

APPLICATION OF ASSESSMENT TOOLS IN SUSTAINABLE-ARCHITECTURE DESIGN PROCESSES IN SOUTH AFRICA

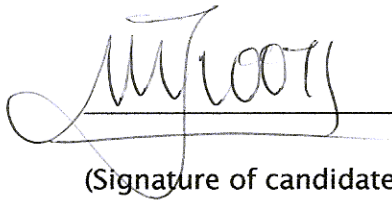
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A dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Architecture.

Johannesburg, 2008

DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Architecture in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.


(Signature of candidate)

30th day of April (year) 2008

ABSTRACT

Assessment tools are occasionally applied in architectural design processes to facilitate the realisation of sustainability goals. But as these tools are only equipped to provide assessment feedback, their limitations in providing sustainability design guidance throughout the design process create major decision-making obstacles.

In this study, four design process components are identified to distinguish between conventional and sustainable design processes. These are: project target setting; decision-makers' education and expertise; team coordination; and the use of modelling/simulation tools. The study applied a comparative case-study method on four design process case studies to evaluate how assessment tool applications complement the four design process components and to determine the extent to which the tools were able to facilitate sustainability integration.

The study concludes that the inherent limitations in assessment tools and their flaws in design process applications constrain their ability to effectively facilitate realisation of sustainability goals. Other difficulties encountered in design processes include dealing with conflicting development objectives and fragmented problem-solving approaches among design team members.

DEDICATION

*Always to You
Beautiful One
From whom
I have come.
And to whom
I shall happily
Return.*

- Alice Walker
in **Her Blue Body Everything We Know**

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NOMENCLATURE

AT	assessment tools
BEE	Black Economic Empowerment
BP	British Petroleum
BRE	Building Research Establishment Ltd.
BREEAM	Building Research Establishment Environmental Assessment Method
BSD	Business and sustainable development
CaGBC	Canada Green Building Council
CAD	computer-aided drawing
CD	conventional design
CEC	Commission of the European Communities
CIB	Construction Industry Board
CIRIA	Construction Industry Research and Information Agency
CS-0	Case Study 0 – a hypothetical conventional office building
CS-1	Case Study 1 – office building for the Department of Science and Technology
CS-2	Case Study 2 – office building for MTN
CS-3	Case Study 3 – office building for Munich Reinsurance Centre
CS-4	Case Study 4 – office building for British Petroleum
CS-5	Case Study 5 – a hypothetical sustainable office building
CS-X	Case Study X – a hypothetical office building example
CIRIA	Construction Industry Research and Information Agency
CSIR	Council for Scientific and Industrial Research
D4S	Design for Sustainability
DP	design process
DST	Department of Science and Technology
EAC	Environmental Assessment Consortium
EIA	environmental impact assessment
EMS	environmental management system
GBA	green building assessment
GBC	Green Buildings Challenge
GBTool	Green Buildings Tool
GDCPP	Generic Design and Construction Process Protocol

iiSBE	International Initiative for a Sustainable Built Environment
IDP	integrated design process
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LEED®	Leadership in Energy and Environmental Design
LEED-EB	LEED for Existing Buildings
LEED-NC	LEED for New Construction
LEED AP	LEED Accredited Professional
MRe	Munich Reinsurance Centre
Probe	Post-occupancy Review Of Buildings and their Engineering
POE	post-occupancy evaluation
RED	resource-efficient design
RMI	Rocky Mountain Institute
SAIA	South African Institute of Architects
SAPOA	South African Property Owner's Association
SB'04 Africa	2004 African Regional Conference on Sustainable Building and Construction
SBAT	Sustainable Building Assessment Tool
SBL	Sustainable Building Life-cycle
SBTool	Sustainable Buildings Tool
SD	sustainable design
SPeAR®	Sustainable Project Appraisal Routine
US DoE	United States Department of Energy
USGBC	United States Green Building Council
VEWs	value-engineering workshops
WCED	World Commission on Environment and Development

1 INTRODUCTION

1.1 Research context

1.1.1 Sustainable development

From a conventional or traditional development point of view, achieving sustainability is difficult and problematic. The industrial revolution set development precedents that contradict the pursuits of sustainability. Unwittingly, humankind became accustomed to development practices that were founded in the capitalist paradigm and its single-minded pursuit of (monetary) profit and endless growth.

The second half of the twentieth century was characterised by increased awareness and recognition of the destructive impacts of human development that cause environmental degradation and social disparity. Through our increased and deepened understanding of what ‘sustainable’ means, we’ve also come to realise that sustainability is not a goal to be achieved, but rather a moving target where ‘becoming sustainable’ is an ongoing journey that, depending on our chosen course of action, may or may not continue into the distant future. Therefore, the issue here lies not in finding an explicit definition of *what* ‘sustainable’ is, but rather using appropriate definitions that *point the way*. In this sense, it is more relevant to determine where we find ourselves on the road *toward* sustainability at this point in time.

The term ‘sustainable’ is by now a well-known and somewhat over-worn adjective that in layman’s terms describes a circumstance or entity that is *“able to be maintained”* (Encarta, 2005). The most commonly accepted ‘formal’ definition of sustainable development originated from the Brundtland report (WCED, 1987:43) and called for development that *“meets the needs of the present without compromising the ability of future generations to meet their own needs”*. And, in terms of understanding needs, John Elkington defined the ‘triple bottom line accounting’ of sustainability in 1998 which recognises that social and

environmental aspects are as important as economic considerations for business performance (BSD Global, 2005:1).

Upon considering these two definitions, one can identify two distinct components that are interwoven in holistic discussions of sustainability:

- the first is **time**, where ‘sustainable development’ calls for development that recognises and considers development impacts *beyond the present*,
- and secondly, **scope**, where the ‘triple bottom-line’ dimensions of sustainability argue that there are *more factors to consider* than is currently recognised in conventional approaches.

