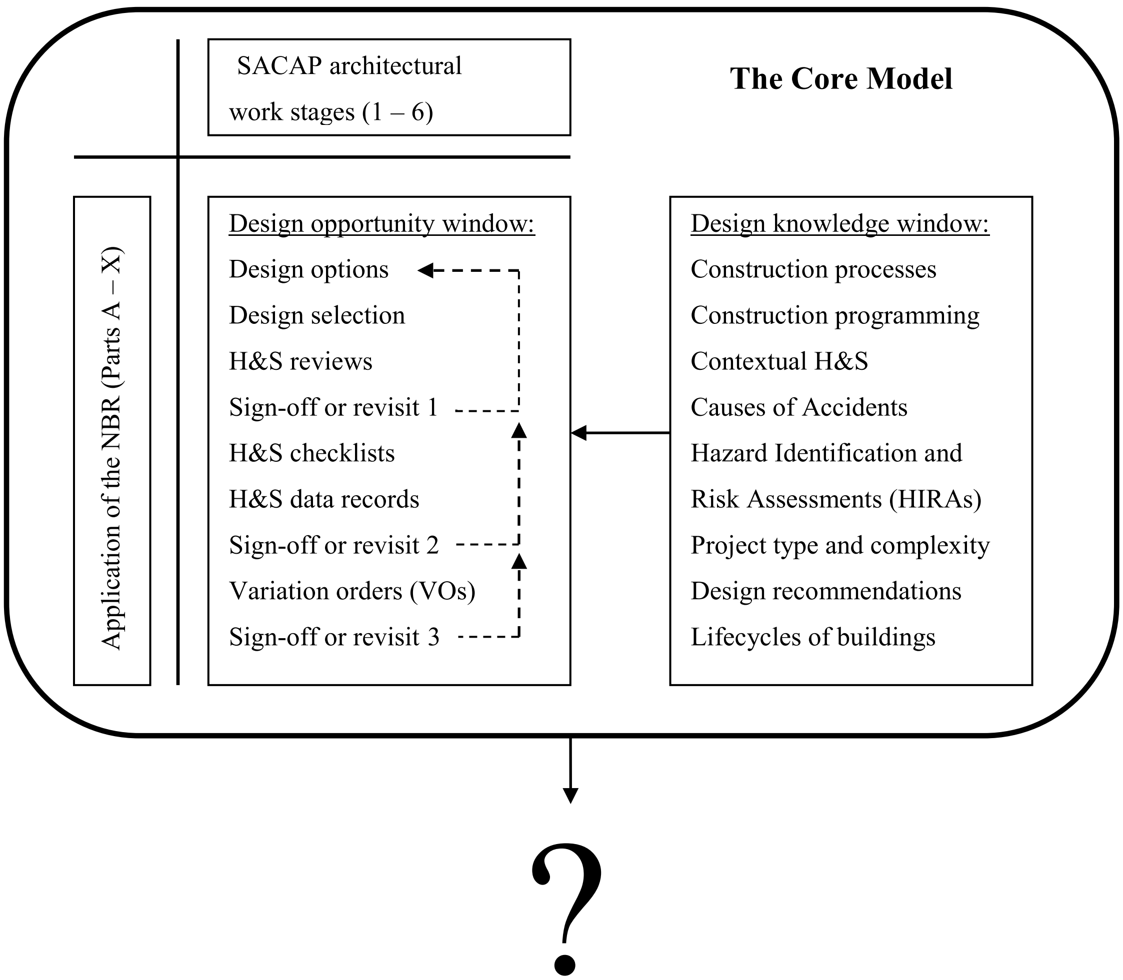
P9 (4.33) There must be far more emphasis on actual technical knowledge.

P10 (4.34) That has gone totally out of the thing. The Tech guys are even worse, because it is all on paper these days, it is not even paper anymore – it's a computer exercise.

Ra (4.36) Ok, so it is not only construction, we're talking about repairs or maintenance and demolition.

The range of contributory factors significantly contributed to populating the provisional ‘design knowledge window’. Linked to the ‘design opportunity window’ as part of the model framework, these come together to create the provisional ‘core model’ as depicted below in the form of the provisional ‘Core Model’ for safer architectural design in South Africa.

Diagram 4: The Core Model



The question arises as to ‘what mechanisms will enable the implementation of the proposed core model?

6.4 THE MECHANISMS

This model component draws primarily on Themes 5 and 6, and realises the need for 'engaging people' in order to promote healthier and safer design, and the need for 'education and training' in order to ensure adequate knowledge for architectural designers to engage in healthier and safer architectural design. In terms of this study, this questions the possibilities for implementation of the core model. Although the aspects are discussed independently a strong interrelationship and interdependency presides.

6.4.1 Engaging people

This section is entitled 'engaging people' as safer design relies on involvement of a range of people – not merely architectural designers. However, the topic of this research remains and architectural designers need 'encouragement' to undertake healthier and safer design, to consider and embrace 'upstream design ownership', and to ensure a 'multi-stakeholder approach' toward healthier and safer design.

While literature and the provisional study data is included in the specific sections to follow, 'education and training' and 'knowledge and access to information' was included in the FG data. A strong interrelationship between the aforementioned sections presides.

In terms of the FG data, 'education and training' is necessary and could lead to 'engagement':

P3 (5.16) All the kind of stuff that the safety guys have experienced on site, that should be fed back into the education system. So the guys who are coming out of the university are already aware of what is expected and what to cover when they design.

P8 (5.17) They will have to make it a 15 year course (chuckles all round).

P3 (5.18) Ok, so once they walk out of university they are at least aware - not going to find out in the big wide world that you start your own practise after 2 years and you still don't know all these things and then the first project that you do the whole wagon hits the wheel and you're sitting with it and you don't know what to do.

The FG data also includes 'knowledge and access to information' as leading to 'engagement'

P1 (7.18) I don't know if it answers the question, but I'd see that if there is this knowledge and this database, that you start specifying different materials, or start utilising different construction techniques for certain elements, if you knew they mitigated a risk. So you'd start looking for pre-fabrication if you knew there is a risk like walls falling down for example. Then maybe new products would start coming on the market and you would specify them - like there's new greener products coming onto the market, you start specifying a greener product because there is more benefit. But that knowledge of why you're specifying it is known - if there is knowledge that whatever you're doing can mitigate risks on site, you'd start using it.

Ra (7.19) Based on knowledge - ok, you'd start using it. Well...

P1 (8.8) After a while you would become satisfied that what you specified causes no risk and you become...

Ra (8.9) So it is like a learning curve and you?

P1 (8.10) Once you get to a recipe that you know is fool-proof, it talks to a standard – and informs the next one.

In terms of the model, the 'design knowledge window' as addressed earlier, and the section on 'education and training' which soon follows are interrelated, but are considered worthy of their own sections. They are therefore not included with the other sub-sections which follow immediately.

a) Encouragement

Vast recognition has been given to the dangers of the construction industry, and many have sought to encourage designers, including architectural designers, to mitigate construction hazards and risks through the design process (Hetherington, 1995; WorkCover NSW, 2001; HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011).

The second provisional study (Appendix 2 and Section 4.2.2) questioned what would encourage architectural designers to engage in healthier and safer design. Some selected commentary, which overlaps with other aspects of the study includes: 'Educating people ... tedious to implement ... should not limit design'; 'Ongoing education to keep it at the forefront of one's mind ... it's becoming more visible as a topic'; 'It is more a case of awareness, even at university level ... it stems back to Architectural School days'; 'One may be able to make up manuals ... needs to be brought to our attention ... an awareness is needed'; Training should include on site experience ... mentorship is lacking', and 'Architects should have hands on knowledge of what the contractor encounters'.

The third provisional study (Appendix 3 and Section 4.2.3) included the statement of 'Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if there was a guiding approach or model in place to assist them'. Response to this statement realised a MS of 4.25, which is well above the midpoint score of 3.00.

Relative to the fourth provisional study (Appendix 4 and Section 4.2.4), the degree of concurrence to a slightly adjusted statement of 'Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if there was a guiding model in place to assist them' realised a MS of 4.18, which is above the midpoint score of 3.00.

With respect to the topic of whether architectural designers need encouragement to practice safer design, the FG data included:

P3 (6.26) At this stage, probably yes.

P4 (6.27) Yes.

P10 (6.26) I think so (nodding from P10).

P9 (6.27) The health and safety aspects are considered by most architects as just another hassle when we are already in a hassled process.

P12 (6.28) Yes, very true, very true.

P9 (6.29) It is just another liability being fostered on us.

P10 (6.30) Even if they consider them at all.

P9 (6.31) So it is something that would need …

P12 (6.32) They are quite good.

P10 (6.33) They need to understand the implications why we should do it.

P9 (6.34) They are nice people, generally (everyone laughs).

To the question of 'what would engender architectural designers to engage in safer design', relevant FG data included:

P7 (6.1) It's exactly what we've spoken about - if you are convinced that it's worth it to save someone's life, then obviously you can engage with it.

Rb (6.9) Would Architectural designers be inclined to want to save lives?

P12 (6.10) Of course yes. The answer has to be yes.

Relative to the facilitators probe on 'having a model and requisite knowledge in place will aid the process', the focus group data was concise:

All (6.29) Yes (much nodding).

P10 (6.36)	Ja (Colloquial 'yes').

P9 (6.36)	Yes, definitely (nodding all round).

Vast literature has recognised the need and encouraged designers, inclusive of architectural designers, to design for construction H&S. The provisional studies offered solid support in terms of encouragement, and the FG data demonstrated that saving lives would certainly serve to encourage architectural designers, and having a model and requisite knowledge in place would promote further encouragement. It is therefore argued that 'encouragement' constitutes a vital means of 'engaging people'.

b) Upstream design ownership

The earlier discussion on 'encouragement' has a natural tendency to lean toward 'upstream design ownership'. If the vast advocacy toward proactive designing for construction H&S (Hetherington, 1995; WorkCover NSW, 2001; HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011) is accepted and undertaken by architectural designers, this would imply 'upstream design ownership'.

The HSE (2003, 58) distinctly mentions factors which "... are a result of originating influences, such as permanent works design …" thereby insinuating the 'upstream' nature of design, while the Gateway model moves ownership of construction H&S risks upstream in a "... structured, systematic, logical, rigorous and transparent ..." manner (HSE, 2004a).

Cowley *et al*. (2000) cite Bender and Hadley (1994) relative to specifications by suggesting that pressure be applied on manufacturers of hazardous chemicals to improve hazard information on packaging, thus making 'upstream target groups', being designers, more aware of the risks presented through the use of specific products.

While ‘upstream design ownership’ was not specifically investigated in the provisional studies, some hint of control or ownership was provided. The second provisional study (Appendix 2 and Section 4.2.2) data infers ownership by suggesting that ‘It is up to the professional … we need to educate the client to trust the professional’.

Similarly, on the topic of ‘upstream design ownership’, relevant FG data included:

P10 (6.14)	They would certainly would want to drive the process, but they would need co-operation from the client.
P12 (6.15)	Exactly
P10 (6.16)	It comes back to where is the designer in this, and the role needs to be related to the principal agent role, because you need to have control over the other consultants to see that there is compliance. You can’t take charge if you have no control over everybody else out there.
P12 (6.17)	If you are only sub-consulting, in many instances, and you are not actually chief there is a problem.
P10 (6.18)	You need to be in control of the process to be able to do that.

Relative to ‘upstream design ownership’, the relationship between architectural designers and contractors was demonstrated by the FG data:

P4 (3.29)	I think that’s important – maybe we should be. We need to accept that we need to take responsibility for these issues in the design stage … (Excerpt only).
P11 (3.58)	The onus is on us to make sure that the contractor understands it…
P12 (3.59)	So that he will understand that he will have high level windows and screen walls and all sorts of …
P10 (3.60)	It also goes around your health and safety plan that you issue at tender stage (future projection). So you are identifying the risk. The problem comes in when you haven’t identified a risk.
Rb (3.61)	Who identifies it – the designer?

P10 (3.62)		The designer.

Relative to the facilitators probe on ‘taking ownership of the situation will assist encouragement’, the FG data was concise:

P2 (6.31)		Responsibility?

Ra (6.32)		Ownership i.e. I want to do it, because I want to save lives?

P2 (6.33)		Ok

P3 (6.34)		Ja (Colloquial ‘yes’).

P8 (6.35)		… and need to save lives.

P12 (6.38)		Of course yes (P10 nods).

A range of literature implies the need for upstream design ownership while some incorporates actual wording. The provisional studies also inferred ownership, while the FG data demonstrated the importance of taking control toward saving lives. It is therefore argued that ‘upstream design ownership’ constitutes a vital means of ‘engaging people’.

c) Multi-stakeholder approach

The construction industry is considered to be a ‘people’ based industry. The CDM Regulations (Neil, 1994; Hetherington, 1995; CDM, 2007) and the South African Construction Regulations serve to protect people by attempting to ensure a multi-stakeholder responsibility, among others, for construction H&S inclusive of designers (Construction Regulations, 2003, Geminiani *et al*., 2005; Smallwood and Haupt, 2005).

The UK’s Gateway model relies on good people management and warrants a multi-stakeholder approach (HSE, 2004a), and similarly the Australian CHAIR model promotes a multi-stakeholder approach by providing time for brainstorming (WorkCover NSW, 2001).

While Chang and Lee (2004) question the link between the construction management and the construction technology realm, Hendrickson (2008) strives for an 'integrated system' whereby all stakeholders need to recognise the design and construction relationship, and Lester (2007) notes that it is also important that all people involved are not only competent but are sufficiently motivated to ensure project success.

The first provisional study (Appendix 1 and Section 4.2.1) included the open ended question of 'do you have any comments in general regarding designing for construction health, safety and ergonomics?' One response included 'The client, the designer and constructor must always take responsibility to ensure that the works is carried out safely. We cannot point finger to one party, it's a joint responsibility'.

The second provisional study (Appendix 2 and Section 4.2.2) also included apt data by suggesting that '... working with an engineer the combined effort must cover those sort of things', and '... one would need to interact with contractor to find out how things could be improved'.

Relative to the facilitator's probe with respect to whether architectural designers can engage safer design on their own, the FG data included:

P9 (6.20)	Probably not. It is teamwork – buildings get built by teamwork.
P10 (6.21)	I would like to add to that we need the client and we should have the contractor at the …
P12 (6.22)	Ideally, ideally yes which is not always the case.
P10 (6.23)	Or if it is subcontract work get a specialist subcontractor.
P12 (6.24)	Yes.
Rb (6.25)	Okay so the teamwork issue is what we are suggesting, the buy-in.

To the more direct probe of 'a multi-stakeholder approach is necessary, the FG data included:

P3 (6.37) Ja (Colloquial 'yes').

P4 (6.38) Yes (some nods).

P10 (6.40) Yes (participants nod).

Rb (6.41) That's the teamwork you were talking about.

Appropriate literature identified the need for a multi-stakeholder approach and the first and provisional studies supported the need. The FG data demonstrated the importance of 'teamwork'. It is therefore argued that a 'multi-stakeholder approach' toward healthier and safer design is essential and that it is vital as a means of 'engaging people'.

6.4.2 Education and training

This section is entitled 'education and training' and considers a range of mechanisms to which current and future architectural designers could be exposed in order to improve their knowledge and thus prepare them to practice safer architectural design. These include awareness, tertiary architectural education and CPD programmes.

Architectural designers generally lack knowledge and experience in construction and maintenance, and do not understand the implication of hazards presiding in their designs and subsequent construction. H&S education toward provision of appropriate knowledge and skills will position them to make the most appropriate design decisions toward hazard and risk mitigation and thus enhanced construction H&S. Expansion and optimisation of tertiary curriculum, stimulating professional accreditation, and engaging CPD courses will raise awareness and subsequently change attitudes of designers (Cowley *et al*., 2000; Hecker, 2005; Schulte *et al*., 2008; Smallwood, 2006; Smallwood, 2006a).

Relative to education and training, the first provisional study (Appendix 1 and Section 4.2.1) included a statement suggesting that 'Design education inadequately prepares construction designers in terms of construction health, safety, and ergonomics', which realised a MS of 3.00, which equates the average. This MS is probably under-emphasised, as the designers' own perceptions relative to the comment of 'Designers lack designing for construction health, safety and ergonomics skills' realised a MS of only 2.52, which is below the midpoint of 3.00.

A similar follow up statement being 'Architectural education in South Africa does not adequately prepare designers to design for construction health, safety, and ergonomics' was included in the third provisional study (Appendix 3 and Section 4.2.3). This realised a MS of 3.33, which is above the midpoint score, but is also possibly under-emphasised for the aforementioned contentious reason.

What follows includes awareness, tertiary architectural education and CPD programmes as the said range of mechanisms.

a) Awareness

A lack of awareness is evident in the vast range of literature demonstrating the hazards and risks to which constructors are exposed and the need for designers, including architectural designers, to mitigate these through the design process (Hetherington, 1995; WorkCover NSW, 2001; HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011).

An overview of appropriate literature relative to the position of design 'education and training' was included in the section above. Embedded therein, more specifically, the need to raise awareness relative to designing for construction H&S was included by Smallwood (2006a) in order to change designers' perceptions and attitude toward the need.

The second provisional study (Appendix 2 and Section 4.2.2) raised the point of awareness and touched on education by suggesting 'It is more a case of awareness, even at university level ... it stems back to Architectural School days', 'We have the competencies because we are designers ... we can design anything. The only way to enhance those competencies is by being made more aware' and 'Something can be developed. Hopefully we're doing it anyway ... it's something we need to be aware of'.

FG data demonstrates that before a problem can be addressed, an awareness of the problem is necessary, and a range of discussions incorporated awareness:

P6 (6.3) I think we first need to be aware that there is a problem - design related - before we actually encompass that problem, before we accommodate, we should be aware that there is a problem …

P4 (3.23) I found with the Part A application form it is a very frustrating process, it is in fact a very interesting exercise – every time having to force yourself to go through it. I think it is like structured - it could initially raise one's awareness of what to think about, just to keep on reminding yourself.

Ra (5.20) Ok, so that education and training - and awareness is the other word that came out of this. Are we sort of concurring on this?

P1, P3, P5 & P6 (5.21) (nodding)

P3 (9.58) Mmm - the designer. What piece of paper or whatever - or what things are we going to put in place to ensure that that guy – the designer - is able to do all of this stuff? I think we need to go back to our training. Training and awareness – where does it need to happen? – I'll say it should happen at your institutions, your educational institutions - and also your CPD for the guys we were not been lucky enough to be trained in these institutions. What should they be covering in that? I think they need to be trained in the regulations – construction regulations. I don't think they need to be trained to the extent that they can become professional safety officers, but it opens up a possibility for another field if they choose to change their fields. I think what also needs to go with that is examples of issues that they are going to encounter out there, so that they are aware of it at that stage already, and also what they see as the mandatory in terms of the act. What is actually required of them - what obligations will they have to deal with? I am going to call this rights and obligations of the mandatory. So those are the things about training and awareness and the things it needs to cover and then coming out of that we get to the point of the in-office situation, and this is where we come to our 'model' if you want to call it that.

Ra (9.59) How to design?

P3 (9.60) Yes. This is where we come to our checklist. In the checklist we have an issue of when do you check, ok, basically each work stage. That might mean you have to employ a specialist - maybe, maybe not? Then there is also an issue of - to show that you have in fact done that. The word that I hate but unfortunately I can't get away from it is your 'admin trail' to protect yourself and it goes through each work stage, and then in what you were saying (gestures to P7) your close-out report. All this documentation gets added to your close-out report to your client. So far there are two issues - one is the 'training and awareness' and then your 'implementation model' - and maybe it doesn't have to be all that complicated especially if you're bringing in your specialists. So basically you put together a very simple documentation thing for your designer to follow. He doesn't need to be a specialist in H&S, but he needs to be aware and this is where it comes in. So common sense and the awareness that he has received at university will prevail while he is busy designing. When he is finished with work Stage 1, he calls in his structural engineer, and he calls in his specialist in health and safety.

P3 (9.70) There's room for growth and I think if you combine that with this here into this process, before we even get to the review of the design, before you become the architect, you've already got the training, you've got the awareness. During the two years that you are doing your practical, you get exposed to it on sites and pick more up, and then someone who has done and has been involved in the training and awareness, can then put together your basic checklist and then that is made available through SACAP to all the professionals - which they can build upon if they want to. I think we'll go a long way in preventing accidents.

P10 (6.8) I think also the client – there needs to be an awareness and responsibility from the client so that they work with the architect and not against the architect and that goes back to your procurement and your construction procedures, because that risk needs to be taken into account.

Pertinent literature demonstrated a lack of designing for H&S, which can be related to, *inter alia*, a lack of awareness. The second provisional study also raised the need for awareness of the topic, while the FG data demonstrated a range of aspects relating to awareness and that awareness is required prior to problems being tackled. It is therefore argued that 'awareness' constitutes a vital aspect of 'education and training'.

b) Tertiary architectural education

As with 'awareness', a lack of 'tertiary education and training' is recorded in literature demonstrating the hazards and risks to which constructors are exposed and the need for designers, including architectural designers, to mitigate these through the design process (Hetherington, 1995; WorkCover NSW, 2001; HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011).

In the earlier overview of 'education and training', a lack of knowledge and experience due to inappropriate tertiary architectural education was evident and improvement of curriculum and enhanced tertiary architectural education was included as an enabler toward education and skills provision (Cowley *et al*., 2000; Hecker, 2005; Schulte *et al*., 2008; Smallwood, 2006a).

Included here, but also applicable to 'CPD programmes' which follows, the first provisional study (Appendix 1 and Section 4.2.1) included the open ended question of 'Do you have any comments in general regarding designing for construction health, safety and ergonomics?' One response was that 'More emphasis should be placed on CHS (respondents' acronym) in training in the construction industry'.

The second provisional study (Appendix 2 and Section 4.2.2) also raised the point of education and training by suggesting 'It should be integrated into the training process ... in terms of the architect going through six years of training'. It also pondered the question of how safer design could be integrated into architectural education. Selected responses include: 'It will have to fit somewhere between Building Design and Construction, which run parallel ... the Building Construction component. How do we put a building together and how do we document it? It needs to be an integral component – a separate course won't receive the emphasis it deserves. In the early years of architecture it needs to create awareness for architects'; 'It should start at root level – day one. Design and methodology go hand in hand like form and structure ... 'varsity' projects – how is it going to be built ... feasible, viable or too risky?', and 'There must be a rational way of thinking ... even as simple as once drawn, imagine building it. Architectural education discourages it ... forget how, it doesn't matter how it gets built ... at what point do we bring it into detail technology ... the subject Building Technology'.

Included here, but also applicable to the CPD section to follow, the third provisional study (Appendix 3 and Section 4.2.3) included the statement of 'It would prove beneficial if the guiding approach or model was incorporated into architectural education and continuous professional development (CPD) programmes'. This realised a MS of 4.25, which is well above the midpoint score of 3.00.

The third provisional study (Appendix 3 and Section 4.2.3) also included a tabular form of questioning relative to the 'form and levels of study' for inclusion of an approach or model into tertiary architectural education. Although considered important, this is included here for thought only, as it is not a priority of this study.

Table 15: Degree of concurrence with regard to the optimal form and levels of study suitable for inclusion of an approach or model in tertiary education

Form	Year / Level of study						Mean score
	Unsure	1	2	3	4	5	
Separate subject	41.7	33.3	25.0	8.3	0.0	0.0	**1.08**
Component of a subject	25.0	8.3	41.7	33.3	16.7	0.0	**2.58**
Module in various subjects	16.7	8.3	33.3	33.3	25.0	8.3	**3.08**
Other (add below)	**No other alternatives were offered**						

The data demonstrates a vast amount of uncertainty, especially noting that across the three possible 'forms' an average of 27.8% of respondents selected the 'unsure' option.

The MSs ranging from 1.08 for a ‘separate subject’, 2.58 for a ‘component of a subject, and 3.08 as a ‘module in various subjects’, which is above the midpoint of 3.00, coupled with uncertainty with regards to the ‘year / level of study’ suggests that further research on the topic is necessary.

The third provisional study (Appendix 3 and Section 4.2.3) also included the open ended question of ‘Do you have any comments in general regarding the development of a guiding approach or model in relation to designing for construction health, safety, and ergonomics’. Selected responses relative to tertiary architectural education include ‘Get the education up and running in tertiary institutes as it is becoming more and more of a factor in the design and production of every project’, and ‘Tertiary education is a great start and professional aids would be very useful as well’.

FG data included tertiary institutions such as universities and ‘technikons’, now ‘universities of technology’, as possible means of providing requisite knowledge:

P3 (5.1)	I don’t know whether lately at university you actually go through the NBR. I know when I was studying building regulations was something you found out only when you got out into the big wide world.
P7 (5.2)	If you think what’s out there, we go off the topic now, but it is ridiculous that you don’t - sorry I’m only talking about a Technikon point of view – I don’t know what you guys did at varsity.
P3 (5.3)	Certainly, my days at varsity we never touched on the NBR.
Ra (5.4)	So tertiary architectural education is a mechanism?
All (5.5)	Yes.
P9 (5.1)	Well obviously formal courses come to mind.
P12 (5.2)	Exactly (Others nod).
P9 (5.3)	It needs to be a subject which they need to pass in their final year.

P3 (5.16) All the kind of stuff that the safety guys have experienced on site, that should be fed back into the education system. So the guys who are becoming out of the university are already aware of what is expected and what to cover when they design.

P8 (5.17) They will have to make it a 15 year course (chuckles all round).

P3 (5.18) Ok, so once they walk out of university they are at least aware - not going to find out in the big wide world that you start your own practise after 2 years and you still don't know all these things and then the first project that you do the whole wagon hits the wheel and you're sitting with it and you don't know what to do.

P2 (5.19) Ja, they should be trained to identify concerns in design.

Literature recorded a lack of designing for H&S, which can be related, *inter alia*, to a lack of tertiary architectural education. The provisional studies raised the need for enhanced tertiary architectural education and the support for a model, which could be incorporated into such education toward enhancing designing for construction H&S education and skills, while the FG data demonstrated a lack of, and a need for enhanced tertiary architectural education toward improved designing for construction H&S. The provisional studies and the FG data included findings relative to how the model and designing for construction H&S could be integrated into tertiary architectural education, however this was not really focussed upon and the results were inconclusive. Nevertheless, it is argued that 'tertiary architectural education' constitutes a vital aspect of 'education and training'.

c) CPD programmes

As with 'tertiary architectural education', a lack of 'CPD programmes' relative to designing for construction H&S exists. This is demonstrated firstly by the hazards and risks to which constructors are exposed and again the need for designers, including architectural designers, to address these (Hetherington, 1995; WorkCover NSW, 2001;

HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011).

In the earlier overview of 'education and training', stimulating professional accreditation and engaging CPD courses was also included as an enabler toward education and skills provision (Cowley *et al*., 2000; Hecker, 2005; Schulte *et al*., 2008; Smallwood, 2006a).

The first provisional study (Appendix 1 and Section 4.2.1) included the open-ended question of 'Do you have any comments in general regarding designing for construction health, safety and ergonomics?' One response was that 'Practical training lectures would be useful for CPD purposes'.

The second provisional study (Appendix 2 and Section 4.2.2) also raised the point by suggesting 'An ongoing process to sensitise people ... CPD makes it easier to introduce', and 'Ongoing education to keep it at the forefront of one's mind ... it's becoming more visible as a topic'.

Straddling the previous section and repeated here, the third provisional study (Appendix 3 and Section 4.2.3) included the statement of 'It would prove beneficial if the guiding approach or model was incorporated into architectural education and continuous professional development (CPD) programmes'. This realised a MS of 4.25, which is well above the midpoint score of 3.00.

FG data also included CPD programmes as a possible means of providing requisite knowledge:

P9 (5.7) It must be specific. Another aspect that was mentioned is CPD, those of us who are not covered by any - but not only to cover people who are not qualified, but to continue your learning experience.

P12 (5.8) Provided that the CPD thing actually teaches you and it is not only an attendance thing.

P10 (5.9) It has to be an interactive hands-on thing, but there needs to be a follow-up with this. Like you were saying you actually need to learn from what is going on out there.

P11 (5.10) The other aspect is, maybe it doesn't affect you so much but a lot of these CPD courses has become a money making exercise.

P12 (5.11) That is what I was alluding to, actually.

P4 (5.7) I think CPD is probably also an opportunity.

Literature demonstrated a lack of designing for construction H&S, which can be related to, *inter alia*, a lack of inclusion in CPD programmes. The provisional studies demonstrated the enthusiasm both quantitatively and qualitatively for inclusion of CPD programmes as a means of education and training. The FG data also offered support for the inclusion of designing for construction H&S in CPD programmes, and cautioned that it must not just be a money making exercise. It is therefore argued that 'tertiary architectural education' must also constitute a vital aspect of 'education and training'.

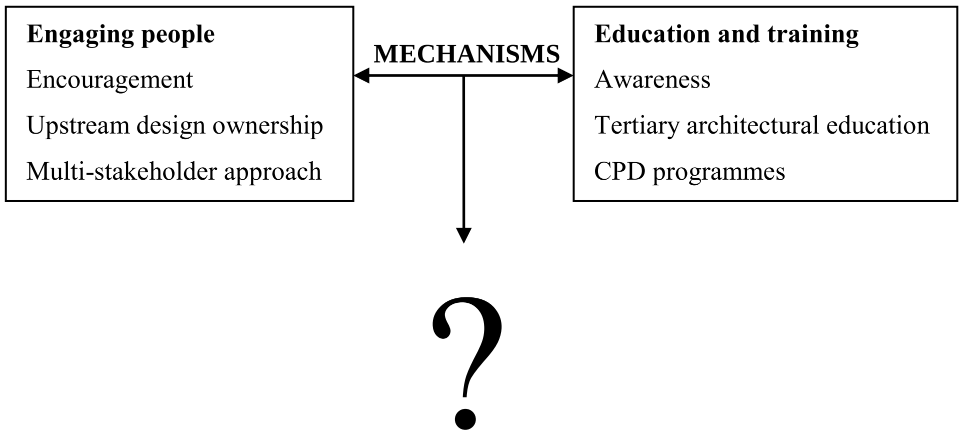
6.4.3 Summary and graphic representation

The mechanisms toward implementation of the core model comprised two main aspects. These were both synthesised through inclusion of related literature, the provisional studies, and the FG data.

Firstly, 'engaging people' was included relative to designing for construction H&S and included the need for encouragement, upstream design ownership and a multi-stakeholder approach. Secondly, 'education and training' was included relative to designing for construction H&S and included the need for awareness, and inclusion in and enhancement of tertiary architectural education and appropriate CPD programmes.

The synthesis supports the inclusion of these as 'mechanisms' toward implementation of the core model. These are demonstrated graphically below:

Diagram 5: The mechanisms



The question arises as to what is achieved through implementation and use of the model?

6.5 THE KEY OUTPUTS

This model component draws primarily on Theme 7 and realises architectural design and a range of architectural documentation, which can be improved in terms of designing for construction H&S if architectural designers adequately engage the process.

Initial FG data included some general comments:

P10 (7.1)	If you improve construction health and safety, hopefully you would also have better ergonomics - keep the safety side separate from the ease of work.
P7 (7.2)	Less fatalities on site I suppose.
P3 (7.3)	Maybe some new innovative design.
P5 (7.5)	New approaches.

Such possibilities are certainly plausible and are embedded within the broader range of the work and documentation produced by architectural designers. What follows considers the products produced, while buildings or structures, including the full life-cycle thereof, truly become the final product of architecture.

6.5.1 Establishing the range of key outputs

A range of literature demonstrated inadequate design in terms of construction H&S (Hetherington, 1995; WorkCover NSW, 2001; HSE, 2004a; Hinze, 2005; Haslam *et al*., 2005; Mroszczyk, 2005; Toole and Gambatese, 2006; Behm, 2006; Schneider, 2006; Smallwood, 2006a; Behm and Culvenor, 2011), while some proffered enhanced education and training in order to improve designing for construction H&S (Cowley *et al*., 2000; Hecker, 2005; Schulte *et al*., 2008; Smallwood, 2006a) thereby suggesting that improved design for construction H&S would be a 'product' of the process.

The HSE (2003) spoke of 'originating influences' such as permanent works design as leading to construction accidents. The products produced by architectural designers can well be seeing as the originating influences. One of the 'principles of safe design' embedded in the Australian CHAIR model is 'information transfer' (WorkCover NSW, 2001; Australian Safety and Compensation Council, 2006) which raises the question of what is used to transfer the information stemming from the afore-mentioned products?

Hetherington (1995) proposed design interventions during the 'concept stage', 'design evolution' and the 'detailed specifications', thereby suggesting design, drawings, details and specifications are undertaken by architectural designers, and further claims that designers should provide information along with their designs to ensure that potential risks and associated issues are identified.

The lists of design recommendations offered by Behm (2006) advocating Gambatese and Weinsteins' earlier work include reference to design and drawings. Examples of these include: design special attachments or holes at elevated work areas to provide permanent, stable connections for supports, lifelines, guardrails, and scaffolding; locate on contract drawings the existence of overhead power lines and their location in relation to the new structure, and note on the drawings the source of information and level of certainty on the location of underground utilities.

Behm (2006) offers 'new design recommendations' which include design and drawing references, but adds to these by including specifications and residual risk information. Examples of these include: design scaffolding tie-off points into exterior walls of buildings for construction and renovation purposes; provide warning through the plans and specifications when electrical systems create floor openings, and consider the existing site and its potential hazards in relation to the heavy equipment required to perform the scope of work. Provide a warning and information to constructors.

The range of key outputs was not directly questioned in the provisional studies, however some aspects insinuate the work and documentation undertaken by architectural designers. As an example, the first provisional study (Appendix 1 and Section 4.2.1) included the statement of 'Appropriate design and specifications can mitigate the use of hazardous materials which cause illness and terminal disease'. The fact that a MS of 4.05 which is well above the midpoint score of 3.00 was recorded clearly indicates that design and specifications form part of the work and documentation undertaken by architectural designers. Similarly, the second provisional study (Appendix 2 and Section 4.2.2) specifically mentions drawings, not that the included perception is necessarily correct. The comment made was 'Some design occurs with health and safety in mind but it cannot be specified on drawings'. Residual risk was in no way included in the provisional studies, however reference to risk was frequently made. An example of this includes the fourth provisional study (Appendix 1 and Section 4.2.1) which included the statement of 'Architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics'. A MS of 3.53, which is above the midpoint score of 3.00 was recorded, suggesting that the existence of risk is real. Residual risk was however included in the FG deliberations to follow.

The FG data included a discussion which exposed a range of 'products' produced by architectural designers:

P3 (7.7) You produce your design, your drawings, and specifications.

Ra (7.8) Design, drawings, specifications - can all construction hazards and risks be eliminated through the design process?

All (7.9) No.

Ra (7.10) That’s a clear no – are you all in agreement with that?

P4 (7.11) Yes (nods all round).

P10 (7.10) Well it will be the specification and the procedure of work - which is your health and safety plan and your project implementation plan. You should be writing in terms of, what you were referring to (gestures to P11) - especially alterations. For any project - which most people don’t do.

Rb (7.11) Okay, so you need decent drawings, decent detailing and decent specifications to move in the right direction. Can all construction hazards and risks be eliminated through the design process?

P12 (7.12) No, it sounds stupid but it is true.

P9 (7.13) Construction by nature is a risky business, let’s face it. If you hit a nail with a hammer you are going to hit yourself with it at some point.

Ra (7.12) What can designers do if they are aware of unresolved hazards and risks?

P3 (7.13) You mean at the design stage?

Ra (7.14) Yes, or when you finish the design before construction starts - what can you do if you are aware?

P6 (7.15) You need to point that out to the contractor.

P3 (7.16) Make the contractor aware of the unresolved risks.

Ra (7.17) Awareness – I think that was brought to the table earlier.

P10 (7.20) They should come up with a mitigation plan with the constructor.

P9 (7.21) As long as you identify the risks, I think the contractor can then address it.

The data includes a range of key outputs which are interpreted in the ‘summary and graphic representation’ to follow.

6.5.2 Summary and graphic representation

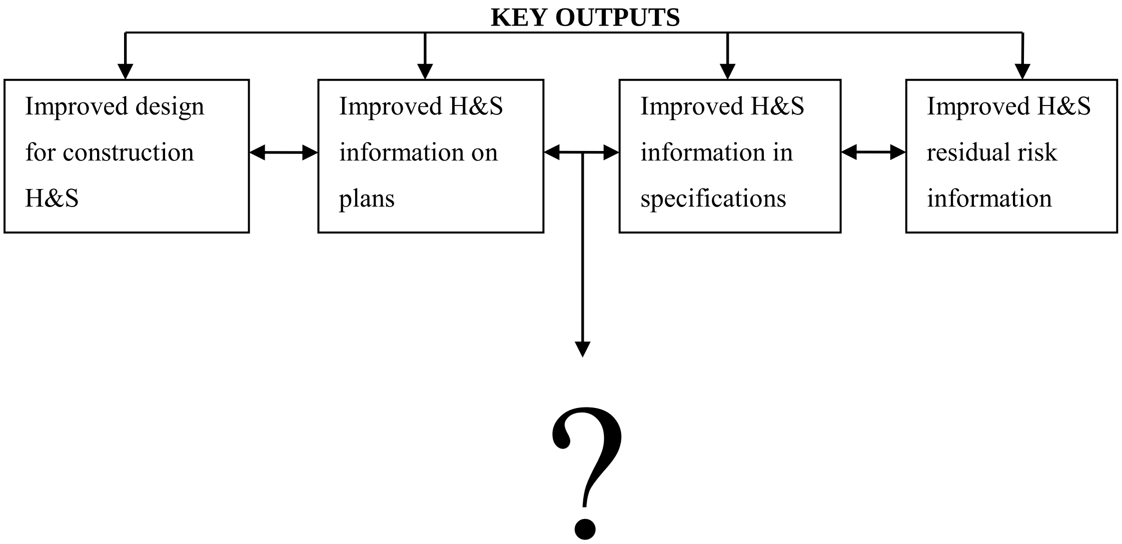
Literature included regular reference to design, drawings and specifications, and further included the need to include warnings on hazards and risks on drawings and specifications to contractors. The provisional studies insinuated design and specifications and included mention of drawings. They also discussed hazards and risks, however never considered them in terms of ‘key outputs’.

The FG data exposed design as culminating in a range of construction drawings and specifications as the products of the work performed by architectural designers. It further clarified that all hazards and risks cannot be eliminated through safer design which culminates in the said products, and that unresolved hazards and risks should be made clear to the contractor. In order to make such hazards and risks clear, the researcher proffers that these would require accurate documentation, drawing on, *inter alia*, the ‘H&S data records’ (discussed in Section 6.3), as compiled throughout the SACAP architectural work stages.

Relative to safer design, it is therefore argued that the ‘key outputs’ produced by architectural designers include: improved design for construction H&S; improved H&S information on plans; improved H&S information in specifications, and improved H&S residual risk information.

The contribution of the ‘key outputs’ toward the greater process model is essential, as the products produced by architectural designers is key to construction of the true final product being the buildings or structures they design. What follows graphically depicts the key outputs as part of the process model.

Diagram 6: The key outputs



The question arises as to 'what becomes of the key outputs?'

6.6 DISSEMINATION

The identified key outputs are of no use if they are not effectively distributed and effectively used to their full potential. This section draws on Theme 8 being the 'purpose of model outputs'.

6.6.1 Dissemination of information

WorkCover NSW (2001) includes the need for 'information transfer' as an essential requirement of the Australian CHAIR model, while Hetherington (1995) insists that designers should provide information along with their designs to ensure that potential risks and associated issues are identified.

As ‘upstream owners’ (Section 6.4.1b) architectural designers should embrace the multi-stakeholder approach (Section 6.4.1c) and be expected to provide information, being the range of key outputs, to a wide range or variety of stakeholders.

The ‘dissemination of information’ was not directly included in the provisional studies, however statements included in the first provisional study (Appendix 1 and Section 4.2.1) such as ‘Appropriate design and specifications can mitigate the use of hazardous materials which cause illness and terminal disease’, and ‘Appropriate design can mitigate hazardous construction work which places contractors at risk’, which realised MSs of 4.05 and 3.29 respectively, both above the midpoint score of 3.00, insinuate that, *inter alia*, design documentation exists and filters through to contractors, in order for construction to take place.

The question becomes that of ‘to whom should the range of key outputs be distributed’? The FG data was relatively concise:

P10 (8.2) They should be part of the contract documentation.

P12 (8.3) They are actually – or not? They should be, ja (Colloquial ‘yes’).

P3 (8.2) We give it to the tenderers.

Ra (8.3) Mmm – tenderers?

P10 (8.5) The client and the contractor.

P3 (8.4) And to the quantity surveyors for the bills of quantities.

Ra (8.5) QSs for bills.

P7 (8.13) to a regulating authority who is responsible to regulate that industry, possibly to update current regulations for a series of projects, I’m guessing.

Ra (8.14) Ok, authorities?

P9 (8.14) If it was me it would be the entire project team (Participants nod).

P10 (8.15) They should be part of the process all the way through.

Ra (8.33) And we can add the authority in there – you brought it up. Early distribution and involvement of all stakeholders is essential.

P3 & P4 (8.34) Yes (P5 nods).

All (8.17) Yes (Nodding).

The data includes a range of 'destinations' to which the key outputs should be disseminated. These are included in the 'summary and graphic representation to follow.

6.6.3 Summary and graphic representation

Literature exposed the need for 'information transfer' in order to ensure that potential risks and associated issues are identified, which was further insinuated by aspects of the provisional studies. The FG data exposed a range of 'destinations' relative to the key outputs. These include inclusion in contract documentation, and distribution to tenderers, clients, contractors, subcontractors, quantity surveyors, and regulating authorities. The FG data eventually encapsulated the notion of the 'entire project team'. It is proffered that the range of key outputs needs to, as far as possible, encapsulate the earlier mentioned 'multi-stakeholder approach' through early involvement, and architectural designers should continually liaise and disseminate information to all stakeholders as the project progresses.

Due to every project being different in terms of the number and nature of the stakeholders involved it is argued that for purposes of the model that the range of 'destinations' remain broad and that architectural designers define all stakeholders by specific project. It is therefore argued that the broad range includes all integral sub-categories in no particular order: clients; authorities; consultants; tenderers; contractors, and subcontractors.

The dissemination of the key outputs to all stakeholders of any given project will not only contribute to the success of the model, but toward a reduction of construction H&S risk. What follows is a graphic representation of 'dissemination' toward the process model.

Diagram 7: Dissemination

DISSEMINATION

Clients; authorities; consultants, tenderers; contractors, and subcontractors

$\dashrightarrow$?

With the majority of the essential components of a model in place, what follows considers a 'continuous information feedback loop' prior to 'assembling' the complete model.

6.7 THE CONTINUOUS INFORMATION FEEDBACK LOOP

The importance of the feedback loop is two-fold. It speaks firstly to continual evolution of the model as more information and requisite knowledge becomes available, meaning that the model is not 'cast in concrete' and that continual evolution means improvement and greater opportunity to mitigate construction hazards and risks. Secondly, it speaks to the ever evolving knowledge of architectural designers as they gain project feedback following the challenges of safer design, which can be ploughed into future projects.

6.7.1 Feedback loop necessity

Literature was not directly interrogated in terms of 'a continuous information feedback loop'. Research however alludes to this as Booth *et al*. (1995) consider a research process which really includes feedback, but is possibly better defined by Leedy and Ormrod, (2010) supporting Cresswell (1998) and consider an up and down ‘data analysis spiral’, really helical in nature meaning that feedback is essential for further development – and in this case sustainability of the model in question.

The shocking statistics demonstrated in the review of the literature relative to South Africa and abroad can also be considered as ‘feedback’, without which the need for this study may not have been confirmed. Similarly, other studies implicated within this research would not have been possible without statistics or other records for example the comprehensive study conducted by Behm (2006), with the support of Veltri and Gambatese, included the review of 450 records of accidents and concluded that approximately one third could have been mitigated through safer design, and the HSE (2003) study, which concluded that up to 50% of accidents could have mitigated the risks through alternative design.

The UK’s Gateway model (HSE, 2004a) and the Australian CHAIR model (WorkCover NSW, 2001) both insist on the need for accurate recordkeeping for use on current and future projects – a means of ‘feedback’ itself.

The notion of a continuous information feedback loop was not directly included in the provisional studies either, however data commentary included in the second provisional study (Appendix 2 and Section 4.2.2) such as ‘On-going education to keep it at the forefront of ones’ mind …’ and the earlier argument that the provisional studies which constitute research and ultimately facilitated the development of the structured questions used in the main study, would beg the question of the purpose of education and research if it was not ploughed back into ‘the system’?

Relative to the continuous information feedback loop, the facilitator probed as to whether information can prove beneficial to future projects. FG data includes:

P1 (8.6) Doesn’t that start like talking to a standard?

Ra (8.7)	Which standard are you talking about?
P1 (8.8)	After a while you would become satisfied that what you specified causes no risk and you become...
Ra (8.9)	So it is like a learning curve and you?
P1 (8.10)	Once you get to a recipe that you know is fool-proof, it talks to a standard – and informs the next one.
P4 (8.28)	Very much so – Ja (some others nod)
P12 (8.7)	Isn't that the purpose - It should be.
P9 (8.8)	I would say yes, it will be.
Ra (8.29)	Can this evolve into continuous H&S improvement on projects?
All (8.30)	Yes (and nodding).
P10 (8.10)	Definitely (nodding from participants).

The data includes the importance of feedback toward continual improvement. This is summarised in the section to follow.

6.7.2 Summary of the continuous information feedback loop

The provided definition, the helical approach of research, the use of statistics and other records, and the insistence of record keeping for current and future projects were all identified in the literature, and were concealed within the notions of some provisional studies. While the notion of a continuous feedback loop was not specifically directed at the FG participants, the data gained through probing relative to benefits to future projects was positive. The researcher thus proffers the need for and importance of a 'continuous information feedback loop' to ensure continual evolution of the model in order to maximise the potential for mitigation of construction hazards and risks.

The continuous information feedback loop is not graphically demonstrated here in isolation, but is included in the completely assembled graphic model as closure to the ‘summary’ which follows.

6.8 SUMMARY AND PRESENTATION OF THE PROVISIONAL MODEL

This chapter explored the vast volume of qualitative data divulged by the focus group participants as presented in the Chapter 5 themes, and synthesised the data in terms of related literature and the provisional studies. It bracketed appropriate themes into model components, and gradually translated the outcomes into a provisional model. The process evolved more than just a model, but a ‘core model’ embedded within a greater ‘process model’.

Despite the underlying perception that construction H&S is the contractor’s responsibility, the data and the synthesis process contributed positively toward the development of the provisional model.

The six identified model components include: key inputs; the core model; mechanisms; key outputs; dissemination, and the continuous information feedback loop.

Based on the synthesis outcomes, the researcher attempted a logical approach in order to create a sequence for the model. What follows, provides a simplified explanation to clarify the sequence of the model and entertains the purpose of the model components:

- Firstly, the ‘key inputs’ are considered toward development and on-going updating of the model as more information becomes available and feeds into the core model;
- Secondly, the ‘core model’ comprises a matrix ‘model framework’ which incorporates a ‘design opportunity window’ (cyclic design process) supported by a ‘design knowledge window’ (requisite knowledge needed to support the cyclic design process), and is envisaged to create a development platform to feed the ‘mechanisms’;

- Thirdly, the ‘mechanisms’ involve the use of the core model toward development of appropriate ‘education and training’ and that of ‘engaging people’ in order to prepare architectural designers to use the core model;

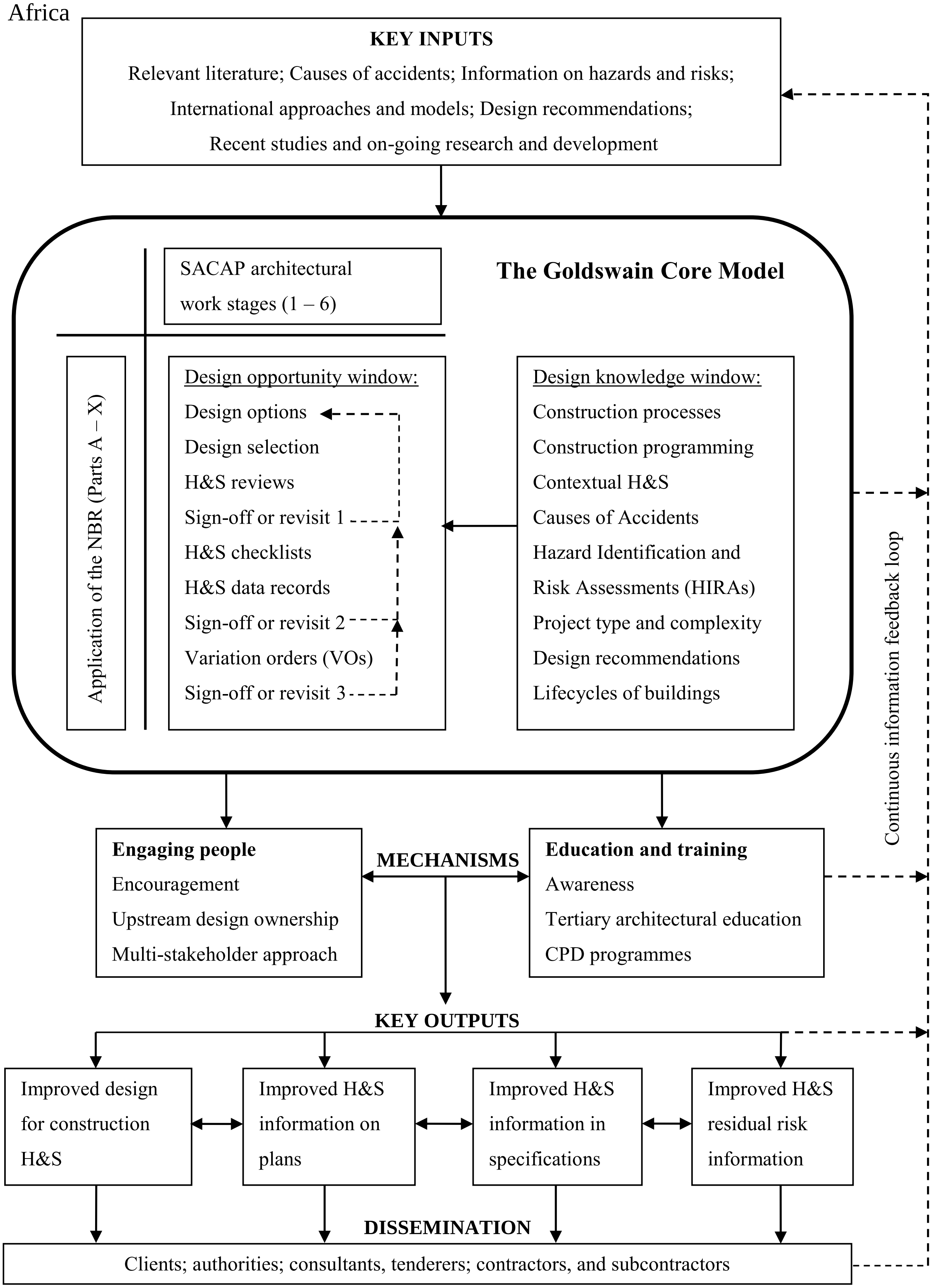
- Fourthly, the ‘key outputs’ rely on the ability of architectural designers to use the model effectively in order to produce the range of ‘improved’ key outputs toward mitigation of construction hazards and risks;

- Fifthly, ‘dissemination’ relies on the distribution of the improved key outputs to all stakeholders involved in a project, and

- Sixthly, the ‘continuous information feedback loop’ can emanate from virtually any aspect of the overall model and loops back toward improving the model through a cyclic (or helical) process.