Moving from the conceptual level of internationally-relevant sustainable development definitions to the strategic level of regionally appropriate definitions, Agenda 21 for Sustainable Construction in Developing Countries suggests that “*sustainable construction means that the principles of sustainable development are applied to the comprehensive construction cycle*” (CIB et al, 2002:6). This definition encompasses both of the critical components of sustainability identified above. In this definition the time aspect is considered in the realm of a comprehensive construction cycle and in terms of applying sustainability principles, the scope aspect is addressed.

1.1.2 The design process

The term ‘comprehensive construction cycle’ hints at the various stages involved in the creation of a building and, in terms of sustainability, it refers to much more than the mere construction phase of a building (CIB et al, 2002:6). In order to be ‘comprehensive’, a holistic life-cycle approach to the building is taken, which considers the planning processes that take place *before* construction (e.g. the design processes and materials manufacture/ production processes) as well as the operational processes that take place *after* construction (i.e. in the use of the building, during its lifetime and thereafter).

It is commonly recognised that the earlier in the cycle sustainability aspects are considered and incorporated into the development process, the higher the chances of successful building outcome in terms of achieving its project-specific sustainability objectives. In addition, Reed and Gordon (2000:329) point out that early integration of sustainability issues could also reduce additional expenses of sustainability features, as is shown in Figure 1.01. In this respect the scenarios surrounding design decision-making processes for sustainability are especially critical.

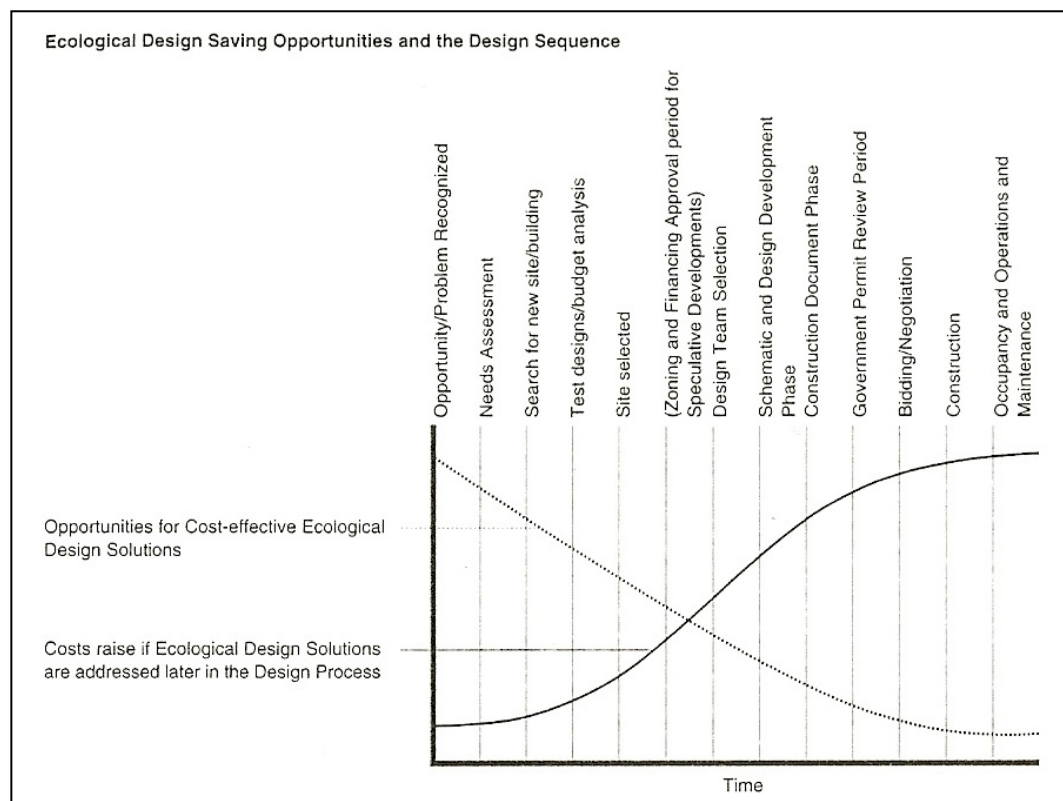


Figure 1.01 Relationship of cost and ecological design opportunity in a typical development scenario (Reed and Gordon, 2002:329)

Reed and Gordon (ibid.) furthermore argue that there are significant differences between the linear approach used in conventional design processes and the integrated design processes undertaken in ecological/sustainability projects. In order to shift toward more sustainable development practices, it is evident that conventional project approaches need to adjust to incorporate a wider range of sustainability requirements.

The first steps taken in any development process is to set project-specific targets in order to define and establish the design brief. The extent and scope of these project-specific targets determine what aspects will be considered and addressed in the design processes that follow to create the building. In many instances the development team is selected according to the skills requirements derived from the project brief and as such the rigour and expertise brought to the project by the development team lies embedded in the extent of knowledge and experience of those who are appointed. Another crucial factor in the design decision-making process lies in the manner in which coordination between different disciplines is conducted and these have a significant impact on the outcome of the building. The last point of relevance here relates to the tools that designers use to facilitate decision-making and often vary notably between different projects and their coordination teams.

The critical differences in design process approaches between ‘conventional’ and ‘sustainable’ can therefore be categorised in terms of the following components:

- client priorities and the extent of development targets that are set,
- the expertise of the development team’s consultants,
- the nature of the coordination process between consultants, and
- the modelling tools that they employ to assist design decision-making.

It is problematic that conventional design decision-making approaches go hand-in-hand with unsustainable development practices, although unintentionally so. If the intended shift toward sustainability is to be successful, the provision of solutions that facilitate sustainability integration *within* conventional process approaches is critical. It is at this point that the aspects of the application of ‘sustainability principles’ and the role of sustainability assessment tools in construction processes becomes relevant.

1.1.3 Assessment tools

Having briefly discussed the time aspect in the comprehensive construction cycle (with particular focus on the design stage), we will now

consider the scope-issues of ‘sustainability principles’ to which earlier reference has been made in the sustainable construction definition.

As mentioned previously, achieving sustainability is a concept of relativity with many influencing variables that are dependant on circumstances. It may be possible to agree on an over-arching definition of sustainable development, but when sustainability objectives are considered in a specific situation, the particular project’s respective variables of economic, social and environmental performance expectations determine the appropriate and achievable development priorities – an interpreted sustainability definition as it were. As a result the extent to which sustainability targets are covered is specific to a particular project and the manner in which present and future needs are addressed is unique in every development.

Various tools are available that facilitate development processes (from decision-making to operational management) across the various stages of a building’s construction cycle and its lifetime. Assessment tools in particular assist in the evaluation of a building’s performance in terms of a set of pre-determined criteria. As Cole (1999:231) points out, *“building environmental assessment methods have emerged as a legitimate means to evaluate the performance of buildings across a broad range of environmental considerations”*. Cole (ibid.) continues by identifying three distinct roles for building environmental assessment methods: they provide

- *“a common and verifiable set of criteria and targets*
- *the basis for making informed design decisions*
- *an objective assessment of a building’s impact on the environment”*.

Most assessment tools currently in use focus more on the environmental aspects of sustainability, which suggest that they lack comprehensive sustainability coverage. Cole et al. (2004:4) also recommends *“broadening the scope of discussion between environmental responsibility and embracing the wider agenda of sustainability”* as a necessary future requirement for assessment tools.

In addition to the increasing need for tools to take a more holistic approach to sustainability by also incorporating social and economic factors, the differences between developing and developed country contexts also need to be considered. Du Plessis (2001:376) points out that *“the definition of sustainable construction, as interpreted within the development priorities of African governments, tends to place the emphasis on social and economic equity, with the environmental issues still a lagging third”*. This illustrates how the sustainability focus in developing countries can differ from that of developed countries (and their assessment tools) where sustainable development places more focus on environmental concerns.

Further aspects of assessment tool applications, which will be considered in more detail later, surround the assessment formats and the manner in which assessment outcomes are communicated, reported and published, the assessment audience to whom these outcomes are communicated (the building’s users, its designers, client, etc.) as well as assessment conduct, i.e. how assessments are done (e.g. at which development stages, under what circumstances, for what purpose) and by whom.

1.2 Problem statement

1.2.1 The research problem

The concepts introduced above can be visually mapped as shown in Figure 1.02. The two core components of sustainability identified above – ‘time’ and ‘scope’ – are positioned at concept level. At strategic level the ‘sustainable construction’ definition introduced the ‘comprehensive construction cycle’ and ‘sustainability principles’ which are placed within the spheres of ‘time’ and ‘scope’ respectively. At application level, the ‘design process’ addresses the concepts of time within the ‘comprehensive construction cycle’ and ‘assessment tools’ provide the scope wherein ‘sustainability principles’ are applied. Where the two components overlap, the ‘sustainable design process’ is located which forms the essence of the research.