What follows graphically demonstrates the provisional model with the six model components and the range of sub-components. The researcher has prudently considered the ‘core model’ and the ‘process model’ and in recognition of the effort made has fittingly renamed these ‘The Goldswain Core Model’ and the ‘Provisional Goldswain Process Model for safer architectural design in South Africa’.

Diagram 8: Provisional Goldswain Process Model for safer architectural design in South Africa



7. VALIDATION AND REFINEMENT OF THE MODEL

7.1 FOREWORD

Chapter 6, 'Interpretation and a provisional model', gave rise to the provisional 'Goldswain Core Model' embedded within the 'Provisional Goldswain Process Model for safer architectural design in South Africa'. The overall model was derived from the interaction of a range of literature, the four provisional studies, and the data arising from the 'Buffalo City' and 'Nelson Mandela' FGs. In order to complete the cycle and not leave the focus groups 'high and dry' it was considered expedient to validate the model through the FG participants who were originally randomly selected from the respondents to the provisional studies due to prior involvement which demonstrated interest and dedication to the topic. While Leedy and Ormrod (2010) consider validation as mainly pertaining to quantitative, statistical research, the 'validation' served two requirements. Firstly, it ensured the continuation of the FGs as a means toward an end, and secondly it rewards the fruits of their labour to at least some degree.

As suggested by Carter and Smith (2006), validation of the model is vital if it is expected to be considered complete. The researcher however considers the state of 'completion' temporary, as the model is deliberately geared to evolve and improve over time.

What follows demonstrates the validation process and its outcomes, and leads to the final model which includes a graphic update of the former provisional model.

7.2 VALIDATION OF THE MODEL COMPONENTS

In order to validate the provisional model the individual contributory model components needed to be considered. A covering letter and a copy of the model was distributed together with a 'model validation questionnaire' (Appendix 7), which incorporated quantitative and qualitative methodologies to the 12 FG participants. Electronic means of distribution and retrieval was used due to time constraints prior to the 2013 end of year industry 'shut-down'. Further detail presides in the methodology of Chapter 3.

Ten of the twelve (83.3%) participants responded. Follow up e-mails and telephone calls attempted to obtain the balance, but these were not forthcoming. One respondent did not respond supposedly due to immense end of year work pressure, and one simply did not respond to the attempt at communication. While Crafford (2007) provides examples of low response rates in the South African construction between 7.3% and 40%, the 83.3% response rate is well above expectancy and demonstrates the commitment of the FG participants.

In the sections and tables which follow, the degree of concurrence is measured in terms of percentage responses to a scale of 1 (totally disagree) to 5 (totally agree), and a resultant MS between 1.00 and 5.00, based on the percentage responses. MSs > 4.20 and ≤ 5.00 indicate that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', while MSs of > 3.40 and ≤ 4.20 indicate that the degree of concurrence can be deemed to be between 'neutral to agree / agree'. MSs > 2.60 and ≤ 3.40 indicate that the degree of concurrence can be deemed to be between 'disagree to neutral / neutral', while MSs of > 1.80 and ≤ 2.60 indicate that the degree of concurrence can be deemed to be between 'totally disagree to disagree / disagree'. Allowance was included for 'unsure' responses.

Following each table relative to the model component in question, responses to an open-ended question are included to demonstrate any recent qualitative insights.

What follows considers the 'model validation questionnaire' and subsequent responses relative to the individual model components, and the overall model.

7.2.1 Validation of the 'key inputs'

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the 'key inputs' statement are presented in Table 16 below.

Table 16: Degree of concurrence relative to the 'key inputs' statement

Statement relative to the 'key inputs'	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The range of 'key inputs' are valuable toward development and on-going updating of the model (model sustainability).	0.0	0.0	0.0	0.0	40.0	60.0	4.60

The MS of 4.60 relative to the statement on the 'key inputs' indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the 'key inputs' toward implementation of the model. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of 'Do you have any comments relative to the key inputs?' the following responses are recorded verbatim:

- Key inputs are crucial to form the basis of moving forward and setting critical guidelines. The more time spent on this in research will alleviate time 'wasted' on later amendments, and

- It's obviously important for the key inputs to be kept up-to-date and relevant to local conditions.

The qualitative data is considered supportive of the key inputs and demonstrates the importance of continued improvement and should be kept relevant to the locality in which they preside.

The key inputs being 'relevant literature, causes of accidents, information on hazards and risks, international approaches and models, design recommendations, and recent studies and on-going research and development' are considered valid.

7.2.2 Validation of the 'core model'

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the 'core model' statements are presented in Table 17 below.

Table 17: Degree of concurrence relative to the 'core model' statement

Statement relative to the 'core model'	Unsure	Response % Totally disagree……Totally agree					Mean Score
		1	2	3	4	5	
The 'matrix framework' comprising the NBR structure and the SACAP architectural work stages is appropriate.	0.0	0.0	0.0	20.0	40.0	40.0	4.20
The range of opportunities in the cyclic 'design opportunity window' incorporated in the matrix framework is appropriate.	0.0	0.0	0.0	0.0	60.0	40.0	4.40
The range of requisite knowledge offered in the 'design knowledge window' is appropriate.	0.0	0.0	0.0	0.0	70.0	30.0	4.30

The MS of 4.20 relative to the statement on the 'matrix framework' indicates that the degree of concurrence can be deemed at the uppermost extreme of 'neutral to agree / agree', and is significantly higher than the midpoint score of 3.00. The MS of 4.40 relative to the statement on the 'design opportunity window' and the MS of 4.30 relative to the statement on the 'design knowledge window' far outscore the midpoint score of 3.00, indicating that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree' thus demonstrating the respondents' high level of agreement with the sub-components of the core model and the core model itself. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of 'Do you have any comments relative to the core model?' the following responses are recorded verbatim:

- The NBR structure and SACAP work stages are familiar frames of reference and would support the core model well;
- It may be useful to also include engineers in your thinking and model layout – by mentioning SACAP specifically, it may appear that members of ECSA are excluded from your model, although I do note that you are specifically targeting architectural design in your research / model;

- The term ‘variation order’ is not used in the JBCC documents but is referred to as a ‘contract instruction’, and
- Concern that the core model process of H&S will delay progress on the built enviro projects.

The qualitative data is considered supportive of the core model.

Firstly, the framework is suggested to be familiar to architectural designers.

Secondly, while one respondent mentions engineers and the Engineering Council of South Africa (ECSA) - he realises that the research surrounds architectural design. The research does not attempt to exclude engineers, but integrated them into the multi-stakeholder approach.

Thirdly, the term ‘variation order’ is questionable as one respondent refers to a ‘contract instruction’ as used by the JBCC - Joint Building Contracts Committee. It is noted that the terminologies are ‘localised’ in specific contract documentation however the HSE (2004a) loosely uses the term ‘changes to design’ in places.

The researcher, in order to avoid terms used in different contract documentation, and to remain all-encompassing has selected to use the ‘changes to design’ terminology. The change is included in the updated model to follow this section.

One respondent raised concern relative to use of the core model in that it could delay progress on projects. The researcher can only note and reason that speed on project design and lack of designing for construction H&S will continue to exacerbate project risk.

The core model comprising the matrix framework, the design opportunity window, and the design knowledge window is considered valid.

7.2.3 Validation of the 'mechanisms'

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the 'mechanisms' statement are presented in Table 18 below.

Table 18: Degree of concurrence relative to the 'mechanisms' statement

Statement relative to the 'mechanisms'	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The range of 'mechanisms' toward implementation / use of the model are appropriate.	0.0	0.0	0.0	0.0	40.0	60.0	4.60

The MS of 4.60 relative to the statement on the 'mechanisms' indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the 'mechanisms' toward implementation of the model. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of 'Do you have any comments relative to the mechanisms?' the following responses are recorded verbatim:

- The CPD program has been very successful with awareness and education - would similarly encourage a responsible approach to this crucial aspect of our built environment and I believe be welcomed by stakeholders;

- Education is crucial at tertiary level to set a mind set for young professionals to move forward incorporating H&S into designs, and

- Voluntary organisations – SA Institute of Architects; SA Institute of Architectural Technologists.

The qualitative data is considered supportive of the mechanisms by providing encouragement for CPD within the built environment and acceptability of stake-holders, and suggesting tertiary education as being crucial to budding professionals.

While voluntary organisations are suggested, these would easily integrate into the range of categories included in the mechanisms.

The mechanisms being encouragement, upstream design ownership, multi-stakeholder approach, awareness, tertiary architectural education, and CPD programmes within ‘engaging people’ and ‘education and training’ are considered valid.

7.2.4 Validation of the ‘key outputs’

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the ‘key outputs’ statement are presented in Table 19 below.

Table 19: Degree of concurrence relative to the ‘key outputs’ statement

Statement relative to the ‘key outputs’	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The range of ‘improvements’ relative to construction H&S are appropriate as ‘key outputs’.	0.0	0.0	0.0	10.0	50.0	40.0	4.30

The MS of 4.30 relative to the statement on the ‘key outputs’ indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents’ high level of agreement with the ‘key outputs’ toward implementation of the model. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of ‘Do you have any comments relative to the key outputs?’ the following responses are recorded verbatim: “Design features and creativity may be negatively affected by H&S.”

Only one respondent provided qualitative data, which raised concern relative to ‘design features and creativity’ being affected. Goldswain and Smallwood (2012) advocate Behm and Culvenor (2011) who suggest examples “… where designers have demonstrated creativity and innovation in safe design, and have simultaneously affected cost, quality and schedule positively.” The researcher reasons that opportunity often arises from perceived adversity.

The key outputs being ‘improved design for construction H&S, improved H&S information on plans, improved H&S information on specifications, and improved residual risk information’ are considered valid.

7.2.5 Validation of ‘dissemination’

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the ‘dissemination’ statement are presented in Table 20 below.

Table 20: Degree of concurrence relative to the ‘dissemination’ statement

Statement relative to the ‘dissemination’	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The range of ‘stakeholders’ for distribution of the key outputs are appropriate	0.0	0.0	0.0	0.0	40.0	60.0	4.60

The MS of 4.60 relative to the statement on ‘dissemination’ indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents’ high level of agreement with the ‘dissemination’ component toward implementation of the model. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of ‘Do you have any comments relative to dissemination?’ the following responses are recorded verbatim:

- Possibly feedback to Manufacturer’s & Suppliers where relevant, and
- The more stakeholders the better!

The qualitative data suggest possible feedback to manufacturers and suppliers relative to dissemination. The researcher reasons that the pros and cons would be ironed out with manufacturers and suppliers during the design process, and the outcomes identifiable within the produced documentation. Furthermore, contractors and subcontractors may disseminate information to manufacturers and suppliers during the tendering and construction processes, suggesting that the notion is already embedded in the dissemination 'list'.

The comment pertaining to 'the more stakeholders the better' is considered sensible within the ambit of the specific project(s) at hand.

The dissemination of the key outputs to clients, authorities, consultants, tenderers, contractors and subcontractors, by architectural designers, is considered valid.

7.2.6 Validation of the 'continuous information feedback loop'

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the 'continuous information feedback loop' statement are presented in Table 21 below.

Table 21: Degree of concurrence relative to the 'continuous information feedback loop' statement

Statement relative to the 'continuous information feedback loop'	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The 'continuous information feedback loop' is appropriate for updating and improving the model	0.0	0.0	0.0	10.0	20.0	70.0	4.60

The MS of 4.60 relative to the statement on the 'continuous information feedback loop' indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the 'continuous information feedback loop' toward implementation of the model. It is notable that there were no unsure responses.

In response to the open-ended qualitative question of 'Do you have any comments relative to the continuous information feedback loop?' the following response was recorded verbatim: "Continuous feedback is important, but should not alter the core model too radically and to regularly making it onerous in implementing it into education and CPD."

The data is considered positive and cautions that the on-going improvement and updating must occur through rigorous research to ensure sustainability of the model.

The continuous information feedback loop is considered valid.

7.2.7 Validation of the overall model

Based on the 83.3% response rate, the percentage responses relative to the five-point scale for the 'overall model' statement are presented in Table 22 below.

Table 22: Degree of concurrence relative to the 'overall model' statement

Statement relative to the overall model	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The overall model, in time, can serve toward improved designing for construction health, safety, and ergonomics.	0.0	0.0	0.0	10.0	30.0	60.0	4.50

The MS of 4.50 relative to the statement on the 'overall model' indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the 'overall model' toward implementation. It is notable that there were no unsure responses.

No response was received relative to the open-ended qualitative question of 'Do you have any comments relative to the overall model?'

Given the discussed MS of 4.50 and no negative or contradictory data, the overall model is considered valid.

An overview of the validation is included in what follows.

7.3 VALIDATION SUMMARY AND THE REFINED MODEL

In order to present an overview, the range of statements and responses is integrated into the table below. Based on the 83.3% response rate, the percentage responses relative to the five-point scale relating to the model components are presented in Table 23 below.

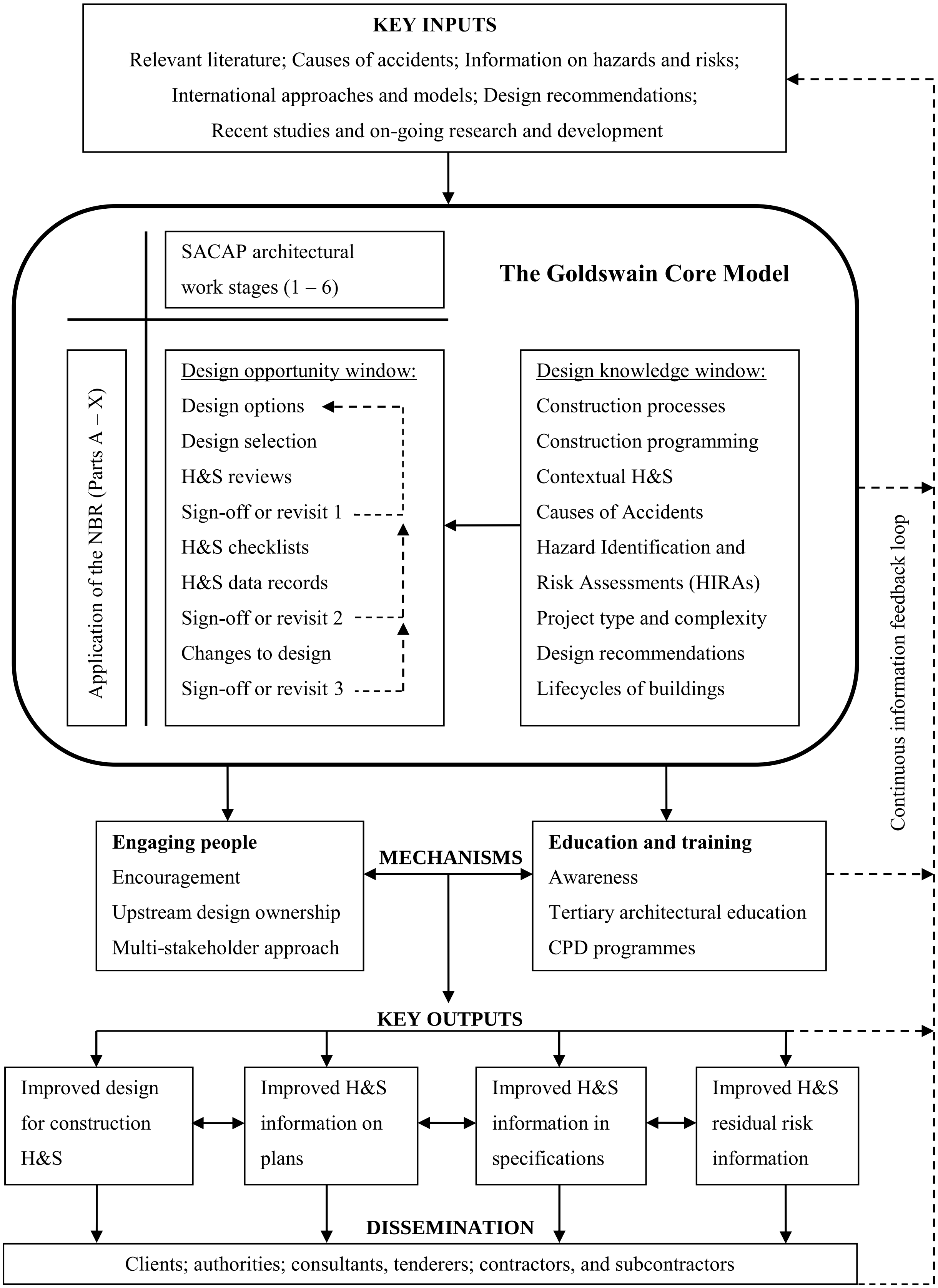
Table 23: Degree of concurrence relative to the model components, the sub-components and the overall model statements

Statement relative to the model components, the subcomponents and the overall model	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
The range of 'key inputs' are valuable toward development and on-going updating of the model (model sustainability).	0.0	0.0	0.0	0.0	40.0	60.0	4.60
The 'matrix framework' comprising the NBR structure and the SACAP architectural work stages is appropriate.	0.0	0.0	0.0	20.0	40.0	40.0	4.20
The range of opportunities in the cyclic 'design opportunity window' incorporated in the matrix framework is appropriate.	0.0	0.0	0.0	0.0	60.0	40.0	4.40
The range of requisite knowledge offered in the 'design knowledge window' is appropriate.	0.0	0.0	0.0	0.0	70.0	30.0	4.30
The range of 'mechanisms' toward implementation / use of the model are appropriate.	0.0	0.0	0.0	0.0	40.0	60.0	4.60
The range of 'improvements' relative to construction H&S are appropriate as 'key outputs'.	0.0	0.0	0.0	10.0	50.0	40.0	4.30
The range of 'stakeholders' for distribution of the key outputs are appropriate	0.0	0.0	0.0	0.0	40.0	60.0	4.60
The 'continuous information feedback loop' is appropriate for updating and improving the model	0.0	0.0	0.0	10.0	20.0	70.0	4.60
The overall model, in time, can serve toward improved designing for construction health, safety, and ergonomics.	0.0	0.0	0.0	10.0	30.0	60.0	4.50

The lowest MS constituting 11.2% of the nine statements is 4.20, which indicates that the degree of concurrence can be deemed to be at the uppermost extreme of 'neutral to agree / agree'. The balance of the MSs constituting 88.8% of the nine statements range from 4.30 to 4.60 and indicate that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and are all well above the midpoint score of 3.0. The significantly high range of MSs is representative of the high level of agreement and the positive outlook provided by the respondents, and further demonstrates the accurate reflection of the FG deliberations and the data. It is notable that there were no unsure responses.

The components and the overall model are all considered valid – at least in the eyes of the FG participants – with the refinement process seeing the change of terminology from 'variation orders' to 'changes to design'. Based on the validation process, the researcher has intentionally removed the word ‘provisional’ from the model title. The refined model is included overleaf.

Diagram 9: The Goldswain Process Model for safer architectural design in South Africa



8. TESTING OF THE HYPOTHESES

8.1 FOREWORD

This chapter considers the outcomes of Chapter 6 and ultimately Chapter 7 in relation to the testing of the hypotheses, and simultaneously draws directly on questions posed to the focus group participants within the validation questionnaire of Chapter 7 (Appendix 7) relevant to the hypotheses. While 'testing of the hypotheses' relates primarily to quantitative research using a statistical approach (Leedy and Ormrod, 2010), the research hypotheses, not the statistical hypotheses, of this qualitative research were tested to some degree at least in a quantitative manner. The relationship to the review of the literature and to the provisional studies is considered, noting that the earlier provisional studies related to the hypotheses to some extent, while the later provisional models were more concerned with the development and character of the model.

8.2 THE MEANS OF TESTING THE HYPOTHESES

The testing of each hypothesis is demonstrated separately in the sections to follow. The tables presented indicate the degree of concurrence measured in terms of percentage responses to a scale of 1 (totally disagree) to 5 (totally agree) and a related MS between 1.00 and 5.00, based on the percentage responses. Relevant to the MSs, the range and categories mimic those included in Chapter 7 'Validation and a provisional model'. Allowance was once again included for 'unsure' responses. The sections which follow attempt to test the hypotheses quantitatively – at least in terms of the ten of twelve (83.3%) FG participants who responded to the survey questionnaire, and reference is made to literature and some examples from the provisional studies are included.

8.2.1 Hypothesis 1

The first hypothesis stated that 'construction work generates hazards, which could be mitigated by improved design, causing constructors to be placed at risk'.

Relative to the model, a statement was included relating to the first hypothesis.

Table 24: Degree of concurrence relative to Hypothesis 1

Statement	Unsure	Response %					Mean Score
		Totally disagree……Totally agree					
		1	2	3	4	5	
The hazards which place construction workers at risk could be mitigated through eventual use of the model.	0.0	0.0	0.0	20.0	30.0	50.0	4.30

The MS of 4.30 relative to the statement pertaining to the first hypothesis indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Section 2.2 'overview of relevant statistics', Section 2.3 'the causes of accidents', and Section 2.4 'construction hazards and risks' present evidence that construction work generates hazards and risks. Section 2.5 'designing for construction H&S' and Section 2.6 'international approaches and models' strive toward mitigation of construction hazards and risks'.

The first provisional study included the statement of 'Appropriate design can mitigate hazardous construction work, which places constructors at risk' which attracted a MS of 3.29, which is toward the upper extreme of 'disagree to neutral / neutral', however is above the midpoint score of 3.00 and indicates possibility in terms of 'eventual use of the model'.

The second provisional study was qualitative in nature, and examples of responses include:

- Risks need to be identified and managed correctly, and
- Construction methods should take safety and worker ability into account.

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the first hypothesis exists. The first hypothesis is therefore considered supported.

8.2.2 Hypothesis 2

The second hypothesis stated that ‘exposure to specific construction processes and materials, which could be mitigated by improved design, causes illness, some terminal’.

Relative to the model, a statement was included relating to the second hypothesis.

Table 25: Degree of concurrence relative to Hypothesis 2

Statement	**Unsure**	**Response %**					**Mean Score**
		Totally disagree……Totally agree					
		1	**2**	**3**	**4**	**5**	
Illness and terminal illness caused by exposure to specific construction processes and materials could be mitigated through eventual use of the model.	0.0	0.0	0.0	10.0	60.0	30.0	4.20

The MS of 4.20 relative to the statement pertaining to the second hypothesis indicates that the degree of concurrence can be deemed to be at the uppermost extreme of ‘neutral to agree / agree’, and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents’ level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Section 2.2 ‘overview of relevant statistics’, and Section 2.3 ‘the causes of accidents’ demonstrated hazards and risks relative to construction health. Section 2.4 ‘construction hazards and risks’ included a sub-section 2.4.2 ‘construction health hazards and risks’, which exposed construction processes entailing the use of HCSs which can enter the human body through inhalation, absorption through the skin, and ingestion, which can cause illness and terminal illness.