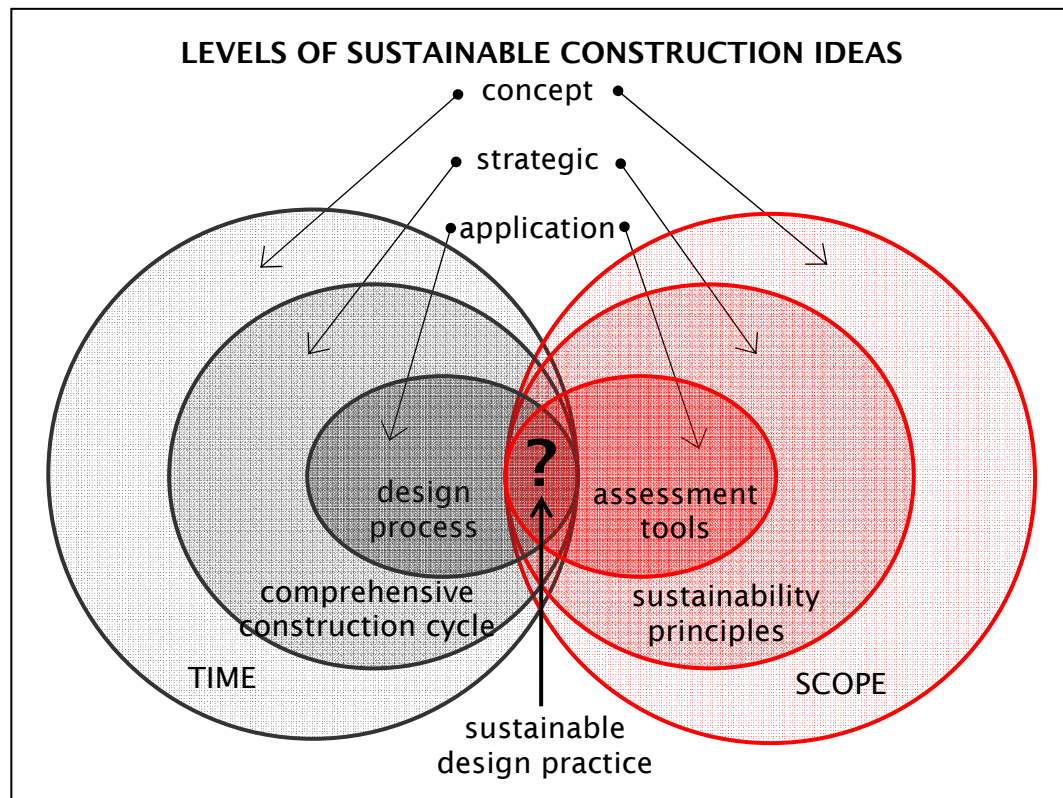


Figure 1.02 Theoretical framework

It seems logical to conclude that assessment tools provide the ideal mechanism whereby sustainability principles can be applied in the (conventional) design process. However many constraints exist which inhibit the successful application of assessment tools and as is evident in the nature and character of construction developments that surround us today, these constraints ultimately perpetuate unsustainable development practices. As Loots and Irurah (2005:1658) point out, “... *the absence of tools and mechanisms which systematically link sustainability criteria, targets and assessment outcomes with decision-making processes significantly inhibits the transformation from conventional to sustainability practice in the built environment*”.

Originally assessment tools were applied at a building’s operational stages to assess the building’s environmental impact and report on its *actual* outcome. Subsequently assessment tools were also used to facilitate target setting in the development project’s planning stages to determine sustainability objectives, thereby reporting on *predicted* outcomes. In this application the expectation is created that assessment

tools are and can be applied as design tools (Cole, 1999:238). Years later Cole (2005:1935) reiterates this statement in his comparison of initial and emerging roles/intentions of assessment methods: *“Since environmental assessment methods present an organized set of selected environmental criteria, by default they communicate to building owners and design teams what are understood as being the most significant environmental considerations. As such existing assessment methods are used as design tools, even though they were not specifically designed to do so.”* He argues that in this application the assessment tools perform conflicting roles – they either assist in points-chasing (i.e. where only specific sustainability points are pursued) or in defining green building practices. In their latter role assessment tools initially facilitate sustainability target setting, but lack the mechanism whereby creative decision-making can be facilitated. It is in this misplaced expectation and application where assessment tools fail.

Furthermore, assessment tools largely fulfil a reporting function, i.e. they express what has been or needs to be achieved. In order to successfully facilitate decision-making toward sustainability, tools that address the ‘how’ questions for design teams are required. As Loots and Irurah (2005:1662) also argue, *“assessment tools say ‘what’ to do to achieve a specific sustainability rating, whereas a design tool would illustrate ‘how’ to do it”*.

Main problem

From the above discussion the foremost problem identified in the research is that **assessment tools fail to successfully facilitate sustainability integration when applied in the design process.**

Three pertinent aspects inform the main problem of the research and are categorised as follows, where

- a) **Sub-problem 1** surrounds the issues and obstacles of facilitating sustainability integration to ensure success, and
- b) **Sub-problem 2** involves the nature of the design process and the constraints that exist when the conventional is compared to the sustainable design process,

- c) with **Sub-problem 3** referring to the problems associated with the application and inherent characteristics of assessment tools in relation to sub-problem 2.

1.2.2 Research questions

Main question

The main question arising from the problem definition provided is **why do assessment tools fail to successfully facilitate sustainability integration when applied in the design process?**

Again, the same three sub-aspects identified in the main problem form part of the main question of the research and these are put as follows:

- a) **Sub-question 1** asks how sustainability integration is/can be facilitated through the design decision-making process to ensure success,
- b) **Sub-question 2** looks into the critical attributes of the conventional design process as it differs from the sustainable design process, and
- c) **Sub-question 3** explores the where, how and nature of assessment tools and their application environments.

1.2.3 Research argument

Main argument

The foregoing discussion provided some brief clues as to the reasons behind the failure of assessment tools. In answer to the main question posed above, the research argues that **assessment tools fail to successfully facilitate sustainability integration when applied in the design process, because they are not adequately adapted to serve as sustainability design tools.**

Accordingly, the three pertinent sub-arguments that inform the main argument of the research are listed as follows, with

- a) **Sub-argument 1** showing how/what constitutes failed and successful facilitation of sustainability integration;

- b) **Sub-argument 2** suggesting that constraints exist in conventional approaches which inhibit sustainability integration whereas pertinent attributes of the sustainable design process enable sustainability integration; and
- c) **Sub-argument 3** substantiating sub-optimal outcomes in the application of assessment tools within design processes.

1.2.4 Research aims and objectives

In summary, the main purpose of the research project is **to determine how assessment tools could be transformed into design tools, in order to ensure that they succeed in facilitating sustainability integration into the design process.**

The following goals are subject to the chief research aim and form part of the interwoven sub-aspects that comprise the overall research objective:

- to determine how sustainability integration is hindered and can be better facilitated in the design process;
- to identify constraints in conventional design process approaches and opportunities in sustainable design process approaches for improved integration of sustainability interventions; and
- to establish how/where assessment tools fail in facilitating sustainability integration when compared to how/where sustainability design tools would succeed.

1.2.5 Research assumptions and delimitations of the study

It is not the intention of the research to evaluate assessment tools or the design quality of the selected case studies. However, and in line with the research objective, the approach is to investigate the relationship between the design process and the role (or not) of assessment tools in each of the selected case studies. The results of the respective case study relationships are compared with the established theoretical parameters, and then discussed to explain the different outcomes in terms of the extent to which sustainability was integrated in the

respective design processes, with or without the use of assessment tools. In this respect the project-specific team players, specific assessment tools that are used and the eventual building product are secondary informants to the primary relationship. Consequently, the research outcomes of the respective approaches taken in each of the case studies indicate their sustainability outcomes *in relation to* the theoretical parameters developed, and are therefore not an evaluation of their individual sustainability performance.