The first provisional study included the statement of ‘Appropriate design and specification can mitigate the use of hazardous materials, which cause illness and terminal disease’ which realised a MS of 4.05 indicating that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and is significantly higher than the midpoint score of 3.00, and is subsequently well positioned in terms of ‘eventual use of the model’.

The second provisional study was qualitative in nature, and examples of responses include:

- Everything has risks, which can be minimised through design and material choice, and
- Materials and Methods – what materials, how to use them ... what to use where.

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the second hypothesis exists. The second hypothesis is therefore considered supported.

8.2.3 Hypothesis 3

The third hypothesis stated that 'exposure to specific construction hazards, which could be mitigated by improved design, can lead to injuries and fatalities'.

Relative to the model, a statement was included relating to the third hypothesis.

Table 26: Degree of concurrence relative to Hypothesis 3

Statement	Unsure	Response %					Mean Score
		Totally disagree……Totally agree					
		1	2	3	4	5	
Injuries and fatalities caused by exposure to specific construction hazards could be mitigated through eventual use of the model.	0.0	0.0	0.0	10.0	40.0	50.0	4.40

The MS of 4.40 relative to the statement pertaining to the third hypothesis indicates that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree', and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents' high level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Section 2.2 'overview of relevant statistics', and Section 2.3 'the causes of accidents' demonstrated hazards and risks relative to construction safety.

Section 2.4 ‘construction hazards and risks’ included a sub-section 2.4.3 ‘construction safety hazards and risks’, which physically give rise to construction injuries and fatalities.

The first provisional study included the statement of ‘Constructors are injured, including fatal occurrences, due to exposure to hazardous construction work’ which attracted a MS of 3.41 which indicates that the degree of concurrence can be deemed to be between ‘neutral to agree / agree’, and is somewhat higher than the midpoint score of 3.00, and offers possibility in terms of ‘eventual use of the model’.

The second provisional study was qualitative in nature, and examples of responses include:

- The trade is becoming more aware of the problems, and
- We need to understand alternative methods of construction. Recycle and re-use ... reduce manpower and reduce risk.

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the third hypothesis exists. The third hypothesis is therefore considered supported.

8.2.4 Hypothesis 4

The fourth hypothesis stated that ‘exposure to specific construction work, which could be mitigated by improved design, can lead to WMSDs’.

Relative to the model, a statement was included relating to the fourth hypothesis.

Table 27: Degree of concurrence relative to Hypothesis 4

Statement	Unsure	Response %					Mean Score
		Totally disagree……Totally agree					
		1	2	3	4	5	
Work related musculoskeletal disorders (WMSDs) caused by exposure to specific construction work could be mitigated through eventual use of the model.	0.0	0.0	10.0	30.0	40.0	20.0	3.70

The MS of 3.70 relative to the statement pertaining to the fourth hypothesis indicates that the degree of concurrence can be deemed to be between 'neutral to agree / agree', and is somewhat higher than the midpoint score of 3.00, thus demonstrating the respondents' level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Section 2.2 'overview of relevant statistics', and Section 2.3 'the causes of accidents' demonstrated hazards and risks relative to construction ergonomics. Section 2.4 'construction hazards and risks' included a sub-section 2.4.4 'construction ergonomics hazards and risks', which exposed work activities giving rise to WMSDs.

The first provisional study included the statement of 'Constructors experience work-related musculoskeletal disorders (WMSDs) due to the nature of construction work' which attracted a MS of 3.08, which is toward the upper extreme of 'disagree to neutral / neutral', however is above the midpoint score of 3.00 and indicates possibility in terms of 'eventual use of the model'.

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the fourth hypothesis exists. The fourth hypothesis is therefore considered supported.

8.2.5 Hypothesis 5

The fifth hypothesis stated that 'improved design can reduce the exposure of constructors to hazardous work'.

Relative to the model, a statement was included relating to the fifth hypothesis.

Table 28: Degree of concurrence relative to Hypothesis 5

Statement	Unsure	Response %					Mean Score
		Totally disagree……Totally agree					
		1	2	3	4	5	
Improved design relative to construction health, safety, and ergonomics through use of the model can reduce the exposure of constructors to hazardous work.	0.0	0.0	0.0	10.0	30.0	60.0	4.50

The MS of 4.50 relative to the statement pertaining to the fifth hypothesis indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents’ high level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Section 2.5 ‘designing for construction H&S’ and Section 2.6 ‘international approaches and models’ strive toward mitigation of construction hazards and risks’ from a healthier and safer design perspective.

The first provisional study included the statement of ‘Appropriate design can lead to the improvement of construction health, safety and ergonomics’ which attracted a MS of 3.20, which is toward the upper extreme of ‘disagree to neutral / neutral’, however is above the midpoint score of 3.00 and indicates possibility in terms of ‘eventual use of the model’.

The second provisional study was qualitative in nature, and examples of responses include: “More time spent on the design development stage could benefit ... to build it in, we do Advanced Technologies as part of our design course ... it’s glanced over ... we don’t fully understand how things are put together.”

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the fifth hypothesis exists. The fifth hypothesis is therefore considered supported.

8.2.6 Hypothesis 6

The sixth hypothesis stated that ‘design education is inadequate in terms of construction health, safety and ergonomics’.

Relative to the model, a statement was included relating to the sixth hypothesis.

Table 29: Degree of concurrence relative to Hypothesis 6

Statement	Unsure	Response % Totally disagree……Totally agree					Mean Score
		1	2	3	4	5	
The model can be used toward improving the adequacy of architectural design education in terms of construction health, safety, and ergonomics.	0.0	0.0	10.0	0.0	30.0	60.0	4.40

The MS of 4.40 relative to the statement pertaining to the sixth hypothesis indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and is significantly higher than the midpoint score of 3.00, thus demonstrating the respondents’ high level of agreement with the statement. It is notable that there were no unsure responses.

In terms of the literature, Chapter 1 included a sub-section 1.5 ‘the appropriateness of design education’ which realised the need for inclusion of designing for construction H&S in tertiary architectural education and CPD programs.

The first provisional study included the statement of ‘Improved design education in terms of construction health, safety and ergonomics can mitigate hazardous construction work’ which realised a MS of 3.43, which indicates that the degree of concurrence can be deemed to be between ‘neutral to agree / agree’, and is somewhat higher than the midpoint score of 3.00, and is therefore well positioned in terms of ‘eventual use of the model’.

The second provisional study was qualitative in nature, and examples of responses include:

- I don’t believe any of us do – we were never taught. What is known is purely through experience – if a detail causes a big problem it won’t be used again;

- No ... interaction of the team to thrash out ideas. Awareness is needed ... goes back to ‘varsity’ days, and

- Something can be developed. Hopefully we’re doing it anyway ... it’s something we need to be aware of.

A strong interrelationship between the range of literature, the data from the provisional studies, and the MS relating to the statement relative to the sixth hypothesis exists. The sixth hypothesis is therefore considered supported.

8.3 SUMMARY OF THE HYPOTHESES TESTS

In order to present an overview, the range of statements and responses is integrated into the table below. Based on the 83.3% response rate, the percentage responses relative to the five-point scale relating to the research hypotheses are presented in Table 30 below.

Table 30: Degree of concurrence relative to the research hypotheses

Statements	Unsure	Response %					Mean Score
		Totally disagree……Totally agree					
		1	2	3	4	5	
The hazards which place construction workers at risk could be mitigated through eventual use of the model.	0.0	0.0	0.0	20.0	30.0	50.0	4.30
Illness and terminal illness caused by exposure to specific construction processes and materials could be mitigated through eventual use of the model.	0.0	0.0	0.0	10.0	60.0	30.0	4.20
Injuries and fatalities caused by exposure to specific construction hazards could be mitigated through eventual use of the model.	0.0	0.0	0.0	10.0	40.0	50.0	4.40
Work related musculoskeletal disorders (WMSDs) caused by exposure to specific construction work could be mitigated through eventual use of the model.	0.0	0.0	10.0	30.0	40.0	20.0	3.70
Improved design relative to construction health, safety, and ergonomics through use of the model can reduce the exposure of constructors to hazardous work.	0.0	0.0	0.0	10.0	30.0	60.0	4.50
The model can be used toward improving the adequacy of architectural design education in terms of construction health, safety, and ergonomics.	0.0	0.0	10.0	0.0	30.0	60.0	4.40

The lowest MS constituting 16.6% of the six statements equates 3.70 and indicates that the degree of concurrence can be deemed to be between ‘neutral to agree / agree’, and is above the midpoint score of 3.00. The MS of 4.20 follows, and also constitutes 16.6% of the six statements, and indicates that the degree of concurrence can be deemed to be at the uppermost extreme of ‘neutral to agree / agree’, and is significantly higher than the midpoint score of 3.00. The balance of the MSs constituting 66.6% of the six statements range from 4.30 to 4.50 and indicate that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’, and are significantly higher than the midpoint score of 3.0. It is notable that there were no unsure responses.

The range of MSs from 3.7 to 4.5 are all generally well above the midpoint score of 3.00, which demonstrate the respondents’ perceptions relative to the model and its impact on the research hypotheses. The range of literature together with the data provided by the provisional studies is considered to support the hypotheses. Within the ambit of this qualitative study, all six research hypotheses are therefore considered supported.

9. CONCLUSION AND RECOMMENDATIONS

9.1 FOREWORD

Architecture has long searched for beauty and included form and function in its quest, yet seems to have forgotten the well-being of the construction team by not focusing on designing for construction H&S.

Based on this observation, this research set out to investigate issues pertaining to health, safety, and ergonomics within the construction industry, in order to develop an architectural design oriented model toward a reduction of construction hazards and risks in South Africa, which can be engendered through optimum design related programmes at tertiary education institutions, and through CPD courses. The ultimate aim is to realise a paradigm shift in architectural design relative to construction H&S as architectural designers in South Africa still view it as the constructor's problem.

The objectives of the study thus sought to:

- conduct a review of relevant literature;
- comprehend the extent and worth of relevant extant models and lists of remedies;
- consider the relevance of the above-mentioned within the context of South Africa;
- develop a model which would encourage architectural designers in South Africa to engage in designing for construction H&S, and
- validate the model through SACAP registered architectural designers

The study is considered important as any reduction of H&S hazards and risks through design will save lives, reduce illness and injury, reduce the direct and indirect cost of accidents, improve quality, reduce legal encounters, improve labour relations, improve public relations, and improve the image of the construction industry at large.

Many relate their research as a 'journey', however that alludes to a starting point and an end point. The researcher considers this study to be an 'exploration' and while the cyclic or helical research process has yielded a model toward mitigation of construction hazards and risks, it would appear that the real exploration is about to begin.

What follows offers conclusion to the eight chapters of this thesis followed by a summary and recommendations.

9.2 REVIEW OF THE LITERATURE

The international construction industry traditionally measures project success in terms of cost, quality, and schedule, This however, results in constructors being exposed to a wide range of construction hazards and risks, which culminate in construction accidents and cause illness, injury, and death. Construction accidents also result in environmental damage, lead to reduced productivity, marginalise quality, extend the duration of projects, and ultimately increase construction costs, which are all counteractive in terms of economics.

The construction industry in South Africa is no different, and while our ‘constitution’ is underpinned by the OH&S Act and the Construction Regulations toward the well-being of constructors, it ranks ninth in terms of accident frequency rate, fifth in terms of accident severity rate, and third in terms of fatality rates among 24 listed industries.

The main causes of accidents include ‘falls onto different levels’, ‘MVAs’, ‘struck by’, ‘inhalation, absorption and ingestion’, and ‘WMSD’s or body stressing’ and literature proffers that construction hazards and risks which lead to such accidents can be mitigated by up to 50% through proactively designing for construction H&S. It is not expected that all construction hazards and risks can be mitigated through design, but it is suggested that those which can be reasonably foreseen during the various stages of design and specification can be mitigated.

Literature informs that designs can be reviewed toward mitigation of hazards and risks, and considers HIRAs as key to the process. International approaches such as the United Kingdom’s Gateway model and the Australian CHAIR model rely on a multi-stakeholder approach, and provide much insight into mechanisms, opportunities, and tools for designers, including architectural designers, to review their designs, document their findings, consider alternatives, and keep accurate records, which are beneficial to current and future projects. Some researchers have developed and disseminated lists of design recommendations, which architectural designers, *inter alia*, can interrogate toward mitigation of construction hazards and risks. Literature further imposes the need for architectural designers, *inter alia*, to have a sound knowledge of construction processes, including construction technologies, and of construction programming as they impact directly on construction performance, and the ability to achieve the range of strategic objectives, including the mitigation of construction hazards and risks, whereas development of comprehensive method statements can be useful in describing not only the work to be undertaken, but the sequencing and resources required.

Despite the statistics, the need, and the potential mechanisms offered by the literature, architectural designers generally, and in South Africa, are not committed to designing for construction H&S and do not adequately conduct HIRAs during the design process mostly due to inadequate appropriate education and training, which can be enhanced through tertiary architectural education and CPD programmes.

9.3 THE RESEARCH PARADIGM AND METHODOLOGY

Research is a cyclic or helical process, which seeks to methodically provide answers to observed problems through the interrogation of primary and secondary data. This study made use of a range of resources to establish secondary data as backdrop, and in order to support the study.

A range of qualitative and quantitative provisional studies were undertaken at different stages of the research to further enlighten the process and place the study in the context of South Africa, and progressively provided information toward development of structured questions for the main study. The provisional studies made use of SACAP registered architectural designers from the Eastern Cape Province of South Africa as the research sample, and were successful in enlightening the research, and ultimately provided nine structured questions for use in the main study. All four provisional studies were published as international conference papers. Further discussion takes place in Section 9.4 ‘establishing questions through exploration’.

The main study was qualitative in nature and made use of research FG methodology within the AR paradigm. Two FGs were planned for the Buffalo City and the Nelson Mandela metropolitan regions of the Eastern Cape Province considered representative of South Africa. The FG participants were randomly selected from the range of SACAP registered architectural designers who had responded to the provisional studies as they were considered to be more committed to the process. Both research FGs were required to complete consent forms and their anonymity was guaranteed. Both FGs were presented with the same nine structured questions, and the proceedings were audio-visually captured and the arising themes were transcribed verbatim. Appropriate coding of the participants and the data was introduced for tracking purposes.

The AR paradigm and the use of FG methodology proved beneficial in deriving the themes and the data for the study. Further discussion takes place in Section 9.5 ‘The data: Action research and focus groups’.

9.4 ESTABLISHING QUESTIONS THROUGH EXPLORATION

Four provisional studies were undertaken in order to contextualise the research locally, and to develop questions for the main study using FG methodology. SACAP registered architectural designers from the Eastern Cape Province of South Africa served as the research sample.

The first provisional study was primarily quantitative and tested the perceptions of architectural designers in South Africa relative to mitigating construction hazards and risks through design. It found that: “… architectural designers do not adequately conduct HIRAs during the design process; appropriate design and specification can mitigate health, safety, and ergonomic risks; design education inadequately prepares architectural designers in terms of construction health, safety, and ergonomics and associated risks can be mitigated through improved design education.” (Goldswain and Smallwood, 2009)

The second provisional study was qualitative in nature and sought to determine what would encourage architectural designers to proactively mitigate construction hazards and risks through design. The findings included: "… architectural designers need 'designing for construction health, safety, and ergonomics' competencies; a guiding approach or model should be developed and incorporated into architectural education and on-going training; the guiding approach or model should be technologically grounded and should not stifle architectural freedom." (Goldswain and Smallwood, 2011)

The third provisional study was quantitative in nature and sought to establish an architectural design model framework toward improved construction H&S in South Africa. The salient findings included: "… architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding approach or model in place to assist them; the model should be flexible in nature and should promote a buy-in situation as opposed to being prescriptive and regulatory in nature; the application of the National Building Regulations forms a suitable basis for development of the model, and the model should be incorporated into architectural education and CPD courses." (Goldswain and Smallwood, 2012) What was not elaborated in the salient findings, but was included by nature of the matrix method of questioning was the cross-referencing of National Building Regulations with the six 'work stages' defined by SACAP (Republic of South Africa, 2010). The cross-reference matrix in itself could thus be considered as a basis for development of a model – the 'model framework' the preliminary study sought to identify (Goldswain and Smallwood, 2012).

The fourth provisional study which was also used a quantitative methodology and included 'background objectives' drawing on the previous provisional studies, and 'main objectives' being the identification of key inputs which could be integrated into the architectural design model framework of the prior studies. The findings relative to the 'background objectives' included, *inter alia*, the familiarity and the use of the NBR and the SACAP architectural work stages during the design process. The main findings included: consideration of 'local and international literature' would prove beneficial to developing a guiding model suitable for use in the context of South Africa; architectural designers would need to understand the 'causes of construction accidents' in order to design for construction health, safety, and ergonomics; architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics; consideration of suitable ‘international models’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa; consideration of existing ‘design recommendations would also prove beneficial , and a guiding approach or model should include ‘checklists’ and allow for ‘design notes’ in order to facilitate the process (Goldswain and Smallwood, 2013).

The four provisional studies were successful in enlightening the research and ultimately provided the nine structured questions used in the main study. These are repeated here for ease of reference:

- What would be considered as suitable key inputs for a ‘designing for construction health, safety, and ergonomics’ model?
- What would be considered a suitable framework for a ‘designing for construction health, safety, and ergonomics’ model?
- Within the suggested framework, is there a process which can support ‘designing for construction health, safety, and ergonomics’?
- What requisite knowledge would architectural designers need to have in order to engage the suggested process?
- What mechanisms could be put in place to provide requisite knowledge to architectural designers?
- What would engender architectural designers to engage in ‘designing for construction health, safety, and ergonomics’?
- In terms of the work performed by architectural designers, what would the improved outputs of using the model be?
- What becomes of the range of outputs produced by architectural designers?
- Is there anything we may have missed, and is it possible to ‘assemble’ a model from the information gathered?

9.5 THE DATA: ACTION RESEARCH AND FOCUS GROUPS

AR FG gatherings were held as planned in the Buffalo City and Nelson Mandela metropolitan regions respectively. The nine structured questions solicited a broad range of rich, qualitative data from the research FG participants. The data cannot be repeated here, but a broad range of data was captured audio-visually and transcribed verbatim, and integrated into themes aligned with the structured questions.

One arising perception not conducive to development of a model was evident, that being the initial perception of construction H&S as the contractor's responsibility. Names applied to the included themes, based on the structured questions were: the search for key inputs into a model; the search for a model framework; the search for a working process; the search for requisite knowledge; mechanisms to provide requisite knowledge; engaging architectural designers; deriving outputs through using a model; purpose of the model outputs, and can participants 'assemble' a model? This however was not expected.

A range of additional themes were also included in the data which did not directly 'fit' the themes, however much of this data was integrated during 'interpretation and a provisional model'. The additional themes included: recognition of a multi-stakeholder approach; the issue of client responsibility; maintaining contractor responsibility; building types and complexity; stifling architectural freedom, and construction in the context of South Africa.

The vast amount of rich qualitative data obtained through the AR paradigm using FG methodology was deemed suitable toward 'interpretation and a provisional model' which follows.

9.6 INTERPRETATION AND A PROVISIONAL MODEL

The wealth of qualitative data was synthesised in terms of the literature and the four provisional studies. It achieved this by bracketing appropriate themes into model components, and gradually translated the outcomes graphically into a provisional model. While the perception of contractor responsibility was acknowledged it was not considered ‘developmental’. The process realised more than just a model, and embedded a ‘core model’ within a greater ‘process model’.

The discussions are included by model component.

Firstly, ‘the key inputs’ were found to include: relevant literature; causes of accidents; information on hazards and risks; international approaches and models; design recommendations, and recent studies and on-going research and development.

Secondly, ‘the core model’ was found to include a cross-reference matrix as model framework comprising the NBR (Parts A – X) forming the vertical ‘y-axis’ of the model framework, and the SACAP architectural work stages (1 – 6) form the horizontal ‘x-axis’ of the model framework. The concept offered no intention to repeat the NBR, but to use the ‘headings’ or ‘breakdown’ of the parts as guidance. The core model included a ‘design opportunity window’ as design process within the model framework. This included: design options; design selection; H&S reviews; sign-off or revisit 1; H&S checklists; H&S data records; sign-off or revisit 2; variation orders, and sign-off or revisit 3. The process however recognises that design is cyclic and therefore maintains that the design opportunity window cannot be static. The question arose as to what knowledge architectural designers would require in order use the design opportunity window, and a ‘design knowledge window’ was included. This included requisite knowledge on: construction processes, inclusive of technologies; construction programming; contextual H&S; HIRAs; project type and complexity; design recommendations, and lifecycles of buildings. The core model was ‘completed’.

Thirdly, a range of interrelated ‘mechanisms’ needed inclusion toward implementation of the core model. This involved ‘engaging people’ through encouragement, upstream design ownership, and a multi-stakeholder approach. It also involved ‘education and training’ through awareness, tertiary architectural education, and CPD programmes.

Fourthly, the benefits arising are considered as ‘key outputs’ being what is produced by architectural designers assuming that knowledge and implementation of the core model is in place. These include: improved design for construction H&S; improved H&S

information on plans; improved H&S information in specifications, and improved H&S residual risk information.

Fifthly, ‘dissemination’ involves the range of stakeholders to whom the key outputs should be distributed. Included are: clients; authorities; consultants; tenderers; contractors, and subcontractors. This list is however also not considered static due to the range of stakeholders differing from project to project.

Sixthly, ‘the continuous information feedback loop’ was included for two reasons. It provides opportunity for continual evolution of the model as more information and requisite knowledge becomes available, and it speaks to the ever evolving knowledge of architectural designers based on project feedback.

The six identified model components included: key inputs; the core model; mechanisms; key outputs; dissemination, and the continuous information feedback loop. The provisional model is not graphically repeated here. The next section considers FG feedback.

9.7 VALIDATION AND REFINEMENT OF THE PROVISIONAL MODEL

The opinions of the FG participants relative to the provisional model was considered key to ‘closing the loop’ and rewarding the fruits of their labour. Literature also proposed the validation of the model as a vital element of research if it is going to be considered complete.

A covering letter and a copy of the provisional model were distributed together with a ‘model validation questionnaire’ incorporating quantitative and qualitative methodologies to the 12 FG participants. Electronic distribution and retrieval was used due to time constraints prior to the end of year industry ‘shut-down’. Ten of the twelve FG participants responded, despite follow up, which equate to a response rate of 83.3%.

Statements relative to the components of the model and the overall model were included and participants were expected to respond in terms of the degree of concurrence relative to a five-point scale which included an unsure option. Open-ended questions were also included.

Four equal MSs of 4.60 were recorded relative to the key inputs, the mechanisms, the range of stakeholders, and the continuous information feedback loop, and indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’. Relative to the overall model, a MS of 4.50 was recorded and also indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’. A MS of 4.40 relative to the design opportunity window was recorded and once again indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’. Two MSs of 4.30 were recorded relative to the design knowledge window and the key outputs, and yet again also indicates that the degree of concurrence can be deemed to be between ‘agree to totally agree / totally agree’. Finally, a MS of 4.20 was recorded relative to the matrix framework of the model, and indicates the degree of concurrence to at the upper extreme of ‘neutral to agree / agree’. The significantly high range of MSs from 4.20 to 4.60 are all well above the midpoint score of 3.00, and is representative of the high level of agreement and the positive outlook of the FG respondents, and further demonstrates a true reflection of the deliberations and the data. It is notable that there were no unsure responses.

The range of qualitative feedback emanating from the open-ended questions was generally positive in respect of the model. One respondent however cautioned that the term ‘variation order’ is not used in the JBCC documents and that the term ‘contract instruction is included. It is noted that such terminologies are ‘localised’ in specific contract documents, however specific literature used the term ‘changes to design’. To remain all-encompassing, the term ‘variation order’ was converted to ‘changes in design’ in the refined model.

The components and the model were considered valid including the shift in terminology relative to ‘changes to design’, and the ‘provisional’ status of the model was transformed (Diagram 9).

9.8 THE TESTING OF THE HYPOTHESES

While 'testing of the hypotheses' relates primarily to quantitative research and really relates to testing of the statistical hypotheses, the research hypotheses of this qualitative research were tested to some degree at least, in a quantitative manner. Included in the validation questionnaire survey, which realised an 83.3% response rate, were six statements relative to the six research hypotheses to which participants were expected to respond in terms of the degree of concurrence relative to a five-point scale which included an unsure option.