In addition, the primary data collection is restricted to interviews with the architects on the project-specific design process of each of the selected case studies. Architects have an enormous contribution to make in facilitating sustainability integration through their knowledge, design skill and role on the professional team. Their viewpoints and experiences therefore provide valuable insight into the nature of the design process and priorities in built environment development practices, whether 'conventional' or 'sustainable'. Also, architects often perform the role of principal agent responsible for the building design and consultant team coordination and they can therefore represent the interests and experiences of the entire decision-making team.

Sustainability in the private vs. public sector

Development objectives of the private sector (specifically in terms of commercial offices) differ greatly from public sector developments, in that it is profit-driven, thereby offering its own unique pre-disposition to sustainability pursuits. Furthermore, sustainability in commercial developments focus more on environmental aspects, i.e. the 'high-performance' of the building's systems (in its use of energy, water and waste) and, as such, the social aspects of sustainability (e.g. stakeholder participation) discussed earlier as characteristic of developing country priorities are less applicable to commercial projects. Also, an office building is developed for a specific tenant, by a property developer and therefore the development has a (perceived) lesser impact on the community than that of public property developments.

Building type

Office layouts are often copied and duplicated, and therefore they can be seen as possessing template characteristics. Many people work in offices and tenants are continuously relocating or re-leasing their premises. It is possible to compare certain aspects of different buildings to one another or to repeat design solutions, inter alia in terms of its structural grid layout, future use flexibility (partition layouts, etc.), façade cladding, ventilation solutions etc. Offices are potentially also more receptive to future changes: by getting the basic design principles right for the long term (e.g. orientation, structural grid, ventilation) and by placing recycling/re-use focus on building components that have a shorter lifespan (such as cladding, partitions etc.) significant sustainability progress could be made.

‘Grade A’ commercial office buildings in South Africa are selected as building type for the research case studies. The South African Property Owner’s Association’s (SAPOA) proposed Office Grading criteria for Grade A Office Buildings (Pakose and Schneider, 2004:2) broadly define office buildings as having *“high quality modern finishes, air conditioning, adequate on-site parking, market rental near the top of the range in the area in which the building is located, a good quality lobby finish, quality access to/from an attractive street environment, good safety/security, and high quality presentation and maintenance”*. As far as could be determined, the four case studies selected for discussion here satisfy (at a minimum) the SAPOA criteria.

1.2.6 Definitions of key terms

The following definitions of the key research concepts and terms are offered for clarification of their meaning and use in the research context:

SUSTAINABILITY/SUSTAINABLE DEVELOPMENT *“sustainability is the condition or state which would allow the continued existence of homo sapiens, and provide a safe, healthy and productive life in harmony with nature and local cultural and spiritual values ... sustainable development is then the*

kind of development we need to pursue in order to achieve the state of sustainability” (CIB et al., 2002:6).

DEVELOPMENT PRACTICE refers to construction industry developments, i.e. the practice of building buildings (and of office buildings in particular).

CONVENTIONAL refers to development practice conducted in a traditional, ‘business-as-usual’ manner, where sustainability options are typically not specifically considered in any of the development stages or construction processes.

DESIGN DECISION-MAKING PROCESS refers to the development’s planning phases which precede the building’s construction and in the research context ~ is focussed particularly on the expertise covered by the architectural discipline.

DESIGN TOOLS refers to all the tools that are used by the professional team to facilitate decision-making in the design process, e.g. drawing, model-building, computer simulation software, etc. (the text will differentiate whether these tools are conventional in nature, or if they are/can be used to facilitate sustainability integration).

ASSESSMENT TOOLS refers to (formal and informal) tools, methods, models and frameworks that are used in the design decision-making process (whether conventional or sustainable) to assess a building’s sustainability performance (or aspects thereof). Such tools can also be applied in post-occupation performance evaluation/assessment.

1.2.7 Importance of the study

Kirk (2002:2) comments, *“It is always puzzling that in a subject [e.g. energy efficiency and the environment] in which the building physics are relatively simple and well understood, scientists and the architectural profession have had such difficulty in persuading clients to encompass such useful and cost effective measures ... The management of feedback back to practitioners and clients is essential for improvement*

understanding of how buildings actually perform. Fortunately ... post-occupancy evaluation and other forms of assessment are providing much-needed information on buildings and the building stock." Although Kirk is confident that the mechanisms are in place to provide this much-needed feedback, the research argues that assessment tools in particular fail in this respect. Wrongful expectations exist that assessment tools can be used as design tools to facilitate decision-making toward integrating sustainability in conventional development practice. The research argues that there are a range of challenges as demonstrated by the subsequent failed application of assessment tools and identifies constraints in both assessment tools and design processes with the aim of ultimately suggesting solutions on how more successful applications can be realised in future.

In this respect, the research aims to provide insight into the flaws in the applications of assessment tools as design tools, what the expectations are/should be of sustainable design tools to suggest ways in which assessment tools can be transformed to overcome the obstacles typically encountered in conventional design decision-making processes.

1.3 Research method

The research topic surrounds assessment tools and design decision-making processes in the interest of facilitating the integration of sustainability in conventional development practice. The research questions the attributes, expectations and applications of assessment tools, the nature and differences between conventional and sustainable design decision-making processes and, fundamentally, the failure of assessment tools to facilitate sustainability integration in conventional development practice. The research argues that the *failed* application of assessment tools lies in their inherent inability to function as design tools. The objective of the research is to substantiate on this failure and propose ways in which assessment tools can be transformed to incorporate the critical attributes of design tools to ensure their successful application in design decision-making processes.

1.3.1 Research design, style and strategy

The research problem originates in the real-world scenarios of ‘soft’ issues as is characteristic of descriptive and interpretive qualitative research methods (Fellows and Liu, 1997:79). This research project is furthermore concerned with the experience and view of current development practice, the application of assessment tools and issues surrounding sustainability integration from the perspective of key design decision-makers (in this case limited to the viewpoints of the architects on the respective selected projects).

In order to address these aspects, the case study method is selected as the most suitable way to investigate the research problem. Yin (1994:13) defines the case study as a research strategy in terms of the following:

- the case study scope investigates *“a contemporary phenomenon within its real-life context ...”* (ibid.)

In this sense the experiences and viewpoints of the architects become paramount to investigating the research problem. Here the design process itself is under investigation, not the building, which is in fact the outcome or consequence of the foregoing design process.

- the technical characteristics of the case study approach relate to data collection and analysis strategies to *“cope with the technically distinctive situation in which there will be many more variables of interest than data points [that] ... relies on multiple sources of evidence ... [and] ... benefits from the prior development of theoretical propositions ...”* (ibid.)

One of the main predicaments with case studies lies in the problem of deriving research results that are relevant and applicable beyond the context of the particular case. Yin (1994:37) points out that researchers often attempt to select a ‘representative’ set of cases in order to thereby overcome the obstacles to facilitate generalisation between cases. But it is exactly the unique nature of each case study that makes it challenging to draw comparisons between cases (irrespective of the number of cases investigated), as Yin also argues. He suggests that *“... an analyst should*

try to generalize findings to 'theory', analogous to the way a scientist generalizes from experimental results to theory" (ibid.) which will in turn also facilitate dealing with the data collection and analysis.

From this approach the first step in the research process is to establish the research parameters within this particular research context, i.e. define the 'theory' and then develop a method whereby the selected case(s) can be referenced to the theory to draw suitable research-relevant conclusions that resolve the original problem and question.

Robson (1993:161) also touches on the issues of selecting multiple case studies in order to be able to generalise conclusions. Drawing from Yin's earlier (1989) recommendations, Robson suggests the process of 'analytic generalization' where the first selected case study supports the 'theory'; its outcome (in reference to the theory) then guides the selection of subsequent case studies where particular aspects are further researched. In this way, generalisations are drawn from common findings and so-called 'patterns of data' identified between the various case studies *referenced to the research theory* (i.e. not *in relation to one another*).

The research approach is therefore mapped in the following sequence:

- identify research parameters to determine the research-specific theory in terms of what constitutes a conventional (i.e. hypothetical Case Study 0) vs. a sustainable office building (hypothetical Case Study 5) and the characteristics of successful assessment tool applications;
- select and review one case study (Case Study 1) where information can be gathered that satisfies the relevant research criteria in terms of sustainability integration, the design process approach and applied assessment tools;
- select and review additional case studies which highlight particular aspects identified in Case Study 1 in relation to the research criteria that support or contradict the research argument;
- discuss the different case studies and analyse the data outcomes based on the research criteria and parameters identified in reference to the established research theory/framework; and, lastly,

- derive research conclusions that address the research argument and provide recommendations that answer the research questions and solve the research problem.

The following section discusses in further detail the research strategies adopted to deal with the “*variables of interest*” (Yin, 1994:13) surrounding the respective case studies and the research-specific “*data points*” (ibid.) which were informed by specific primary (i.e. interviews with architects) and secondary data sources (such as photos, drawings, published books and articles, assessment results and/or the building product).

1.3.2 Data collection

Robson (1993:159) summarises commonly used techniques to collect the primary data for case study research projects, under the three categories of observation, interviews and the use of documents and records. In this research project, the primary source of data of the design process is obtained through interviews with the key decision-makers (i.e. the architects) on the respective selected case studies.

Background to the research context and focus as well as a set of interview questions were distributed to the selected architects who were going to be interviewed to provide them with relevant information as to the purpose and objectives of the scheduled interview discussion (included in Appendix A-1). In order to allow the free expression of design process experiences, the interviews took an informal course with the questions providing guidance throughout the discussion. Accordingly, the interviews were transcribed in a summarised format as it pertains to the research and specific words or expressions by the interviewed architects are highlighted in italics where a significant point is made. These transcriptions were reviewed by the architects and approved for inclusion in Appendix B.1 – B.4.

A clear distinction can be made between the primary and secondary data sourced for this research project. The secondary data largely provides the information needed to define the research parameters and context

which is discussed in depth in Chapter 2 and aids in the development of the study's investigative framework (Chapter 3). In Chapters 4 and 5 the case study specific primary data on the case studies are discussed and analysed as they relate to the investigative framework.

Secondary data relevant to the research context and specific case studies was sourced from selected printed publications (books, magazines, conference proceedings and research articles) and from the internet/world-wide web. Supporting documentation pertaining to each of the case studies, such as drawings and assessment outcomes (wherever available) is also included in Appendix B.1 – B.4. A summary table at the beginning of each case study's transcript indicates the selection of included/outstanding information in the appendices.

Case study selection criteria

In the investigative framework the different (and sometimes conflicting) aspects which influence the context of the research problem are mapped and prioritised in order to create a mechanism whereby primary data derived from the interviews can be referenced back to the overarching research theory, i.e. the 'data points' of targets, expertise, coordination and tools. Aspects derived from defining the research problem and question and which influence the research theory are primarily related to the level of sustainability integration, the nature of the design process and applications (or not) of assessment tools.

Accordingly, the criteria needed to select the first source of primary data (i.e. Case Study 1) are identified through the secondary data search and also constitute the core 'principles' of the research-specific investigative framework. As noted above, the outcomes of Case Study 1 (as it relates to the research theory) shed further light on the selection of subsequent case studies as the research process intends to solve the research question.