All MSs were above the midpoint score of 3.00. The lowest MS of 3.70 relative to the fourth research hypothesis demonstrates concurrence in terms of mitigating WMSDs through design, however also exhibits some sense of vagueness relative to ergonomics as was evident in the data. The MS of 4.20 relative to the second research hypothesis demonstrates concurrence in terms of mitigating illness and terminal illness through improved design. The MS of 4.30 relative to the first research hypothesis demonstrates concurrence in terms of mitigation of hazards and risks through eventual use of the model. Equal MSs of 4.40 relative to the third and sixth research hypotheses demonstrate concurrence in terms of mitigating injuries and fatalities through eventual use of the model, and that the model can serve toward improving architectural design education respectively. The MS of 4.50 relative to the fifth research hypothesis demonstrates concurrence in terms of mitigating exposure of constructors to hazardous work.

While testing of the hypotheses normally relates to testing of the statistical hypotheses, the qualitative nature of this research led to the testing of the research hypotheses. The lowest MSs of 3.70 indicates that the degree of concurrence can be deemed to be between 'neutral to agree / agree', while the MS of 4.20 is at the uppermost extreme of that category. The range of MSs from 4.30 to 4.50, indicate that the degree of concurrence can be deemed to be between 'agree to totally agree / totally agree'. The MSs are all significantly above the midpoint score of 3.00 and are representative of the relevance and the potential of the model relative to the research hypotheses.

In terms of this research, all six research hypotheses are considered supported.

9.9 SUMMARY AND RECOMMENDATIONS

The observation that architecture, or at least architectural designers, seem to have forgotten the well-being of the construction team led to a vast exploration in search of intervention. Local and international literature provided evidence of devastating statistics and the need for proactive design toward mitigation of construction hazards and risks. Along with international approaches, models, and recommendations, literature provided an enthusiastic backdrop for this study. While forwarding the opportunity for publication through international conferences, the four provisional studies used the backdrop to localise the research within the context of South Africa, and gradually served to enable the main qualitative study using research FG methodology in the AR paradigm. Synthesis of the rich qualitative data with literature and the provisional studies gave rise to a provisional model which was validated and refined while simultaneously testing the research hypotheses by means of FG participants.

The model includes a core model embedded in a greater process model. Implementation and use of the core model relies on the knowledge of architectural designers relative to designing for construction H&S. It is therefore recommended that the interrelated 'mechanisms' included in the greater process model are of utmost importance. These include 'engaging people', which proffers the encouragement of architectural designers to take upstream design ownership and to involve a multitude of stakeholders in an enthusiastic attempt at designing for construction H&S. It is acknowledged that this is no simple task, and further recommendation is therefore made for in terms of 'education and training' whereby architectural designers gain awareness through various means, including tertiary architectural education and through architectural CPD programmes.

In order to achieve this, role players such as tertiary education institutions offering architectural programmes and their academic staff, and those interesting in developing and offering architectural CPD programmes themselves take 'upstream design ownership' and use the model as basis for designing appropriate tertiary academic programmes and architectural CPD programmes.

This research does not consider the model as a complete means to an end. Further investigation is needed in order to design the recommended programmes and thus populate the model accordingly. While the research touched on the mechanisms for inclusion of the model into tertiary architectural education, the findings were far from conclusive. Further research in this regard is essential.

The model and the recommendations offer prospect for the real exploration to begin.

From adversity arises opportunity. This is an opportunity to realise a paradigm shift in architectural thinking and practice – the new upstream owners of safer construction.

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APPENDIX 1 – PROVISIONAL STUDY PAPER 1

The provisional study paper 1 is located overleaf.

Mitigating Construction Health, Safety, and Ergonomic Risks: Perceptions of Architectural Design Professionals

Craig Goldswain[1] and John Smallwood[2]

[1]PhD Candidate, Department of Construction Management,
Nelson Mandela Metropolitan University. cgoldswain@telkomsa.net

[2]Professor, Head – Department of Construction Management,
Nelson Mandela Metropolitan University. John.Smallwood@nmmu.ac.za

ABSTRACT

Purpose

This paper presents the findings of an exploratory survey regarding the perceptions of architectural design professionals with regard to the mitigation of construction health, safety, and ergonomic risks through appropriate design.

Design

A review of literature preceded a questionnaire survey distributed to a regional population of professional architectural designers.

Findings

The most significant findings include: architectural designers do not adequately conduct hazard identification and risk assessments during the design process; appropriate design and specification can mitigate health, safety and ergonomic risks; design education inadequately prepares architectural designers in terms of construction health, safety and ergonomics and associated risks can be mitigated through improved design education.

Value

The perceptions, although arising from an exploratory survey, contribute significantly towards the finalisation of a research proposal for a PhD study, and provide an indication of the need and direction for the study, which ultimately aims at mitigating construction health, safety, and ergonomic risks.

Keywords: architectural designers; construction health, safety, and ergonomics.

1. INTRODUCTION

While the majority of construction designers strive toward 'beauty' in order to satisfy clients, as demonstrated by De Botton (2007) in his book *The Architecture of Happiness*, the risks, in terms of health, safety, and ergonomics, to the constructors is inadequately considered by the designers. The "… safety of the construction worker is often left solely to the contractor." (Szymberski, 1997)

Construction work is hazardous and the exposure to health, safety and ergonomic risks is enormous. Such risks give rise to a high incidence of illness, injury and fatalities, which a number of studies suggest could have been avoided, reduced or even eliminated (Mroszczyk, 2005; Schneider; Smallwood, 2006).

The traditional means of measuring project success is the interrelationship of cost, quality and time. This approach has little effect on mitigating hazardous construction work, which can lead to environmental damage, be counter productive, render poor quality and cause time overruns, which cumulatively increase construction costs (Schneider; Smallwood, 2006).

Hinze (2005) actively promotes the need for a paradigm shift through a proactive approach by suggesting that construction designers are in a position to make design decisions, which impact positively on the health and safety of constructors.

Toole and Gambatese (2006) capture the notions of the 'traditional approach' and 'being proactive' by suggesting that construction designs are reviewed to include health and safety considerations as well as to meet the traditional expectancies, and refer to this process as 'constructability'.

Beyond the logical dimensions of constructability, there is also the issue of professional ethics and legislation, which considers expectancies of professional conduct within a legal framework. The Constitution of South Africa serves to protect the citizens, while the Occupational Health and Safety Act strives toward protection of workers in all sectors. The South African Construction Regulations spell out the responsibilities of all people involved in the construction industry, including architectural design professionals, while the Architectural Professions Act ensures competence and integrity of 'designers'.

In summary, if architectural designers competently consider professional ethics and legislation together with a proactive approach to designing for constructability, the high incidence of illness, injury and fatalities, can be avoided, reduced or even eliminated.

The objectives of the initial exploratory phase questionnaire are to determine the perceptions of architectural designers relative to:

- The extent to which design dictates construction relative to health safety and ergonomic risks;
- The extent to which architectural designers conduct hazard identification and risk assessments during the design process;
- The level of design skills relative to construction health, safety and ergonomics;
- The extent to which appropriate design can mitigate health safety and ergonomic risks, and
- The appropriateness of design education, in terms of health, safety and ergonomics, in mitigation of construction risks.

2. REVIEW OF THE LITERATURE

2.1 The Traditional Approach

Construction work is extremely hazardous and the exposure to health, safety and ergonomic risks is enormous. Such risks give rise to a high incidence of illness, injury and fatalities (Mroszczyk, 2005; Schneider; Smallwood, 2006).

Traditionally, construction health and safety is the responsibility of the contractors and other site professionals, and entails the construction work undertaken between the design and the completion of a structure (Mroszczyk, 2005).

There are numerous economic forces at play within the construction industry, which impact on construction health, safety and ergonomics. These are traditionally viewed, and used to assess project success, as the interrelationship of cost, quality and time. Unfortunately, this traditional approach has little effect on mitigating project risk, which leads to a high incidence of ill health, injury and death (Schneider; Smallwood, 2006). Such incidence can create environmental damage, lead to reduced productivity, sacrifice quality, extend the duration of projects and ultimately increase construction costs (Smallwood, 2006).

2.2 Professional Ethics and Legislation

Pearl (2005) quotes numerous texts to elaborate the differing opinions relating to professional ethics, in order to achieve a specific purpose. He speaks of principles which guide decisions of right and wrong conduct relative to specific groups, professions or society, as well as requiring such decisions to be of higher conduct than dictated by law, a test for the conscience of the professional.

The Constitution of South Africa (Republic of South Africa, 1996) makes founding provisions, which include 'human dignity', among others, and the 'rights' of the citizens of the country. By law, the state must respect, promote and fulfil these rights. Relative to this paper, everyone has the right to "an environment that is not harmful to their health or well-being."

Occupational health and safety in South Africa is legislated by the OH&S Act No. 85 of 1993, and all organisations are legally required to abide by the Act for the protection of workers. Underpinning this Act, and relative to the construction industry, the new South African Construction Regulations were promulgated on 18 July 2003 (Geminiani *et al.*, 2005).

More specifically, Smallwood and Haupt (2005) contend that the intent, inter alia, of the South African Construction Regulations is to ensure multi-stakeholder responsibility for construction health and safety. Responsible parties include clients, designers and quantity surveyors, as well as the principal contractors. Their roles are not all elaborated here, however designers are required to, inter alia, provide the client with relevant design information which has an effect on cost, inform the contractor of likely construction risks, provide a geo-science technical report, advise on methods and sequence of construction, and modify the design where construction risks are apparent (Republic of South Africa, 2003).

The argument for professional ethics and legislation is enhanced by the professional, ethical and legal requirements of The Architectural Professions Act, No. 44 of 2000, which prohibits any practise in architecture without appropriate registration and provides a code of conduct ensuring that registered persons competently carry out their duties with integrity (SACAP, 2008), a case for construction health, safety and ergonomics itself.

2.3 Risk management through effective planning

With reference to safety, health, environment and quality (SHEQ) management, Cameron *et al.* (2005) see effective planning as being essential if projects are to be completed according to schedule and budget and without the negative experiences arising from construction risks.

The Construction Design and Management (CDM) regulations of 1994, since superseded by the new CDM regulations of 2007, served toward development of the 'gateway' approach in which five specific project phases, which need effective planning, were identified, namely the concept, feasibility, design, construction and maintenance phases (Cameron et al., 2005). The 'gateway' approach, simply put, creates a method of assessing designers' and contractors' work and provides a model which includes performance assessments, at given intervals, throughout the construction phases.

These are not all elaborated here, but the initial two phases are briefly included to demonstrate the planning initiative and the 'gateway' approach. The 'concept' phase allows for a needs analysis which includes the possible need for the project and defines the user needs, which is followed by 'gateway 1' involving a strategic assessment. The 'feasibility' phase then follows and is divided into two sections. The first of these includes a needs analysis providing for options to meet user needs and considers preparation of a business case. This paves the way for 'gateway 2' involving a project risk assessment. Section 2 of the 'feasibility' phase includes a needs analysis of the project brief, the feasibility study options, and the procurement strategy. 'Gateway 3' then follows requiring a procurement strategy assessment.

The 'gateway' approach ensures interim assessments that consider H&S risks, among others, at various project phases, prior to continuing with the subsequent phases (Cameron *et al.*, 2005). Such risk management through effective planning at the early stages of construction projects facilitates management of the traditional economic forces within construction projects, as well as the health, safety, and environmental risks, while still promoting quality in construction (Cameron *et al.*, 2005).

2.4 Mitigation of Construction Risks through Appropriate Design

The 'design' phase follows the concept and feasibility phases as demonstrated by Cameron *et al.* (2005), and forms the crux of this paper.

Hinze (2005) actively promotes the need for a paradigm shift from simply monitoring H&S performance to proactively improving H&S performance through continuous operational improvement, and further supports the proactive approach by suggesting that decisions made by construction designers can have a positive impact on the H&S of construction workers. Projects with a H&S focus during the design phase are more likely to render good H&S performances (Hinze, 2005).

Toole and Gambatese (2006) capture the notions of the 'traditional approach' and 'being proactive' by suggesting that "… design is reviewed to ensure it can be constructed safe(l)y, as well as meet cost, schedule and quality goals", and refer to this process as 'constructability'. Toole and Gambatese (2006) further suggest that 'Designing for Construction Safety' (DfCS) has three intrinsic qualities, recognising that:

- The construction industry is extremely dangerous and that a multi-stakeholder approach can mitigate construction risks;
- Construction risks can be mitigated through involvement of adequately educated professionals making design decisions, and that
- Design professionals are in a position to make decisions which affect H&S during the early stages of construction projects.

In short, designers should make appropriate design decisions which not only consider cost, quality and schedule, but must be all inclusive in terms of mitigating construction health, safety, and ergonomic risks. The question arises as to the extent to which design professionals can be expected to design for health, safety and ergonomics, and how they can approach the issue at hand?

Hetherington (1995) suggests that design professionals are only expected to consider projected risks which are identifiable during the design process and that professional designers will have different input at different stages and each should aim toward reducing construction H&S risks, and further suggests that there are three main stages in the design process where construction H&S can be addressed through design interventions, namely:

- Concept stage[4], where fundamental decisions about the design are taken such as the location of structures on a building site;

[4] This is the 'concept stage' of design and should not be confused with the 'concept phase' suggested in the 'Gateway' approach, as documented by Cameron et al (2005).

- Design evolution, where earlier stages of the design process may be influenced by later decisions for example the arrangement for fixing curtain walling, and
- Detailed specifications, where decisions could further influence H&S for example the solvent content of glues and adhesives to be used for fixings.

Clients should ensure that the contractors they appoint are competent. Professional designers can only assume that the appointed contractors are sufficiently competent to execute their designs. It is important that designers therefore provide the necessary information along with their design documentation to ensure that potential risks and associated issues are clearly identified (Hetherington, 1995).

2.5 The appropriateness of design education

Toole and Gambatese (2008) reinforce the contention of Hecker *et al*. (2005), as well as Toole (2005), by suggesting that construction designers have insufficient knowledge of construction safety and relative construction processes required to adequately address mitigation of risks through design, and that people with suitable education in H&S would contribute to best design decisions. Further suggestion is that that a strong emphasis on 'designing for constructability' must be ensured through education (Toole & Gambatese, 2006).

In discussing Prevention through Design (PtD), Schulte *et al.* (2008) suggest that education can be enhanced through two mechanisms, namely through expansion of curriculum and through stimulation of professional accreditation.

H&S education is inappropriate and optimisation of construction design programmes at tertiary education institutions is essential. Further education, in the form of Continuing Professional Development (CPD) courses will raise awareness levels in terms of H&S and a subsequent change of perceptions (Smallwood, 2006).

3. METHODOLOGY

The research conducted was quantitative in nature and aimed toward determining the perceptions of architectural design professionals with regard to mitigation of construction health, safety, and ergonomic risks through appropriate design.

A survey of the literature preceded the questionnaire survey conducted among 102 members of the East Cape Institute of Architects. 18 responses were received, which equates to a response rate of 17.5%. The questionnaire survey method was chosen over an interview method as respondents are considered more likely to divulge information more honestly in their own time and in the state of privacy. Furthermore, survey questionnaires were used because of the cost effectiveness thereof and the limited time available to administer the survey.

The questionnaire was designed to determine, *inter alia*, the perceptions of professional architectural designers with regard to the mitigation of construction health, safety and ergonomic risks through appropriate design. Fifteen statements were presented, the respondents being required to indicate on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which they concur therewith. An 'unsure' option was included in order to eliminate doubtful responses. An open ended question was then included to solicit general comments pertaining to the objectives of the survey.

In terms of the perceptions of professional architectural designers, the objectives were to determine the:

- Extent to which design dictates construction relative to health, safety, and ergonomic risks;
- Extent to which architectural designers conduct hazard identification and risk assessments during the design process;
- Level of design skills relative to construction health, safety, and ergonomics
- Extent to which appropriate design can mitigate health, safety, and ergonomic risks, and
- Appropriateness of design education, in terms of health, safety, and ergonomics, and the mitigation of construction risks.

4. FINDINGS

Table 1 indicates the degree of concurrence with statements related to designing for construction health, safety, and ergonomics.

Mean scores $\geq$ 4.2 $\leq$ 5.0 indicate that the degree of concurrence can be deemed to be between agree to strongly agree / strongly agree, while mean scores of $\geq$ 3.4 $\leq$ 4.2 indicate that the degree of concurrence can be deemed to be between neutral to agree / agree. Mean scores $\geq$ 2.6 $\leq$ 3.4 indicate that the degree of concurrence can be deemed to be between disagree to neutral / neutral, while mean scores of $\geq$ 1.8 $\leq$ 2.6 indicate that the degree of concurrence can be deemed to be between strongly disagree to disagree / disagree.

The degree of concurrence is represented in terms of percentage responses to a scale of 1 (strongly disagree) to 5 (strongly agree), and a corresponding mean score between 1.00 and 5.00.

Table 1: Degree of concurrence with statements related to designing for construction health, safety, and ergonomics.

Statement	Response (%)						Mean score
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Appropriate design and specification can mitigate the use of hazardous materials, which cause illness and terminal disease	5.6	0.0	5.6	11.1	50. 0	27.8	4.05
Design dictates construction	0.0	0.0	0.0	27.8	55.6	16.7	3.89
Improved design education in terms of construction health, safety and ergonomics can mitigate hazardous construction work	11.1	11.1	16.7	5.6	38.9	16.7	3.43
Constructors are injured, including fatal occurrences, due to exposure to hazardous construction work	5.6	5.6	16.7	16.7	44.4	11.1	3.41
Appropriate design can mitigate hazardous construction work, which places constructors at risk	5.6	5.6	16.7	27.8	33. 3	11.1	3.29
Designers do not conduct hazard identification and risk assessments during the design process	0.0	5.6	16. 7	33.3	22.2	11.1	3.27

Appropriate design can lead to the improvement of construction health, safety and ergonomics	0.00	11.1	22.2	11.1	50.0	5.6	3.20
Constructors become ill, including terminal diseases, due to exposure to hazardous construction materials	16.7	0.0	22.2	27.8	22.2	5.6	3.14
Constructors experience work-related musculoskeletal disorders (WMDs) due to the nature of construction work	33.3	5.6	16. 7	16.7	22.2	5.6	3.08
Design education inadequately prepares construction designers in terms of construction health, safety and ergonomics	11.1	16.7	16.7	22.2	16.7	16.7	3.00
Appropriate design can mitigate construction accidents, which cause injuries and fatalities	5.6	16.7	11.1	38.9	27.8	0.00	2.82
Design dictates construction leading to hazardous work being undertaken by constructors	0.0	16.7	33.3	22.2	27.8	0.0	2.61
Designers lack 'designing for construction health, safety and ergonomics' skills	5.6	22.2	27.8	16.7	27.7	0.0	2.52
Constructors are placed at risk due to a lack of 'designing for construction health, safety and ergonomics' skills	5.6	16.7	33.3	33.3	5.6	5.6	2.47
Appropriate design can mitigate the incidence of constructors experiencing WMDs	33.3	11.1	16.7	22.2	5.6	0.0	2.40

The mean score of 4.05 relative to "Appropriate design and specification can mitigate the use of hazardous materials, which cause illness and terminal disease" indicates that the degree of concurrence is between neutral and agree / agree. This mean score concurs to some degree with the mean score of 3.14 relative to "Constructors become ill, including terminal diseases, due to exposure to hazardous construction materials" indicating that the mean score is between disagree and neutral / neutral, however the 16.7% unsure answer should be noted.

The mean score of 3.89 relative to "Design dictates construction" is discordant with the mean score of 2.61 relative to "Design dictates construction leading to hazardous work been undertaken by constructors", but concurs with the mean score of 3.41 relative to "Constructors are injured, including fatal occurrences, due to exposure to hazardous construction work" and the mean score of 3.29 relative to "Appropriate design can mitigate hazardous construction work, which places constructors at risk". The mean score of the latter (3.29) also concurs with the mean score of 3.20 relative to "Appropriate design can lead to the improvement of construction health, safety and ergonomics", but less concurrent with the mean score of 2.82 relative to "Appropriate design can mitigate construction accidents, which cause injuries and fatalities" and the mean scores of 3.14 and 3.08 respectively, relative to "Constructors become ill, including terminal diseases, due to exposure to hazardous construction materials" and "Constructors experience work-related musculoskeletal disorders (WMDs) due to the nature of construction work", but the unsure responses of 16.7% and 33.3% respectively must be noted. The lowest ranking mean score of 2.40 relative to "Appropriate design can mitigate the incidence of constructors experiencing WMDs" is discordant with the mentioned mean score of 3.29, but once again the unsure response of 33.3% should be noted.

The mean score of 3.43 relative to "Improved design education in terms of construction health, safety and ergonomics can mitigate hazardous construction work" concurs with the mean score of 3.00 relative to "Design education inadequately prepares construction designers in terms of construction health, safety and ergonomics", but is in discordance with the mean scores of 2.52 and 2.47 respectively with regard to "Designers lack 'designing for construction health, safety and ergonomics' skills" and

“Constructors are placed at risk due to a lack of ‘designing for construction health, safety and ergonomics’ skills”.

The mean score of 3.27 relative to “Designers do not conduct hazard identification and risk assessments during the design process” is in discordance with the mean scores of the previously mentioned 2.52 and 2.47 respectively with regard to “Designers lack ‘designing for construction health, safety and ergonomics’ skills” and “Constructors are placed at risk due to a lack of ‘designing for construction health, safety and ergonomics’ skills”.

Respondents were also given an open ended concluding question: “Do you have any comments in general regarding designing for construction health, safety and ergonomics?” 44.4% had no comment, 33.3% had one, 5,6% had two, 11.1% had three, and 5.55% had four, which equates to a mean of 1.0 comments per respondent. These are demonstrated as follows:

- “ Take note that any construction site can be hazardous depending on the behaviour of the ‘constructors’ on site”;
- “There are many safety procedures related to dangerous areas of construction, most of which are not followed by the constructors”;
- “The nature of construction work is dangerous”;
- “It is extremely rare for designers to specify hazardous materials – 99% of materials are accepted common-use materials”;
- “Building at 1m can be as dangerous as at 20m – The contractor is responsible for using appropriate technology and systems”;
- “Design cannot take a back seat due to improper health designs”;
- “Although designers need to be more aware and practiced in appropriate and safe design, I feel that the constructors whos(e) job place them at risk, to (where possible) lias(e) & suggest optimum methods to ensure safety and achieve design requirements”;
- “Practical training lectures would be useful for CPD purposes”;
- More emphasis should be placed on CHS in training in the construction industry”;
- “By law, architects must instruct their client to appoint an H&S consultant to draw up an H&S plan and ensure that this is implemented. This is not a normal part of an architects work. Should a client ask the architect to do this, that’s a different story”;
- “Construction work is dangerous by nature”;
- “All materials if not used correctly, can be dangerous”;
- A Professional contractor should have all the necessary skills and equipment to be able to deal with any design”;
- “90% of all designs are conventional construction with no more than average risk”;
- “Construction by it’s nature is hazardous (High rise, basements, machinery etc). How this is managed is the contractor’s responsibility. However, architects need to be informed by the industry how to assist safety thro’ designs”;
- “Besides that the design may be challenging and unconventional, constructors like short cuts and cutting costs even if it means carryout works unsafely. There is always a way to carry out works safely, but it is costly for unconventional projects”;
- The client, the designer and constructor must always take responsibility to ensure that the works is carried out safely. We cannot point finger to one party it’s a joint responsibility”, and
- “There must always be health and safety officer on site 24hrs to makes sure works are carried out safely”.

5. CONCLUSIONS

Given the objectives and methodology of the study, it is likely that the responses received were from the more committed architectural designers.

The responses from the open ended question in particular, indicate that architectural designers perceive H&S to be the contractor's problem and constitute a mindset that does not promote a multi-stakeholder approach to H&S.

The study indicates that architectural designers do not adequately conduct hazard identification and risk assessments during the design process, yet consider their designing for construction health, safety, and ergonomics skills to be adequate.

They concur that appropriate design and specification can mitigate health, safety, and ergonomic risks, especially in terms of hazardous materials usage, which causes illness and terminal disease. However, with respect to this and work-related musculoskeletal disease (WMDs) there appears to be some doubt, or lack of knowledge, as demonstrated by the number of 'unsure' answers.

The respondents also concur that design education inadequately prepares architectural designers in terms of construction health, safety and ergonomics and further concur that the associated risks can be mitigated through improved design education.

6. RECOMMENDATIONS

Further research in relation to designing for construction health, safety, and ergonomics is essential and design education must fully integrate health, safety, and ergonomic issues into the design process. This must be addressed by tertiary education institutions which offer architectural design programmes, as well as through Continuing Professional Development (CPD) programmes.

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APPENDIX 2 – PROVISIONAL STUDY PAPER 2

The provisional study paper 2 is located overleaf.