1.3.3 Analysing the data

Yin (1994:106, 110) identifies two strategies whereby case studies can be analysed: pattern-matching and explanation building. In pattern-matching, the case study data is descriptive in nature, e.g. where design

process approaches are described. In explanation building, the case study data is explanatory and data is analysed by explaining the case, such as discussing influencing factors that drive decision-making. In order to define the manner in which data is analysed in this research project, aspects of both these strategies are considered.

Pattern-matching

In descriptive case studies, Yin (1994:106) recommends defining the ‘predicted pattern of specific variables’ prior to data collection. In other words, it is necessary to firstly identify inconsistencies between theory and case study in order to direct the discussion along the lines of the identified theoretical principles. Through Chapter 2’s literature review, these variables are noted for consideration in the data discussion.

Trochim (Yin, 1994:106) suggests that in pattern-matching logic an empirically based pattern is compared with a predicted one (or several alternative predictions), the results which can aid in strengthening the case study’s internal validity.

In applying this approach in this research context, the ‘predicted’ pattern would consist of the components and actions that make up the design process. Certain steps are taken (or not) to arrive at building outcomes, whether conventional or sustainable. In formulating the conceptual investigative framework, it is necessary to derive the aspects that comprise the predicted design process. A theoretical template of both the conventional and sustainable approaches are described in order to be able to compare the empirical design process of the selected case study(s) with the predicted processes within the pre-established CS-0 and CS-5 research parameters.

Explanation building

Yin (1994:110) points out that “*to explain a phenomenon* [in this case the design process] *is to stipulate a set of causal links about it*” and that through explanatory, narrative discussion, the complex and imprecise, often immeasurable links explained in the more successful case studies “*have reflected some theoretically significant propositions*” (ibid.).

As stated, the strategy in the research project is to describe the nature of both the conventional and sustainable design processes and thereafter explain the ‘causal links’ in the process that lead from conventional to sustainable, such as project target setting, the role of the professional team, their coordination relationships and the use of tools in facilitating design decision-making. These causal links may, as Yin (1994:111) suggests is the case in the examples he used, ‘*reflect critical insights*’ into the role of assessment tools in facilitating the shift from conventional toward sustainable design.

Yin (1994:111) proposes a series of steps to determine the final explanation of a case: at the outset a theoretical statement is defined (in this case the investigative framework) and the findings of an initial case (i.e. Case Study 1) are tested against the theoretical statement. The theoretical statement is revised (if necessary) and the details of the initial case compared against it (i.e. the pattern is matched). Thereafter the revised statement is compared against multiple cases (e.g. Case Studies 2, 3 and 4) and the revision process repeated, if required. Yin (1994:111) explains that “*the final explanation may not have been fully stipulated at the beginning of the study*”. In this sense, the proposed research argument is a suggested and possible answer to the research question. The argument is tested against the investigative framework throughout the data analysis process.

“If this approach is applied to multiple case studies, the result of the explanation-building process is also the creation of a cross-case analysis, not simply an analysis of each individual case” (Yin, 1994:111). In this manner the respective case study results that are referenced to the investigative framework (i.e. in terms of targets, education, coordination and simulation tools) also reveal other aspects for comparison in terms of e.g. the nature of assessment tool applications in conventional design processes.

1.3.4 Deriving findings

Robson (1993:401) suggests a few tactics that can be used to draw conclusions from qualitative data. Further to the data collection and

analysis methods described above that are relevant to this particular research project, a combination of the following approaches are applicable here:

- patterning: *“noting of recurring patterns and themes”*, e.g. in the design process approaches in terms of case study specific target setting, appointment of project teams and decision-making tools used
- relating variables: *“discovery of the type of relationship (if any) between two or more variables”*, e.g. targets, education, coordination, simulation tools, etc.
- building of causal networks: *“development of chains or webs of linkages between variables”* where e.g. the use of assessment tools lead to certain consequences in design processes that aim to achieve sustainability results
- relating findings to general theoretical frameworks: *“attempt to find general propositions that account for the particular findings in this study”* where, at the conclusion of the data analysis, the respective case study findings are ‘generalised’ to the pre-determined theoretical parameters (especially the sustainable design process)

It is the purpose of the data discussion and case study comparisons in relation to the research-specific investigative framework to enable a process whereby conclusions can be drawn to address and solve the research problem and substantiate/negate the research argument. As is the case in using qualitative research methods, the data results serve to point in a direction and are thus not conclusive, merely indicative of outcomes in particular circumstances and generalised to a limited extent.

1.4 Brief document outline

The following is a brief summary of each chapter’s content.

Chapter 1

The first chapter starts with a brief discussion of the critical components that comprise the research context. Thereafter the research rationale, its

problems, the related questions and the working argument are explained. This section follows with a description of the selected research method applied to gather and analyse information, resolve the research problem and test the research argument.

Chapter 2

The literature review in Chapter 2 sketches the research background with respect to sustainable building, its performance contexts and life-cycle approaches; development practice, the design process and types of tools in use. It also delves into the role of assessment tools, their focus and application environments. In conclusion, the different components informing the research problem are framed within the established literature context.

Chapter 3

From the background discussion that precedes Chapter 3, theoretical parameters are identified in terms of conventional vs. sustainable design as well as that of assessment tools. An investigative framework is proposed where the relationships between these processes as well as the application of assessment tools to facilitate the shift toward more sustainable practices are demonstrated. The chapter concludes with a discussion of how this framework will assist in the respective case study discussions which follow.

Chapter 4

In this chapter the four selected case studies are discussed and examined alongside the investigative framework. The discussion surrounds the nature of each case study's specific design process approach, in particular how each has responded to the four distinct design process components identified. Each case study discussion concludes with a brief discussion of its particular outcome in relation to the evaluative criteria identified through the use of the investigative framework.