Design for construction health, safety, and ergonomics: Encouraging architectural designers

Craig Goldswain[1] and John Smallwood[2]

[1]PhD Candidate, Department of Construction Management,
Nelson Mandela Metropolitan University, Port Elizabeth, South Africa
cgoldswain@telkomsa.net

[2]Professor and Head – Department of Construction Management,
Nelson Mandela Metropolitan University, Port Elizabeth, South Africa
John.Smallwood@nmmu.ac.za

Abstract

A prior exploratory survey demonstrated, inter alia, that architectural designers: perceive H&S to be the contractor's problem; do not adequately conduct hazard identification and risk assessments during the design process; concur that appropriate design and specification can mitigate health, safety, and ergonomic risks; concur that design education is inadequate in terms of construction health, safety, and ergonomics, and further concur that associated risks can be mitigated through improved design education.

This paper presents the findings of a qualitative pilot study conducted among a regional group of architectural designers registered with the South African Council for the Architectural Profession (SACAP) to determine what would encourage architectural designers to proactively mitigate construction hazards and risks through design.

The salient findings are: architectural designers need 'designing for construction health, safety, and ergonomics' competencies; a guiding approach or model should be developed and incorporated into architectural education and ongoing training; the guiding approach or model should be technologically grounded and should not stifle architectural freedom.

The findings, although arising from a pilot study, will contribute significantly toward questionnaire development for a PhD study, which ultimately aims at mitigating construction health, safety, and ergonomic risks through architectural design.

Keywords: architectural designers; construction: health, safety, and ergonomics.

1. Introduction

The South African construction industry, as worldwide, is dangerous. The outdated Compensation for Occupational Injuries and Diseases (COID) report (Compensation Commissioner, 1999) suggests that of the listed 24 industries, Building and Construction ranks ninth in terms of accident frequency rate, fifth in terms of accident severity rate, and third in terms of accident fatality rates.

The South African Construction Regulations were promulgated in 2003 and require a multi-stakeholder approach to construction health and safety, inclusive of designers (Republic of South Africa, 2003), while SACAP expects "... registered persons to competently carry out their duties with integrity." (Goldswain & Smallwood, 2009) The impact on 'designing for construction health, safety and ergonomics' remains questionable. The traditional 'cost, quality and time' project success measurement tool is no longer applicable and needs to embrace construction health, safety, and ergonomics (Mroszczyk, 2005; Schneider, 2006; Smallwood, 2006). Numerous studies suggest that half of construction accidents can be eliminated through proactively 'designing for construction health, safety, and ergonomics' (Health and Safety Executive (HSE), 2003; Behm, 2006; Toole and Gambatese, 2006).

The literature review considers a range of factors, which can exacerbate construction hazards and risks leading to accidents. It identifies predominant accident types leading to construction related illness, injuries and fatalities. A discussion on 'mitigation of hazards and risks through design' suggests that up to half of construction accidents could be avoided through design, and entertains separate discussions on construction health, construction safety, and construction ergonomics. Approaches toward mitigation of construction hazards and risks are exposed in the form of lists of recommendations and models which have been devised to engage, inter alia, designers in the process of 'designing for construction health, safety, and ergonomics'. In closing, relative perceptions of architectural designers are exposed through a prior exploratory survey.

This qualitative pilot study forms part of a PhD (Construction Management) study, which ultimately aims to realise a paradigm shift relative to construction health, safety, and ergonomics. The objectives are to determine the perceptions of architectural designers as to:

- Whether they engage in 'designing for construction health, safety, and ergonomics' or not, and to establish the need for development of competencies;
- What mechanisms could be introduced which would promote engagement and commitment to the process, and
- What format the introduced mechanisms should take.

2. Review of the literature

Accident factors and causes of illness, injuries and fatalities

A convergence of factors leads to construction accidents. Firstly, 'proximal factors', which include the attitude, ability, awareness, health and fatigue status of workers, as well as site hazards created in the absence of suitable planning, management and supervision. Secondly, 'distal factors' include issues surrounding design, in terms of choice of material and equipment and the application of the design situation. Similarly, these factors can be grouped as worker factors, site factors and material / equipment factors, which stem from 'originating influences', such as permanent works design, inter alia, which in turn are affected by client requirements, economic climate and the education, knowledge and experience of the people involved (Health and Safety Executive (HSE), 2003; Gibb *et al*., 2006).

The main causes of illness, injuries and fatalities in South African construction and internationally are 'falls onto different levels', 'motor vehicle accidents', 'struck by', 'inhalation, absorption and ingestion', and 'work-related musculoskeletal disorders' (WMSDs) or 'body stressing' (The Health and Safety Executive (HSE), 2006; Penny, 2007; Weitz and Luxenberg, 2008; Bureau of Labour Statistics (BLS), 2008; Construction Industry Development Board (cidb), 2009; Safe Work Australia, 2010).

Mitigation of hazards and risks through design

Toole and Gambatese (2006) suggest that mitigating hazards and risks can be achieved by conducting reviews at various stages of the design process, while Behm (2006) suggests that one third of the hazards and risks "... could have been eliminated or reduced if design-for-safety measures had been implemented". The HSE (2003) suggests that up to 50 of 100 studied cases could have mitigated the hazards and risks through alternative design.

Construction health hazards and risks include inhalation, absorption and ingestion of hazardous chemical substances (HCSs), which can lead to a range of illnesses and ultimately death (Smallwood and Wheeler, 1999). Cowley *et al.* (2000) advocate Bender and Hadley (1994) and suggest more pressure be applied on manufacturers of HCSs to improve hazard information on packaging to make 'upstream target groups' more aware of the risks presented by using specific products.

Construction safety hazards and risks include 'motor vehicle accidents', 'falls onto different levels' and 'struck by' possibilities, as well as electrical contact, contact with moving parts of machinery and vehicles, fire and explosion, excavation collapse, and working in confined spaces (Deacon and Smallwood, 2010). Cowley *et al*. (2000) advocate The Consultancy Company (1997) suggesting that by the time hazards are assessed it is usually too late to intervene.

Deacon and Smallwood (2010) suggest that construction ergonomic hazards and risks include repetitive movements, working in awkward positions, climbing, heavy equipment and material handling, bending or twisting, reaching overhead or away from one's self, noisy and vibrating tools, use of body force, working in limited space, reaching away from the body, working in a varied range of weather conditions, and working while injured. Rotation of activities and rest periods can alleviate problems, however ultimate risk mitigation can be achieved through avoidance of labour intensive construction (Deacon and Smallwood, 2010).

Approaches toward mitigation of construction hazards and risks

Behm (2006) presents a list of design suggestions originally developed by Gambatese (1996) suggesting modifications to permanent features of projects. For example: *Design the parapet to be 42 inches tall. A parapet of this height will provide immediate guardrail protection and eliminate the need to construct a guardrail during construction or future roof maintenance.* Behm (2006) created a new list of design suggestions. For example: *When design features, such as ventilation systems, trash chutes, chimneys, and elevators, cause floor openings to occur during construction, provide a warning in the plans and specifications for construction, and design in permanent guardrail systems and sequence them in early in the construction process for use by all contractors;*

Numerous researchers contend that up to half of construction accidents can be mitigated through design, which can be enhanced by conducting construction H&S reviews throughout design stages (Toole *et al*., 2006; Toole and Gambatese, 2006; Behm, 2006; HSE, 2003). To this end two models come to the fore, namely the United Kingdom's Gateway model (HSE, 2004) and the Australian CHAIR model (WorkCover NSW, 2001). These differ and are not elaborated here, but focus on a multi-stakeholder approach requiring interim assessments of designer's work, inter alia, with construction health, safety and ergonomics being an inclusive factor.

Perceptions of architectural designers

A prior quantitative exploratory survey was conducted to determine the perceptions of architectural designers with regard to the mitigation of construction health, safety, and ergonomic risks through appropriate design (Goldswain and Smallwood, 2009).

The paper is not elaborated here, but the most significant findings include: *architectural designers do not adequately conduct hazard identification and risk assessments during the design process; appropriate design and specification can mitigate health, safety and ergonomic risks; design education inadequately prepares architectural designers in terms of construction health, safety, and ergonomics and associated risks can be mitigated through improved design education.*

It recommended additional research with regard to 'designing for construction health, safety, and ergonomics', which should be fully integrated into appropriate tertiary education design programmes, as well as Continuing Professional Development (CPD) courses.

3. Methodology

A quantitative pilot study was conducted among a regional group of architectural designers registered with the South African Council for the Architectural Profession (SACAP) to determine what would encourage architectural designers to proactively engage in mitigation of construction hazards and risks through the design process.

The process involved development of thirteen semi-structured interview questions in order to determine the perceptions of architectural designers as to:

- Whether they engage in 'designing for construction health, safety, and ergonomics' or not, and to establish the need for development of competencies;
- What mechanisms could be introduced which would promote engagement and commitment to the process, and
- What format the introduced mechanism should take.

Approximately 60 telephone calls were made to set up interviews. Of these, twelve interviews were secured and only 10 took place due to two cancellations. Interviews were recorded and corresponding hand written notes were captured.

4. Findings

The data gathered is too rich for inclusion in a concise paper, but will serve toward the greater PhD study. Only responses to the more pertinent questions are included here.

To the question '*Do you believe that construction hazards and risks can be mitigated through alternative design?'* 80% of respondents confirmed their belief, with commentary suggesting that:

- Everything has risks, which can be minimised through design and material choice;
- It is the responsibility of the architect to understand construction technology;
- Risks need to be identified and managed correctly;
- There are definitely ways, but the form of buildings should not change;
- Construction methods should take safety and worker ability into account;
- Risks can be reduced by pre-manufacturing and spending less time at high levels;
- One should mitigate risks, but this should not become a driver for design, and
- There is a lack of awareness and the profession should advise and set out preambles.

20% of respondents do not believe that mitigation of hazards and risks is a design issue. Commentary includes:

- It doesn't really matter as the risks and dangers are contractor responsibility, and
- It is not so much design as management of site procedure.

To the question '*Do you actively engage in 'designing for construction health, safety, and ergonomics'? (Please support your answer with an explanation of 'how' or alternatively with 'reasons' for not engaging)'* 60% of respondents suggested that they do actively engage, yet the responses suggest that the understanding and level of engagement is minimal. Some selected commentary suggests:

- Some design occurs with health and safety in mind but it cannot be specified on drawings;
- Not when taking form into account, but maybe when starting to detail things;
- It is kept in back of mind, but is not a sole reason;
- To a certain extent, risks are noted and sorted out;
- I think I do ... it's not at the forefront of one's mind, and
- One does or should ... we don't think about it enough.

40% responded to the negative, with commentary including:

- I don't think one can ... don't consciously think about it;
- I wouldn't say we actually design for it ... the challenge is to look at how it can be done;
- Inspectors check on how a contractor manages his staff, and
- Not specific, it depends on the project.

To the question *"Is there 'something' which could be introduced that would encourage architectural designers to engage in 'designing for construction health, safety, and ergonomics'?"* 60% of respondents offered positive suggestions, which include:

- Educating people ... tedious to implement ... should not limit design;
- Ongoing education to keep it at the forefront of one's mind ... it's becoming more visible as a topic;
- It is more a case of awareness, even at university level ... it stems back to Architectural School days;
- One may be able to make up manuals ... needs to be brought to our attention ... an awareness is needed;
- Training should include on site experience ... mentorship is lacking, and
- Architects should have hands on knowledge of what the contractor encounters.

40% of respondents were less forthcoming with suggestions and commentary including:

- Nothing specific ... think it's logic;
- Wonder if it happens in high architecture ... nothing off hand;
- No – dangers come more from under-design by engineers, and
- Can't think of anything off hand ... would hate design to be stifled. Is there a design criteria? ... I don't think there can be.

To the question *"In terms of your recommendation, is there any specific means or format which could be integrated into the design process in order to promote 'designing for* *construction health, safety, and ergonomics'?"* 80% of respondents offered positive input, while 20% did not respond. Commentary includes:

- Find out how to do it safely ... stipulate how it's got to be done;
- Education ... consulting agents or representative visits ... buy-in is required;
- An ongoing process to sensitise people ... CPD makes it easier to introduce;
- Some sort of methodology is crucial ... a method or awareness of the building programme;
- Not sure of a format (earlier suggested manual) ... it should make a worthwhile contribution ... something which reminds one to think about it all the time;
- More time spent on the design development stage could benefit ... to build it in, we do Advanced Technologies as part of our design course ... it's glanced over ... we don't fully understand how things are put together;
- It should be integrated into the training process ... in terms of the architect going through six years of training, and
- Architects need to understand how buildings are put together and how methodologies are spelt out ... but the contractor is the expert in building.

To the question *"How could the aforementioned means or format be integrated into your everyday design process?"* 70% of respondents offered positive commentary:

- It should be part of integral thinking ... part of design and documentation;
- Architects should build up specialist knowledge over time;
- It is up to the professional... we need to educate the client to trust the professional;
- The fundamentals of health and safety should be discussed, even at university, and should be monitored and recorded;
- Keep it real and honest – practical and buildable. Do not simplify form and make architecture less exciting and stimulating ... methodology should check and double check your decisions as you proceed;
- Education must be relevant and must address the real problems of design, and
- What must not happen ... we must be very careful with any manual ... it must not be prescriptive and must invite deeper thinking ... if you start closing doors, your design process will be stunted and you can't have that.

30% of respondents did not contribute effectively:

- Never really thought of it;
- We do specify that contractors should conform to safety standards; and
- Accidents seen are due to on site carelessness ... no problems where architectural designs are not safe.

To the question *"Do you feel you have the necessary competencies to 'design for construction health, safety, and ergonomics', and how could these competencies be enhanced?"* 40% of respondents felt that they have the necessary competencies, although commentary suggests otherwise:

- Must do ... most definitely ... working with an engineer the combined effort must cover those sort of things;
- I believe I've got the competencies ... to enhance those competencies one would need to interact with contractor to find out how things could be improved;
- Yes, but we must understand our limitations ... ask for help when we need it and consult with specialists. Experience helps – and do the research, and
- We have the competencies because we are designers ... we can design anything. The only way to enhance those competencies is by being made more aware.

50% of respondents did not feel they had the necessary competencies, while 10% of responses could not be deemed valid. Commentary received includes:

- I don't believe any of us do – we were never taught. What is known is purely through experience – if a detail causes a big problem it won't be used again;
- No, I'm not a health and safety 'fundi'. Aware, but learning as we go;
- No ... interaction of the team to thrash out ideas. Awareness is needed ... goes back to 'varsity' days;
- Not something we factor in enough ... but we don't want it to govern form totally. Architects take thousands of different influences to determine form ... this needs to be one of them, and
- It would be arrogant to say that – maybe adequate but never enough. Education is needed to enhance competencies ... there's a chasm between the two. We actually need to marry the thought processes.

To the question *"If 'designing for construction health, safety, and ergonomics' could somehow be incorporated into tertiary education for architectural students, then how do you think it could be integrated?"* 80% of respondents offered a way forward:

- It needs to be instilled from basics. It's difficult, but there must be a way to define objectives ... to fit into Building Construction – the nuts and bolts – not into Design ... must be non-restrictive;
- Alternative construction usage could be enhanced ... risks are not clear. It could form a module with OHS incorporated ... or a subsection of Materials and Methods – what materials, how to use them ... what to use where;
- It will have to fit somewhere between Building Design and Construction, which run parallel ... the Building Construction component. How do we put a building together and how do we document it? It needs to be an integral component – a separate course won't receive the emphasis it deserves. In the early years of architecture it needs to create awareness for architects;
- There must be a rational way of thinking ... even as simple as once drawn, imagine building it. Architectural education discourages it ... forget how, it doesn't matter how it gets built ... at what point do we bring it into detail technology ... the subject Building Technology;
- It should be taught by an architectural professional, not a health and safety officer;
- It should start at root level – day one. Design and methodology go hand in hand like form and structure ... 'varsity' projects – how is it going to be built ... feasible, viable or too risky?;

- Incorporate it into Design and Construction courses – how to put it together. Architects can become more aware, but are not health and safety officers, and
- We need the correct packaging ... there is too much emphasis on spatial rather than detail. Incorporate it into a design problem – link into the detail – talk to the curriculum to decide what year to introduce it.

20% of respondents did not offer a way forward, with comments such as:

- Wouldn't know, and
- It relies on common sense.

To the final question *"Do you have any other comments or ideas in general with regards to 'designing for construction health, safety, and ergonomics'?"* 70% of respondents offered commentary:

- It's important ... an awareness needs to be made;
- One does not really think about it – it needs to be taught and awareness raised;
- The trade is becoming more aware of the problems;
- We need to understand alternative methods of construction. Recycle and re-use ... reduce manpower and reduce risk;
- Awareness and fairness – people doing a hard job – how do we make their day more comfortable. If teams are happy, they will be more aware and careful;
- Something can be developed. Hopefully we're doing it anyway ... it's something we need to be aware of, and
- It's a new field ... not widely explored. We need research and new ideas brought to us. Information needs to be increased at tertiary education level and workshops held for the professionals.

5. Conclusions

Given the objectives and methodology of the study, it is likely that the more committed architectural designers made themselves available for interviews.

80% of respondents believe that construction hazards and risks can be mitigated through alternative design and 60% of respondents suggested that they do actively engage in designing for construction health, safety, and ergonomics, yet commentary suggests that the understanding and level of engagement is minimal. This is supported by the responses received relative to having the necessary competencies.

In terms of encouraging architectural designers to engage in designing for construction health, safety, and ergonomics, and the possible means or format thereof, the arising themes strongly suggest the need for appropriate and ongoing education and training to create awareness and that designers need 'hands on knowledge of what the contractor encounters'. It was also suggested that a manual could be introduced to guide designers through the process, which would make a worthwhile contribution.

The responses to the question of how designing for construction health, safety and ergonomics could be incorporated into education, as well as into the everyday design process, position themselves somewhere between design and technology, with the majority leaning toward the nuts and bolts – as suggested, 'how do we put a building together and document it?' When to introduce this into education remains questionable, but suggestions of creating awareness 'in the early years of architecture' is inspiring.

An additional important theme running throughout the responses is that designing for construction health, safety, and ergonomics must not stifle the design process and should 'invite deeper thinking', rather than being prescriptive.

6. Recommendations

In order to encourage architectural designers to design for construction health, safety, and ergonomics, further research is necessary. Such research should focus on development of a guiding approach or model – or a manual – suitable for integration into architectural education and continuous professional development (CPD) programmes. The approach or model should be geared toward the early years of architecture and related technologies, and should invite deeper thinking, rather than stifle architectural freedom.

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APPENDIX 3 – PROVISIONAL STUDY PAPER 3

The provisional study paper 3 is located overleaf.

An architectural design model framework toward improved construction health, safety and ergonomics in South Africa

Craig Goldswain
Nelson Mandela Metropolitan University,
cgoldswain@telkomsa.net

John Smallwood
Nelson Mandela Metropolitan University
John.Smallwood@nmmu.ac.za

Abstract

A prior qualitative pilot study demonstrated, inter alia, that: architectural designers need 'designing for construction health, safety, and ergonomics' competencies; a guiding approach or model should be developed and incorporated into architectural education and ongoing training, and the guiding approach or model should be technologically grounded and should not stifle architectural freedom.

This paper presents the findings of a subsequent quantitative pilot study conducted among a regional group of architectural designers in the Eastern Cape province of South Africa, registered with the South African Council for the Architectural Profession (SACAP) in order to establish a framework toward development of a guiding approach or model.

The salient findings are: architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding approach or model in place to assist them; the model should be flexible in nature and should promote a buy-in situation as opposed to being prescriptive and regulatory in nature; the application of the National Building Regulations forms a suitable basis for development of the model, and the model should be incorporated into architectural education and CPD courses.

It is recommended that further research be undertaken in order to develop the model within the NBR framework, and also to establish the optimum means to incorporate it into architectural education in South Africa.

Keywords: architectural designers; construction health, safety, and ergonomics.

1. INTRODUCTION

The construction industry remains dangerous and records notable accident statistics (Mroszczyk, 2005; cidb, 2009; Gangolells *et al*., 2010). Of the 24 listed industries in South Africa, the construction industry ranks ninth in terms of the accident frequency rate, fifth in terms of the accident severity rate, and third in terms of accident fatality rate (Compensation Commissioner, 1999). While architectural designers search for 'beauty' (De Botton, 2007), it has been argued that the health and safety of construction workers is insufficiently considered during design, as designers lack design competencies relative to designing for construction health, safety, and ergonomics (Gangolells *et al*., 2010; Goldswain and Smallwood, 2011). While designers are expected to engage in safe design (Republic of South Africa, 2003), it is inadequately addressed in architectural education, leaving a need for development of such competencies (Goldswain and Smallwood, 2011). Behm and Culvenor (2011) question whether designers are even interested in safe design or consider playing a role in it. We thus need to appeal to the mindset of designers in order to encourage them to design for construction health, safety, and ergonomics as numerous studies advocate that up to half of all construction accidents could be eliminated through a focus on safe design (Health and Safety Executive (HSE), 2003; Behm, 2006; Toole and Gambatese, 2006).

Based on the findings of a prior South African qualitative pilot study (Goldswain and Smallwood, 2011), this quantitative study set out to establish a framework toward development of a guiding approach or model, suitable for use by architectural designers in South Africa, to mitigate construction hazards and risks.

2. REVIEW OF THE LITERATURE

Positioning the designer

The way designers think and their ability to respond to health, safety, and ergonomics issues is considered key in the protection of construction workers (Behm and Culvenor, 2011). Although designers are well positioned to proactively combat construction hazards and risks through the design mechanism (Hinze, 2005), design education inadequately prepares them to engage the process (Smallwood, 2006, Toole and Gambatese, 2006). Optimisation can be achieved through expansion of curriculum and through stimulation of professional accreditation and Continuing Professional Development (CPD) (Schulte *et al*., 2008; Smallwood, 2006; Goldswain and Smallwood, 2009). While Behm and Culvenor (2011) contemplate the 'underpinnings of designers', Smallwood (2006) suggests that appropriate design education and CPD programmes will raise levels of awareness and subsequently change the perceptions of designers. The question arises as to what should be integrated into architectural design education, CPD programmes, and the everyday design process? Relative to South Africa, Goldswain and Smallwood (2011) consider evolving a model, which "... should be geared toward the early years of architecture and related technologies, and should invite deeper thinking rather than stifle architectural freedom."

International approaches to safe design

A number of researchers such as Gambatese, Weinstein and Behm have formulated and disseminated well-serving lists of recommendations, which include considerations such as permanent safety features, guardrails, fixing points, and lifelines (Behm, 2006).

The Australian Construction Hazard Assessment Implication Review (CHAIR), which has an apt acronym, is a tool or model which gives designers time to "... sit down, pause and reflect on possible problems." (Workcover NSW, 2001, 4) A multi-stakeholder approach is ensured through three distinct phases, and includes the 'principles of safe design' and the 'hierarchy of control' (ASCC, 2006). The United Kingdoms' Gateway model (HSE, 2004) presents methods of, inter alia, assessing designers' work. It includes performance assessments at given intervals during design and construction phases and requires a multi-stakeholder approach. It offers 'support tools' to aid the process and sign-off is expected after each performance assessment prior to further progression.

Gengolells *et al*. (2010) advocate proactive hazard identification and appropriate elimination, and provide a quantitative method of evaluating construction safety through risk analysis relative to residential buildings. In order to achieve this, the researchers identified numerous main processes such as earthworks, foundations, structures, and so forth, and reduce these to a total of 219 stages and activities. They seek to identify construction risks related to these processes and then undertake an assessment of the risks. Calculation of the significance of risks through considering the probability of risks and the severity of the consequences then follows. Risks are also relevant to exposure, which is directly related to the volume of required work. Gengolells *et al*. (2010) advocate Frijters and Swuste (2008) and relate the importance of not intruding on the creative process of design while considering safe design recommendations. Behm and Culvenor (2011) considered regulations and code of practice in Western Australia relative to safe design. They provide examples where designers have demonstrated creativity and innovation in safe design, and have simultaneously affected cost, quality and schedule positively. The approach to safe design should embrace enthusiasm and the concept and practice of safe design, and then be underpinned by appropriately adapted regulation (Behm and Culvenor, 2011). This is in line with the findings of Goldswain and Smallwood (2011, 10) in that "... designing for construction health, safety, and ergonomics must not stifle the design process and should 'invite deeper thinking', rather than being prescriptive."

The application of the National Building Regulations (NBR)

This section is included relevant to the findings of this paper. The NBR embraces the Bill of Rights included in the Constitution of the Republic of South Africa in that everyone has the right "... to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures ..." (Republic of South Africa, 2010, 1) The NBR further attempt to "... ensure that buildings will be designed and built in such a way that persons can live and work in a healthy and safe environment" and it was decided that the regulations "... should be concerned only with the health and safety of persons in a building." (Republic of South Africa, 2010, 2) It is notable that this excludes the health and safety of construction workers. A breakdown of the NBR includes: Part A: General principles and requirements; Part B: Structural design; Part C: Dimensions; Part D: Public safety; Part E: Demolition; Part F: Site operations; Part G: Excavations; Part H: Foundations; Part J: Floors; Part K: Walls; Part L: Roofs; Part M: Stairways; Part N: Glazing; Part O: Lighting and ventilation; Part P: Drainage; Part Q: Non-water-borne means of sanitary disposal; Part R: Stormwater disposal; Part S: Facilities for persons with disabilities; Part T: Fire protection; Part V: Space Heating; Part W: Fire installation, and Part XA: Energy efficiency in buildings (SANS 10400, 2010).

3. METHODOLOGY

The research conducted was quantitative in nature and aimed to establish a framework toward development of a guiding approach or model relative to designing for construction health, safety, and ergonomics. A survey of the literature preceded a questionnaire survey conducted among a regional group of architectural designers in the Eastern Cape province of South Africa, registered with the South African Council for the Architectural Profession (SACAP). 76 questionnaires were distributed and 12 responses were received, equating to a response rate of 15.8%. The questionnaire survey method was chosen for cost effectiveness and in order to allow respondents to divulge information in their own time and in the state of privacy. The questionnaire was designed to establish, *inter alia*, a framework toward development of a guiding approach or model relative to designing for construction health, safety, and ergonomics. Eleven statements and three cross reference tables were presented, with respondents being required to indicate on a rating scale, also referred to as a Likert scale as developed by Rensis Likert in the 1930s, of 1 (strongly disagree) to 5 (strongly agree) the extent to which they concur (Leedy and Ormrod, 2010) . An 'unsure' option was included in order to eliminate doubtful responses. Open ended questions were included to solicit general comments pertaining to the objectives of the survey.

This quantitative study, relative to South Africa, thus set out to:

- confirm whether a guiding approach or model would in fact encourage architectural designers to design for construction health, safety, and ergonomics;
- consider the form and nature of a possible model;
- establish if there was any particular extant documentation used by architectural designers to which a possible model could be attached or associated with, and
- consider how the model could be incorporated into architectural education.

4. FINDINGS

In the tables which follow, the degree of concurrence is represented in terms of percentage responses to a scale of 1 (strongly disagree) to 5 (strongly agree), and a corresponding mean score (MS) between 1.00 and 5.00 MSs > 4.2 $\leq$ 5.0 indicate that the degree of concurrence can be deemed to be between agree to strongly agree / strongly agree, while MSs of > 3.4 $\leq$ 4.2 indicate that the degree of concurrence can be deemed to be between neutral to agree / agree. MSs > 2.6 $\leq$ 3.4 indicate that the degree of concurrence can be deemed to be between disagree to neutral / neutral, while MSs of > 1.8 $\leq$ 2.6 indicate that the degree of concurrence can be deemed to be between strongly disagree to disagree / disagree.

Table 1 indicates the degree of concurrence with statements related to designing for construction health, safety, and ergonomics. It is notable that 90.9% of the mean scores (MSs) are above the midpoint score of 3.00, meaning that architectural designers concur with most of the related statements. For purposes of discussion, the findings are elaborated in terms of themes as opposed to MSs, which are simultaneously reflected. The MS of 3.33 relative to 'architectural education in South Africa does not adequately prepare designers to design for construction health, safety, and ergonomics' is supported by a MS of 3.92 relative to 'architectural designers need to improve their designing for construction health, safety and ergonomics competencies', and the MS of 3.33 relative to 'architectural designers do not adequately engage in designing for construction health, safety, and ergonomics because they do not really know where to start or how to engage in the process'. The MS of 4.25 relative to 'a guiding approach or model would assist architectural designers in the process of designing for construction health, safety and ergonomics' equates with the 4.25 MS notion that 'architectural designers would be more encouraged to design for construction health, safety and ergonomics if there was a guiding approach or model in place to assist them'. Relative to such a model, the MS of 3.83 suggests that 'architectural designers would like a guiding approach or model which is flexible in nature and promotes a buy-in situation', which is supported by the only MS below 3.00, being 2.75, relative to 'architectural designers would like a guiding approach or model which is prescriptive and regulatory in nature'. Contrary to the latter, the highest MS of 4.33 relative to 'architectural designers would like a model which provides a series of checklists which can be used during the design process' offsets the flexible, buy-in suggested earlier and contradicts the MS of 3.08 relative to 'architectural designers would like guiding approach or model which provides a series of prompts or keywords in order to engender deeper thinking during the design process. The MS of 3.50 also suggests that 'it would be beneficial to have an approach or model which includes a mechanism for interim assessments during the various stages of the design process. Finally, the third MS of 4.25 suggests that it would prove beneficial if the guiding approach or model was incorporated into architectural education and continuous professional development (CPD) courses.

Table 1: Degree of concurrence with statements related to designing for construction health, safety, and ergonomics.

Statement	Response (%)						Mean score
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Architectural designers would like a model which provides a series of 'checklists' which can be used during the design process	0.0	0.0	0.0	8.3	50. 0	41.7	4.33
A guiding approach or model would assist architectural designers in the process of 'designing for construction health, safety, and ergonomics'	0.0	0.0	0.0	8.3	58.3	33.3	4.25
Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if there was a guiding approach or model in place to assist them	0.0	0.0	0.0	8.3	58.3	33.3	4.25
It would prove beneficial if the guiding approach or model was incorporated into architectural education and continuous professional development (CPD) programmes	0.0	0.0	0.0	8.3	58.3	33.3	4.25
Architectural designers need to improve their 'designing for construction health, safety, and ergonomics' competencies	0.0	0.0	8.3	16.7	50.0	25.0	3.92
Architectural designers would like a guiding approach or model which is flexible in nature and promotes a 'buy-in' situation	8.3	0.0	0.0	8.3	58.3	25.0	3.83
It would be beneficial to have an approach or model which includes a mechanism for interim assessments during the various stages of the design process	0.0	16.7	8.3	16.7	25.0	33.3	3.50
Architectural designers do not adequately engage in 'designing for construction health, safety, and ergonomics' because they don't really know where to start or how to engage in the process	0.0	16.7	0.0	16.7	66.7	0.0	3.33
Architectural education in South Africa does not adequately prepare designers to 'design for construction health, safety, and ergonomics'	0.0	0.0	8.3	25.0	50. 0	16.7	3.33
Architectural designers would like a guiding approach or model which provides a series of 'prompts or keywords' in order to engender deeper thinking during the design process	8.3	0.0	16.7	41.7	16.7	16.7	3.08
Architectural designers would like a guiding approach or model which is prescriptive and regulatory in nature	8.3	8.3	33.3	8.3	33.3	8.3	2.75

Table 2 indicates the degree to which architectural designers consider or use documentation relative to the various stages of the design process. In terms of the SACAP stages of the design process, the MS of 2.83 relative to the application of the NBR is slightly below the midpoint of 3.00, but substantially higher than the 1.75 MS relative to the Work Breakdown Structure (WBS) for Stage 1: Inception. In terms of Stage 2: Concept and viability, the midpoint MS of 3.00 for the NBR outweighs the 1.83 MS for WBS. In terms of Stage 3: Design Development, the MS of 4.50 for the NBR is notable and far outweighs the 1.92 MS for WBS. Unfortunately, project specific Bills of Quantities (BoQs) and project specific Preambles for Construction Trades are not readily available for use during the first three SACAP design stages. In terms of stage 4: Documentation and procurement, the MS of 3.83 for the NBR is followed by the MSs of 3.67 for BoQs, 2.58 for Preambles for Construction Trades and 1.67 for WBS. During Stage 5: Construction, BoQs displays the highest MS of 3.92, closely followed by the NBR with a MS of 3.75. Preambles for Construction Trades follow with a MS of 2.25, and finally a MS of 1.75 for WBS. In Stage 6: Close out, BoQs displays the highest MS of 3.33, followed by the NBR with a MS of 2.92. Preambles for Construction Trades follow with a MS of 1.50, and finally a MS of 1.42 for WBS. Further analysis reveals that: In terms of the NBR, the highest MS of 4.50 demonstrates most consideration or usage of the NBR during Stage 3: Design development, followed by a MS of 3.83 for Stage 4: Documentation and procurement, a 3.75 MS for Stage 5: Construction, a 3.00 midpoint MS for Stage 2: Concept and viability, a 2.92 MS for Stage 6: Close out, and a 2.83 MS for Stage 1 Inception. In terms of BoQs, project specific BoQs are not available for the first three stages, while a MS of 3.92 presides for Stage 5: Construction, a 3.67 MS for Stage 4: Documentation and procurement, and a 3.33 MS for Stage 6: Close out. In terms of a WBS, Stage 3: Design development displays the highest MS of 1.92, followed by a MS of 1.83 for Stage 2: Concept viability, two equally ranked MSs of 1.75 for Stage 1: Inception and Stage 5 Construction respectively, a MS of 1.67 for Stage 4: Documentation and procurement, and a MS of 1.42 for Stage 6: Close out. As for BoQs, project specific Preambles for Construction Trades are not available for the first three phases. A MS of 2.58 for Stage 4: Documentation and procurement is followed by a MS of 2.25 for Stage 5: Construction and a MS of 1.50 for Stage 6: Close out.

As an average of MSs relative to documentation consideration and usage relative to the SACAP stages, the NBR scores 3.47, the BoQs scores 1.82, the WBS scores 1.72 and the Preambles for Construction Trades scores 1.06. It is noted that although opportunity was provided, no other consideration or usage documentation relative to the design process was offered or recommended by any of the respondents.

Table 2: Degree of documentation consideration or usage relative to the stages of the design process **(please note the 'unsure' option denoted U)**.

Documentation	Stages of design (SACAP)					
	Stage 1 : Inception	Stage 2: Concept and viability	Stage 3 : Design development	Stage 4 : Documentation and procurement	Stage 5 : Construction	Stage 6 : Close out
National Building Regulations (NBR)	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	00.0 25.0 25.0 08.3 25.0 16.7	08.3 08.3 00.0 50.0 25.0 08.3	00.0 00.0 00,0 16.7 16.7 66.7	00.0 08.3 00.0 33.3 16.7 41.7	08.3 00.0 16.7 08.3 16.7 50.0	16.7 00.0 33.3 08.3 08.3 33.3
Mean Score	**2.83**	**3.00**	**4.50**	**3.83**	**3.75**	**2.92**
Bills of Quantities (BoQs)	Project specific BoQs will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			00.0 00.0 25.0 08.3 41.7 25.0	08.3 00.0 16.7 00.0 16.7 58.3	08.3 16.7 08.3 08.3 16.7 41.7
Mean Score	**N/A**			**3.67**	**3.92**	**3.33**

Work Breakdown Structure (WBS)	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	50.0 08.3 08.3 00.0 16.7 16.7	50.0 08.3 00.0 08.3 16.7 16.7	41.7 16.7 00.0 00.0 33.3 08.7	41.7 25.0 00.0 00.0 25.0 08.3	50.0 08.3 08.3 00.0 16.7 16.7	58.3 08.3 00.0 08.3 16.7 08.3
Mean Score	**1.75**	**1.83**	**1.92**	**1.67**	**1.75**	**1.42**
Preambles for Constr. Trades	Project specific preambles will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			16.7 25.0 00.0 25.0 08.3 25.0	25.0 16.7 08.3 25.0 08.3 16.7	33.3 33.3 00.0 25.0 00.0 08.3
Mean Score	**N/A**			**2.58**	**2.25**	**1.50**
Other (add below) ………………………	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Comment	**No other documentation was recommended by any of the respondents.**					

Note: Preambles for Construction Trades are not known to all countries. These preambles offer descriptive meaning and a minimum level of specification for materials, finishes and workmanship relative to a vast range of standard construction trades.

Table 3 indicates the degree of concurrence as to which documentation a guiding approach or model should be attached to. In terms of the stages of the design process (SACAP), the MS of 2.58 relative to the NBR is substantially higher than the 0.75 MS relative to the WBS for Stage 1: Inception. In terms of Stage 2: Concept and viability, the MS of 3.08 for the NBR is substantially higher than the 0.75 MS for WBS. In terms of Stage 3: Design Development, the MS of 4.00 for the NBR is substantially higher than the 1.08 MS for WBS. Unfortunately, project specific BoQs and project specific Preambles for Construction Trades are not readily available for use during the first three SACAP design stages. In terms of stage 4: Documentation and procurement, the MS of 3.83 for the NBR is followed by the MSs of 3.17 for BoQs, 2.33 for Preambles for Construction Trades and 1.33 for WBS. During Stage 5: Construction, the NBR displays the highest MS of 3.75, followed closely by BoQs with a MS of 3.25. Preambles for Construction Trades follow with a MS of 2.17, and finally a MS of 1.17 for WBS. In Stage 6: Close out, the NBR displays the highest MS of 2.92, followed by BoQs with a MS of 2.50. Preambles for Construction Trades follow with a MS of 1.42, and finally a MS of 1.25 for WBS. Further analysis reveals that: in terms of the NBR, the highest MS of 4.00 relative to attachment of a guiding approach or model during Stage 3: Design development, followed by a MS of 3.83 for Stage 4: Documentation and procurement, a 3.75 MS for Stage 5: Construction, a 3.08 MS for Stage 2: Concept and viability, a 2.92 MS for Stage 6: Close out, and a 2.58 MS for Stage 1 Inception. In terms of BoQs, project specific BoQs are not available for the first three stages, while a MS of 3.25 presides for Stage 5: Construction, a 3.17 MS for Stage 4: Documentation and procurement, and a 2.50 MS for Stage 6: Close out. In terms of a WBS, Stage 4: Documentation and procurement Stage displays the highest MS of 1.33, followed by a MS of 1.25 for Stage 6: Close out, a MS of 1.17 for Stage 5: Construction, a MS of 1.08 for Stage 3: Design development, and two equal MSs of 0.75 for Stage 1: Inception and Stage 2: Concept and viability. As for BoQs, project specific Preambles for Construction Trades are not available for the first three phases. A MS of 2.33 for Stage 4: Documentation and procurement is followed by a MS of 2.17 for Stage 5: Construction and a MS of 1.42 for Stage 6: Close out.

As an average of MSs relative to attachment of a guiding approach or model, the NBR scores 3.36, the BoQs scores 1.58, the WBS scores 1.06 and the Preambles for Construction Trades scores 0.99. Again, although opportunity was provided, no other documentation relative to attachment of a guiding approach or model was offered or recommended by any of the respondents.

Table 3: Degree of concurrence relative to attachment of a guiding approach or model **(please note the 'unsure' option denoted U)**.

Documentation	**Stages of design (SACAP)**					
	Stage 1 : Inception	Stage 2: Concept and viability	Stage 3 : Design development	Stage 4 : Documentation and procurement	Stage 5 : Construction	Stage 6 : Close out
National Building Regulations (NBR)	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	16.7 16.7 25.0 00.0 16.7 25.0	08.3 00.0 16.7 41.7 16.7 16.7	08.3 00.0 00.0 08.3 41.7 41.7	08.3 08.3 08.3 00.0 16.7 58.3	16.7 00.0 08.3 00.0 16.7 58.3	16.7 16.7 16.7 00.0 08.3 41.7
Mean Score	**2.58**	**3.08**	**4.00**	**3.83**	**3.75**	**2.92**
Bills of Quantities (BoQs)	Project specific BoQs will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			16.7 16.7 00.0 08.3 16.7 41.7	16.7 16.7 08.3 00.0 00.0 58.3	25.0 25.0 08.3 00.0 00.0 41.7
Mean Score	**N/A**			**3.17**	**3.25**	**2.50**
Work Breakdown Structure (WBS)	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	66.7 16.7 08.3 00.0 00.0 08.3	75.0 00.0 16.7 00.0 00.0 08.3	66.7 00.0 16.7 00.0 08.3 08.3	58.3 08.3 08.3 00.0 16.7 08.3	66.7 08.3 00.0 00.0 16.7 08.3	66.7 00.0 08.3 08.3 00.0 16.7
Mean Score	**0.75**	**0.75**	**1.08**	**1.33**	**1.17**	**1.25**
Preambles for Constr. Trades	Project specific preambles will not be readily available for use during these early stages			U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Percentages (%)	N/A			41.7 08.3 00.0 08.3 08.3 33.3	41.7 08.3 08.3 08.3 00.0 33.3	41.7 25.0 16.7 00.0 00.0 16.7
Mean Score	**N/A**			**2.33**	**2.17**	**1.42**
Other (add below) ………………………	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5	U 1 2 3 4 5
Comment	**No other documentation was recommended by any of the respondents.**					

Table 4 indicates the degree of concurrence with regard to the optimal form and levels of study suitable for inclusion of an approach or model in tertiary education. A 'module in various subjects' achieved the highest MS of 3.08 with 8.3% of respondents suggesting level one of tertiary education studies, 33.3% of respondents suggesting levels 2 and 3 respectively, 25% of respondents suggesting level 4 and only 8.3% suggesting level 5. It is notable that 16.7% of respondents selected 'unsure'. A 'component of a subject' attracts the second highest MS of 2.58 with 8.3% of respondents suggesting level one of tertiary education studies, 41.7% of respondents suggesting level 2, 33.3% of respondents suggesting level 3, 16.7% of respondents suggesting level 4 and none suggesting level 5.

It is notable that 25.0% of respondents selected 'unsure'. A 'separate subject' attracts the lowest MS of 1.08 with 33.3% of respondents suggesting level one of tertiary education studies, 25.0% of respondents suggesting level 2, 8.3% of respondents suggesting level 3 and none suggesting level 5. Even more notable is that 41.7% of respondents selected 'unsure'.

Further analysis suggests that an average of 16.3% of respondents selected level 1 studies, an average of 33.3% selected level 2 studies, an average of 25% selected level 3, an average of 13.9% selected level 4, and an average of only 2.8% selected level 5. It is notable that an average of 27.8% of respondents selected 'unsure'.

It should also be noted that no other alternatives for form of education was offered by any of the respondents.

Table 4: Degree of concurrence with regard to the optimal form and levels of study suitable for inclusion of an approach or model in tertiary education **(please note the 'unsure' options. More than one year can be selected per form meaning that percentages indicated do not equate 100%)**

Form	Year / Level of study						
	Unsure	1	2	3	4	5	Mean score
Separate subject	41.7	33.3	25.0	8.3	0.0	0.0	**1,08**
Component of a subject	25.0	8.3	41.7	33.3	16.7	0.0	**2.58**
Module in various subjects	16.7	8.3	33.3	33.3	25.0	8.3	**3.08**
Other (add below)			**No other alternatives were offered**				

To the open ended question, 'do you have any comments in general regarding the development of a guiding approach or model in relation to 'designing for construction health, safety, and ergonomics?', only three responses were given:

It must be "... practical and relevant for implementing in the South African building environment"; "Get the education up and running in tertiary institutes as it is becoming more and more of a factor in the design and production of every project", and "Tertiary education is a great start and professional aids would be very useful as well."

5. CONCLUSIONS

Given the objectives and methodology of the study, it is likely that the responses received were from the more committed architectural designers.

The findings relative to the first part of the study support the findings of the prior qualitative pilot study in that architectural education in South Africa does not adequately prepare designers to design for construction health, safety, and ergonomics. They therefore need to improve their design competencies in this regard because they do not really know where to start or how to engage in the process. The notion of developing a suitable approach or model which should be technologically grounded and should not stifle architectural freedom was also exposed in the prior pilot study. It is supported by the findings of this study in that architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding approach or model in place to assist them. The model is expected to be flexible in nature and should promote a buy-in situation as opposed to being prescriptive and regulatory in nature. Contrary to this, the findings reveal the need for a series of checklists as opposed to a series of prompts or keywords, with the latter being expected to engender deeper thinking during the design process. A mechanism for interim assessments during the various stages of the design process is demonstrated and it would prove beneficial if the approach or model was incorporated into architectural education and CPD courses.

The second part of the study explored the extent to which architectural designers consider or use specific documentation relative to the various stages of the design process. Application of the NBR dominates SACAP design stages 1 to 4, while BoQs displays a slightly higher MS than the NBR in stages 5 and 6, while Preambles for Construction Trades and WBS lag significantly behind.

The third part of the study sought to identify possible documentation to which a suitable approach or model could be attached. Application of the NBR dominated all six SACAP design stages followed by BoQs for stages 4 to 6, while once again Preambles for Construction Trades and WBS lag significantly behind. For parts two and three of the study, it must be borne in mind that project specific BoQs and project specific Preambles for Construction Trades will not be readily available for use anyway, and that no further documentation was recommended by respondents.

Part four of the study sought to identify optimal form and levels of study suitable for inclusion of an approach or model in tertiary education. The MSs pointed in the direction of a ‘module in various subjects’ with most responses concentrated around levels 2 and 3 respectively. Notably, there were a vast number of ‘unsure’ responses throughout and no other alternatives were offered.

The open ended question revealed the need for practicality and relevance, as well as support for inclusion in tertiary education and the usefulness of professional aids.

Further research is required toward the development of a practical and relevant model, which can be integrated into architectural education programmes and CPD courses in order to improve ‘designing for construction health, safety, and ergonomics’ skills. The model should be flexible in nature and promote a buy-in situation in order to encourage architectural designers to engage in the process. Application of the NBR dominates in terms of ‘consideration and usage’, as well as being suitable documentation for ‘attachment’. This renders a suitable framework toward development of a model, which should be technologically grounded and not stifle architectural freedom. Inclusion of the model into architectural education depends on the ultimate outcome of model development and further research.

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APPENDIX 4 – PROVISIONAL STUDY PAPER 4

The provisional study paper 4 is located overleaf.

KEY INPUTS INTO A DESIGNING FOR CONSTRUCTION HEALTH, SAFETY, AND ERGONOMICS MODEL IN SOUTH AFRICA

Craig Goldswain[5] and John Smallwood[2]

1 Department of Construction Management and Quantity Surveying, Walter Sisulu University, East London, South Africa

2 Department of Construction Management, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa

Construction health, safety, and ergonomics is inadequately addressed by architectural designers during the design process and disturbing accident statistics prevail, despite evidence that construction hazards and associated risks can be mitigated through appropriate design. A review of relevant literature and a mix of quantitative and qualitative prior preliminary studies as part of a PhD (Construction Management) study provide a backdrop for this paper.

A pilot study questionnaire comprising a quantitative and qualitative mix was developed and distributed to 73 architectural designers in the Border region of the Eastern Cape Province in South Africa who are registered with the SACAP in order to: establish the dynamics of a model; engender an appropriate framework for a model, and to identify a range of key inputs suited to the model framework.

The salient findings based on response percentages and mean score, and a measure of central tendency: established that architectural designers would be encouraged to design for construction health, safety, and ergonomics if they had a technologically grounded, flexible model which promotes a buy-in situation without stifling architectural freedom to assist the design process; recognised the SACAP work stages as being extensively followed during the design process; found the NBR to be the most widely used construction documentation during the design process, and identified a range of key inputs suited to a proposed model framework. Further research is necessary and it is recommended that the structure of the NBR and the SACAP work stages be suitably integrated in order to form the framework for a proposed model as such a format would be readily understood by architectural designers, and that the proposed range of key inputs be integrated with the proposed model framework to create the proposed model.

Keywords: architectural designers, key inputs, model framework.

[5] cgoldswain@telkomsa.net

[2] john.smallwood@nmmu.ac.za

INTRODUCTION

Internationally, the construction industry has earned a poor reputation for health and safety (H&S) (Mroszczyk 2005; cidb 2009; Gangolells et al. 2010). The South African construction industry is no different and demonstrates disturbing accident statistics (Compensation Commissioner 1999). International regulation such as the UK's Construction (Design and Management) Regulations (CDM 2007), underpinned by The Approved Code of Practice (ACOP) (HSE 2007) place legal duties on architectural designers, among others, to engage in safe design. Similarly, the Construction Regulations of 2003 (with some recent amendment) in South Africa compel architectural designers to practice safe design (Republic of South Africa 2003), however a lack of appropriate education and competencies (Smallwood 2006; Toole and Gambatese 2006) and the level of attentiveness demonstrated by architectural designers (Behm and Culvenor 2011) severely hinders the process. The development of a user friendly model suited to the South African situation is expected to promote encouragement for architectural designers to practice healthy and safe design, and could be integrated into architectural education and training programmes (Smallwood 2006; Schulte et al. 2008). Mitigation of construction hazards and risks through healthy and safe design could eliminate up to 50% of construction accidents (Health and Safety Executive (HSE) 2003; Behm 2006; Toole and Gambatese 2006).

The review of the literature considers a range of possible key inputs suited to a proposed framework for an architectural design model aimed at improving construction health, safety, and ergonomics. These include: local and international literature; causes of construction accidents; hazard identification and risk assessments; international models, and design recommendations.

This paper follows three earlier preliminary studies as part of a PhD (Construction Management) study, and continues to forge the direction of the main study. This predominantly quantitative study set out to: establish the dynamics of a likely model; consider the extent to which architectural designers embrace the SACAP work stages; consider the application of the NBR as the most widely used construction documentation during the design process in order to consider it toward a model framework, and to identify a range of key inputs suited to a recommended model framework.

REVIEW OF THE LITERATURE

Local and international literature

This consideration overlaps other key inputs and is considered more general in nature. It is deliberately kept brief, but is included as a key input not only for consideration of extant literature, but to ensure consideration of future literature deemed suitable for constant evolution of the said model. While exercising healthy and safe design, it is imperative that the creativity of architectural designers is not inhibited (Gangolells et al. 2010). Examples exist where creativity and innovation have flourished while exercising safe design, and have simultaneously demonstrated a positive effect on cost, quality and schedule (Behm and Culvenor 2011). Architectural designers should be encouraged and demonstrate enthusiasm toward safe design which could be underpinned by regulation, rather than being driven by regulation (Behm and Culvenor 2011). Having an appropriate model in place could achieve just that and could enhance competencies by being included in architectural education and on-going training (Smallwood 2006; Schulte et al. 2008).

Hazard identification and risk assessments

Hazard identification involves identifying situations whereby people may be exposed to harm. Risk assessment involves the likelihood of harm occurring, and risk control involves the mechanisms applied to mitigate such hazards and risks (WorkSafe Victoria 2005). Relative to South Africa, Goldswain and Smallwood (2009) identified that "… architectural designers do not adequately conduct hazard identification and risk assessments during the design process." In order to achieve this from a design and construction point of view, Gangolells et al. (2010) identified a range of construction processes which can relate to construction hazards, and consider these in terms of risk probability and consequence severity. They also consider these in terms of the volume of work or exposure to any given process. The processes included are surprisingly similar to the framework of the NBR and includes, for example, earthworks, foundations, and structures (Republic of South Africa 2010).

International models

The Australian CHAIR is a fitting acronym for the Construction Hazard Assessment Implication Review which encourages designers to "... sit down, pause and reflect on possible problems." (Workcover NSW 2001: 4) It offers three vital opportunities for all stakeholders to review design progression, respects the 'principles of safe design' and the 'hierarchy of control' offered by the Australian Safety and Compensation Council (2006). The United Kingdoms' Gateway model (HSE 2004) provides opportunity for all stakeholders to assess the work undertaken by designers', among others at given 'gateways' in the design and construction process. It includes a range of 'support tools' to facilitate such processes, and it expects stakeholders and designers to sign upon satisfaction of each gateway assessment before further work continues.

Design recommendations

Behm (2006) advocates and adds to the contributions of Gambatese and Weinstein who provided a range of design recommendations in order to promote safe design. These include, among others, recommendations relative to aspects of construction sites, inclusion of permanent safety features being incorporated into the design of structures, inclusion of safety information and warnings in construction documentation, appropriate scheduling of activities, establishing of procedures for specific activities, and includes the need for adequate competencies of all persons involved.

METHODOLOGY

This study follows three earlier preliminary studies, one of which was qualitative in nature, as part of a PhD (Construction Management) study which ultimately aims at developing a model suitable for use by architectural designers in South Africa in order to design for construction health, safety, and ergonomics. van Teijlingen and Hundley (2001) propose preliminary studies as crucial toward the success of the main study. All four have been dedicated to a gradualist approach of building a line of structured questioning for the 'action research' paradigm (Dick, 1993) using 'focus group' methodology for the main study (Azhar 2007; Cohen et al. 2007; O'Brien 1998). A survey of the literature and the previous preliminary studies contributed to the development of a questionnaire survey, chosen for cost effectiveness and to give respondents the opportunity to respond within their own time and in privacy (Leedy and Ormrod 2010). The primarily quantitative survey based on percentages, mean score and a measure of central tendency was conducted among a regional group of architectural designers in the Border region of the Eastern Cape Province in South Africa, registered with the SACAP. Questionnaires were distributed in hard copy to 73 randomly selected architectural designers and 15 responses were received, equating to a response rate of 20.5%. The low response rate can be expected from the South African construction industry (Crafford 2007). Relative to this paper, the questionnaire comprised 18 statements, inter alia, with respondents being required to indicate on a rating scale or Likert type scale of 1 (totally disagree) to 5 (totally agree) the extent to which they concur (Leedy and Ormrod 2010). An ‘unsure’ option was included in order to accommodate uncertainty, as opposed to 'forcing' a 'scale' response. Open ended questions followed in order to solicit qualitative comments which could constitute additional emerging themes for the greater study. van Teijlingen and Hundley (2001), with reference to De Vaus' 1993 work, suggest the incorporation of both quantitative and qualitative questioning in pilot studies and what is referred to as 'mixed method design' by Leedy and Ormrod (2010). This quantitative study thus set out to: establish the need and nature of a likely model; consider the extent to which architectural designers embrace the SACAP work stages; consider the application of the NBR as the most widely used construction documentation during the design process in order to consider it toward a model framework, and to identify a range of key inputs suited to a recommended model framework.

FINDINGS

In the table which follows, the degree of concurrence is represented in terms of percentage responses to a scale of 1 (TD = totally disagree) to 5 (TA = totally agree), and a related mean score (MS) between 1.00 and 5.00, based upon the percentage responses. MSs > 4.20 < 5.00 indicate that the degree of concurrence can be deemed to be between agree (A) to totally agree / totally agree, while MSs of > 3.40 < 4.20 indicate that the degree of concurrence can be deemed to be between neutral (N) to agree / agree. MSs > 2.60 < 3.40 indicate that the degree of concurrence can be deemed to be between disagree (D) to neutral / neutral, while MSs of > 1.80 < 2.60 indicate that the degree of concurrence can be deemed to be between totally disagree to disagree / disagree. Allowance has been made for unsure (U) answers.

Table 1 indicates the degree of concurrence with statements related to designing for construction health, safety, and ergonomics. It is notable that 77.8% of the mean scores (MSs) are above the midpoint score of 3.00, meaning that architectural designers concur with most of the related statements. For purposes of discussion, the findings are elaborated in terms of themes as opposed to MSs, which are simultaneously reflected. The first theme seeks to establish the need and nature of a likely model. The MS of 4.18 relative to 'architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding model to assist them' is notable and motivates the need for a model. The profound MS of 4.60 relative to 'a guiding model should be technologically grounded and should not stifle architectural freedom' is significant. The MS of 4.07 relative to 'a guiding model should include checklists and allow opportunity for design notes in order to assist the process' is closely followed by the MS of 4.00 relative to 'a guiding model should be flexible in nature and should promote a buy-in situation making architectural designers more willing to use the model'. To the statement 'a guiding model should include a process which architectural designers can follow in order to design for construction health, safety, and ergonomics', a lesser MS of 3.60 was recorded followed by a MS of 3.40 relative to 'architectural designers would like a guiding model which includes prompts or keywords in order to engender deeper thinking during the design process', however it should be noted that 13.3% of respondents provided an unsure answer. The low MS of 2.64 relative to 'a guiding model should be prescriptive and regulatory in nature whereby architectural designers are forced by regulation to use the model' is also significant. The second theme focusses on a framework for the proposed model and embraces the second and third objectives of this study. The most significant MS of 4.33 relative to 'a guiding model should have a framework which is familiar to architectural designers and offers ease of use' has substance. This is followed by the MS of 4.20 relative to 'architectural designers follow the SACAP work stages during the design process' and the MS of 4.00 relative to 'architectural designers use the application of the NBR during the design process'. Low MSs are recorded relative to the use of other construction documentation and are significantly lower. The MS of 2.53 relative to 'architectural designers use a Bill of Quantities (BoQ) during the design process', the MS of 2.47 relative to 'architectural designers use the Preambles for Construction Trades during the design process', and the MS of 2.33 relative to 'architectural designers use a Work Breakdown Structure (WBS) during the design process' reflect this. The third theme seeks to identify a range of key inputs suited to a proposed model framework. To the statement 'architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics' a MS of 4.07 was recorded. The MS of 3.79 relative to 'consideration of existing design recommendations would prove beneficial to developing a guiding model suitable for use in South Africa' followed. The MS of 3.73 followed relative to 'consideration of local and international literature would prove beneficial to developing a guiding model suitable for use in South Africa'. Finally, two equal MSs of 3.53 were recorded relative to 'architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics' and 'consideration of international models would prove beneficial to developing a guiding model suitable for use in South Africa' respectively.

Table 1: Degree of concurrence with statements related to development of a model

Statement	Response (%)						MS
	U	TD	D	N	A	TA	
Architectural designers would be more encouraged to design for construction health, safety, and ergonomics if they had a guiding model to assist them	6.7	0.0	0.0	0.0	73.3	20.0	4.18
A guiding model should be technologically grounded and should not stifle architectural freedom	0.0	0.0	0.0	0.0	40.0	60.0	4.60
Architectural designers would like a guiding model which includes ‘prompts or keywords’ in order to engender deeper thinking during the design process	13.3	0.0	0.0	26.7	40.0	20.0	3.40
A guiding model should be flexible in nature and should promote a buy-in situation making architectural designers more willing to use the model	6.7	0.0	6.7	13.3	20.0	53.3	4.00
A guiding model should be prescriptive and regulatory in nature whereby architectural designers are forced by regulation to use the model	0.0	13.3	33.3	20.0	26.7	0.0	2.64
A guiding model should have a framework which is familiar to architectural designers and offers ease of use	0.0	0.0	0.0	0.0	66.7	33.3	4.33
Architectural designers use the application of the National Building Regulations (NBR) during the design process	0.0	6.7	6.7	13.3	26.7	46.7	4.00
Architectural designers use a Bill of Quantities (BoQ) during the design process	0.0	13.3	26.7	53.3	6.7	0.0	2.53
Architectural designers use a Work Breakdown Structure (WBS) during the design process	6.7	13.3	33.3	40.0	0.0	6.7	2.33
Architectural designers use the Preambles for Construction Trades during the design process	0.0	20.0	26.7	40.0	13.3	0.0	2.47
Architectural designers follow the SACAP ‘work stages’ during the design process	0.0	0.0	0.0	13.3	53.3	33.3	4.20
Architectural designers would need to understand the causes of construction accidents in order to design for construction health, safety, and ergonomics	0.0	0.0	0.0	26.7	40.0	33.3	4.07
Architectural designers would need to identify hazards and undertake risk assessments in order to design for construction health, safety, and ergonomics	6.7	0.0	6.7	20.0	53.3	13.3	3.53
Consideration of ‘local and international literature’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa	6.7	0.0	0.0	20.0	53.3	20.0	3.73
Consideration of suitable ‘international models’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa	6.7	0.0	0.0	26.7	60.0	6.7	3.53
Consideration of existing ‘design recommendations’ would prove beneficial to developing a guiding model suitable for use in the context of South Africa	0.0	0.0	0.0	40.0	33.3	20.0	3.79
A guiding model should include a process which architectural designers can follow in order to design for construction health, safety, and ergonomics	0.0	6.7	0.0	33.3	46.7	13.3	3.60

A guiding model should include ‘checklists’ and allow opportunity for ‘design notes’ in order to assist the process	0.0	0.0	6.7	6.7	60.0	26.7	4.07

Relevant open ended questions and responses are included as follows:

‘Do you have any comments or suggestions regarding a possible framework for a guiding model?’

- Exposure of professionals to necessity of a model would highlight shortcomings in knowledge, and
- Good idea to relate to SANS 10400 (NBR).

‘Do you have any comments or suggestions regarding possible inputs into the framework of a guiding model?’

- Checklist, and
- Exposure and understanding of construction technologies.

‘Do you have any comments or suggestions relative to construction health, safety, and ergonomics?’

- Designers and architectural practitioners should be actively exposed to the physical construction process of projects to ensure a practical understanding of the erection and construction process and constraints;
- Use CDM regulations from the UK as a benchmark, and
- Very important as deaths / accidents far too high.

CONCLUSIONS

Given the objectives and methodology of the study, it is likely that the responses received were from the more committed architectural designers.

The findings relative to the first theme querying the dynamics of a model indicate that architectural designers would be encouraged to design for construction health, safety, and ergonomics if they had a technologically grounded, flexible model which promotes a buy-in situation without stifling architectural freedom to assist the process. A flexible process is required which includes the need for checklists and allows opportunity for capturing of design notes. Slightly less enthusiasm was expressed relative to the need for prompts and keywords, but some doubt existed in this area. It was made clear that the model must not be prescriptive and regulatory in nature if a buy-in is to be expected.

The findings relative to the second theme clearly indicate that architectural designers suggest a model framework which is familiar to them and offers ease of use. As extensive use is made of both the SACAP work stages and the NBR during the design process, these strongly lend themselves as a model framework which will be familiar and easy for architectural designers to use. It is clear that BoQs, Preambles for Construction Trades and WBSs will not form a suitable model framework. The third theme sought to identify a range of key inputs suited to a proposed model framework. While an understanding of the causes of construction accidents predominated, consideration of existing design recommendations, consideration of local and international literature, the need to identify hazards and undertake risk assessments, and consideration of international models all proved valuable as key inputs. The open ended qualitative questions suggest the importance of the study as accidents and death rates are ‘far too high’, and that exposure and enhanced understanding by designers is required. International benchmarking in the form of the UK's CDM Regulations is also suggested and it is a ‘good idea’ to relate the model framework to the NBR.

Architectural designers require an enhanced contextual understanding of construction health, safety, and ergonomics and further research is required toward development of an appropriate model. It is recommended that the NBR and the SACAP work stages be suitably integrated in order to form the framework for a proposed model as such a format would be readily understood by architectural designers, and that the proposed range of key inputs be integrated with the proposed framework toward development of the envisaged model.

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APPENDIX 5 – FOCUS GROUP CONSENT FORM

The focus group consent form is located overleaf.

RESEARCH FOCUS GROUP CONSENT FORM

THE AIM OF THE FOCUS GROUP

The aim of the research focus group is to consider and discuss some structured questions which are underpinned by a range of probing questions and probing statements in order to assemble a model which could be used by architectural designers in 'designing for construction health, safety, and ergonomics'.

PARTICIPANT CONSENT STATEMENT

I, the undersigned, hereby declare that I have become a participant of the this Research Focus Group of my own free will and that I have in no way whatsoever been placed under duress to participate. I understand the aim of the Research Focus Group, and undertake to participate in an informative manner which is beneficial to the aim. I understand that the data gathered through the Research Focus Group will be used purely for research purposes, and that anonymity is guaranteed meaning that participant coding rather than participant names will be included in any documentation or presentation arising from the research.

PARTICULARS OF PARTICIPANT

The particulars divulged below may be used strictly for statistical measures, or for purposes of contacting the participant in the event that a query should arise.

First Names ______________________________ Surname ___________________________

SACAP registration category ____

SACAP registration number ________________ Years of experience _________________

Age of participant _____________ Sex (M/F) ____________ Date ___________________

Phone __________________ Cell ___________________ E-mail______________________

APPENDIX 6 – COVER LETTER AND MODEL FOR VALIDATION

The cover letter and model for validation is located overleaf.

ARCHITECTURAL DESIGN INTERVENTIONS TOWARD IMPROVEMENT OF CONSTRUCTION HEALTH, SAFETY, AND ERGONOMICS IN SOUTH AFRICA

By Craig Goldswain, PhD (Construction Management) candidate.

Dear research focus group participants.

<u>Provisional model toward safer architectural design in South Africa</u>

I cannot thank you enough for your participation in this research to date. Without your valued contribution reaching this milestone would not have been possible. Following the focus group sessions and subsequent data analysis, I am pleased to announce that a provisional model toward safer architectural design in South Africa has been formulated.

The purpose of this communique is to request your assistance in validating the model by perusing the attached model and responding to the brief qualitative questionnaire attached.

Simplified model explanation:

The model targets the physical design and documentation process undertaken by architectural designers and comprises six components with a range of subcomponents:

1) THE KEY INPUTS: These are broadly considered toward development and on-going updating of the model as more information becomes available;
2) THE CORE MODEL: This comprises a 'matrix framework' which incorporates a 'design opportunity window' (*cyclic design process*) supported by a 'design knowledge window' (*requisite knowledge needed to support the cyclic design process*);
3) THE MECHANISMS: This involves use of the core model toward development of appropriate education, training, and motivation mechanisms to prepare architectural designers on the use of the core model;
4) THE KEY OUTPUTS: These consider the range of 'improvements' emanating from using the model toward mitigation of construction hazards and risks;
5) DISSEMINATION: This contemplates the need to distribute the key outputs to all stakeholders involved in a project, and
6) CONTINUOUS INFORMATION FEEDBACK LOOP: This can emanate from virtually any aspect of the overall model and serve toward improving the model or process (*cyclic*).

Please find and complete the attached electronic questionnaire (MS Word) and return to cgoldswain@telkomsa.net

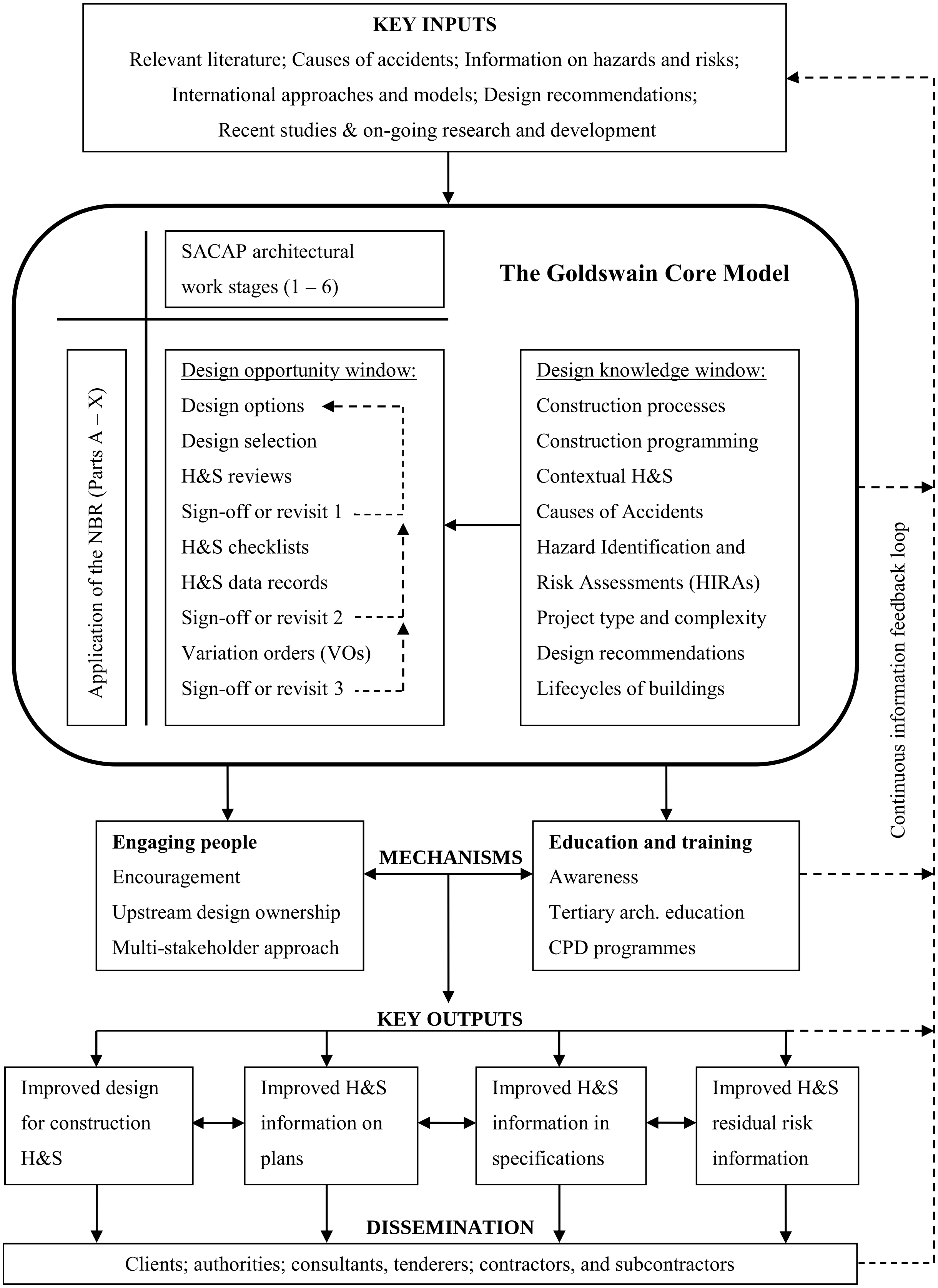
Your assistance toward validation of the model is truly appreciated. Please contact me should you have any queries.

Yours faithfully,

Craig Goldswain (per PDF email).

082 202 1760 / cgoldswain@telkomsa.net

Provisional 'Goldswain Process Model' for safer architectural design in South Africa



APPENDIX 7 – MODEL VALIDATION QUESTIONNAIRE

The model validation questionnaire is located overleaf.

Model validation questionnaire: Anonymity is guaranteed – for research purposes only.

<u>You may enter your data electronically. Save and send to:</u> cgoldswain@telkomsa.net

Please enter a capital 'X' in an appropriate block.

1	Statement relative to the 'key inputs'	Unsure	Totally disagree......Totally agree				
			1	2	3	4	5
1.1	The range of 'key inputs' are valuable toward development and on-going updating of the model (model sustainability).						

1.2 **Do you have any comments relative to the 'key inputs'?**

(Mark text between brackets and type)

2	Statements relative to the 'core model'	Unsure	Totally disagree......Totally agree				
			1	2	3	4	5
2.1	The 'matrix framework' comprising the NBR structure and the SACAP architectural work stages is appropriate.						
2.2	The range of opportunities in the cyclic 'design opportunity window' incorporated in the matrix framework is appropriate.						
2.3	The range of requisite knowledge offered in the 'design knowledge window' is appropriate.						

2.4 **Do you have any comments relative to the 'core model'?**

(Mark text between brackets and type)

3	Statement relative to the 'mechanisms'	Unsure	Totally disagree......Totally agree				
			1	2	3	4	5
3.1	The range of 'mechanisms' toward implementation / use of the model are appropriate.						

3.2 **Do you have any comments relative to the 'mechanisms'?**

(Mark text between brackets and type)

4	Statement relative to the 'key outputs'	Unsure	Totally disagree......Totally agree				
			1	2	3	4	5
4.1	The range of 'improvements' relative to construction H&S are appropriate as 'key outputs'.						

4.2 **Do you have any comments relative to the 'key outputs'?**

(Mark text between brackets and type)

5	Statement relative to 'dissemination'	Unsure	Totally disagree……Totally agree				
			1	2	3	4	5
5.1	The range of 'stakeholders' for distribution of the key outputs are appropriate.						

5.2 **Do you have any comments relative to the 'mechanisms'?**

(Mark text between brackets and type)

6	Statement relative to the 'continuous information feedback loop'	Unsure	Totally disagree……Totally agree				
			1	2	3	4	5
6.1	The 'continuous information feedback loop' is appropriate for updating and improving the model						

65.2 **Do you have any comments relative to the 'continuous information feedback loop'?**

(Mark text between brackets and type)

7	Statement relative to the overall model	Unsure	Totally disagree……Totally agree				
			1	2	3	4	5
7.1	The overall model, in time, can serve toward improved designing for construction health, safety, and ergonomics.						

65.2 **Do you have any comments relative to the overall model?**

(Mark text between brackets and type)

8	Statements relative to the 'research hypotheses'	Unsure	Totally disagree……Totally agree				
			1	2	3	4	5
8.1	The hazards which place construction workers at risk could be mitigated through eventual use of the model.						
8.2	Illness and terminal illness caused by exposure to specific construction processes and materials could be mitigated through eventual use of the model.						
8.3	Injuries and fatalities caused by exposure to specific construction hazards could be mitigated through eventual use of the model.						
8.4	Work related musculoskeletal disorders (WMSDs) caused by exposure to specific construction work could be mitigated through eventual use of the model.						
8.5	Improved design relative to construction health, safety, and ergonomics through use of the model can reduce the exposure of constructors to hazardous work.						
8.6	The model can be used toward improving the adequacy of architectural design education in terms of construction health, safety, and ergonomics.						

Thank you very much for participating in the validation of the model. While anonymity is guaranteed and the data will be used for research purposes only, I request that you please provide the requested details below in the event that a query may arise.

First Names	(Mark text between brackets and type)
Surname	(Mark text between brackets and type)
Phone	(Mark text between brackets and type)
Cell	(Mark text between brackets and type)
E-mail	(Mark text between brackets and type)

Thank you very much for your support. Please save the MS Word file and forward to me electronically at your earliest convenience, but I would appreciate it by 30 November 2013. Please contact me should you have any queries.

Yours faithfully,

Craig Goldswain

Cell 082 202 1760

Email cgoldswain@telkomsa.net