Chapter 5

Whereas the preceding chapter discusses the selected case studies with reference to specific components, Chapter 5 is concerned with the manner in which the different case study approaches relate to the pre-established theory of the investigative framework. Patterns and causal links between the case studies are researched to determine whether conclusions can be drawn that support or negate the research argument.

Chapter 6

In the final chapter the pertinent results and findings of the research project are summarised. Additional research outcomes which fall outside of the immediate scope of the research are also indicated. Recommendations and suggestions for further research are proposed as the chapter concludes.

Appendices

Additional and supplementary information which support the research are included in the Appendices. These consist primarily of the interview guide and other archived material, specifically the primary data (i.e. transcribed interviews, photographs, drawings etc.) of each of the case studies referenced in the main document.

References

References to published work cited in the research document are indicated under the References section.



2 LITERATURE APPRAISAL

The preceding chapter introduced the sustainable construction definition and the discussion that followed differentiated between the time aspects that were covered under the ‘comprehensive construction cycle’ and the scope issues of the ‘principles of sustainable development’. It described where/how the design process plays a role in the construction and what is meant by the term ‘comprehensive’. Then a brief look at assessment tools introduced their application in the construction cycle to facilitate sustainability integration. In the context of the research, assessment tools are perceived as the potential vehicles whereby the principles of sustainable development can be applied in the comprehensive construction cycle, i.e. they could provide the mechanisms whereby sustainable construction can be achieved. However, it is argued that

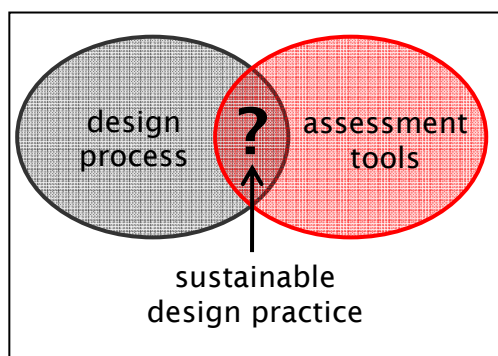


Figure 2.01 *The problem*

assessment tools are inappropriately applied in design processes and therefore fail to successfully facilitate sustainability integration. Figure 2.01 illustrates in a simple way the critical components that in combination comprise the research problem.

The following discussion looks at the numerous aspects that inform the research context wherein design decisions are made and assessment tools are applied in an attempt to facilitate the integration of sustainability. Firstly, aspects surrounding the building context are explored – such as building performance, building systems and life-cycle considerations which comprise the backdrop wherein a sustainable building would be created. Thereafter the design process is investigated and here aspects such as the characteristics of development practices as well as the nature and different roles of the decision-making team are relevant. In this section the process of creating a building is also further explored. Following this, the discussion shifts to focus on assessment tools, providing a brief overview of their aim and focus and the aspects

surrounding their application environments. Finally, the relationship between design process tools and assessment tools is investigated to determine how sustainability integration is/can be facilitated in the design process. The chapter concludes by identifying the gap that exists between design processes and assessment tool applications, thereby underlining the primary research argument.

2.1 The building context

2.1.1 Considering performance

In the design of a building, a range of aspects are considered in order to provide a certain level of performance. Determining performance criteria is a subjective exercise and the process as well as the criteria is unique in every project. Nevertheless, at project outset each team determines the range of performance standards that need to be met, whether it is related to the functioning of the building itself or its functioning within the larger context wherein it is built. In this sense building performance can be divided into two categories: the first that is concerned with the building-specific commissioned performance and the second that focuses on the building's performance in relation to surrounding influences and considerations. Irurah (2003:2) defines these two categories as intrinsic and extrinsic performances respectively.

Intrinsic and extrinsic performance considerations

According to Irurah (ibid.), intrinsic performance considerations include structural stability, thermal control, acoustics, aesthetics, water tightness, fire resistance, anthropometric/ergonomic concerns and finally, cost. Effectively, these performance aspects are all building-specific, tangible and measurable.

Extrinsic performance considerations, on the other hand, are more abstract and concerned with the building's interaction with and relationship to its surroundings. Here performance features such as a building's affordability, acceptability, reliability, sustainability, serviceability, durability and constructability are considered (ibid.).

In the context of the research problem, the relationship between intrinsic and extrinsic performances is especially relevant. For example, a building's water tightness (an intrinsic performance consideration) is connected to its durability (an extrinsic performance consideration), where designing for water tightness results in durable buildings. As such, intrinsic aspects can be seen as the immediate design process considerations and extrinsic concerns as the consequences of addressing those intrinsic aspects. Problems arise in design situations that focus merely on the (immediate) intrinsic performance criteria but fail to make the connection to their (long-term) extrinsic consequences.

Building performance in design and assessment

It can also be argued that intrinsic and extrinsic performance considerations are inherently interconnected, but the mere fact that bad building practices persist is evidence enough that this connection is not made. Cooper et al. (1998:1) references numerous reports calling for the need for change in the construction industry and highlights problems of poor performance which are typically "*measured in terms of cost, time and/or quality*". Building performance impacts which fall beyond these indicators are often not considered in conventional development practices. The argument here and in the research context is that conventional building practices encourage immediate and short-term solutions (i.e. concern for intrinsic considerations) focused on completing a building on time and within budget. In a nutshell: that is commonly accepted as the extent of the conventional development agenda.

In sustainability practices however, thinking beyond the present, the long-term effect of design decisions, a building's impact on its environment and how it is related to its supporting systems are all critical performance criteria (i.e. the extrinsic considerations) that need to be taken into account.

Accordingly, and partly due to their measurable characteristics, it is mostly intrinsic aspects that are assessed through the use of assessment tools. And often the assessment is done when the design has been completed; thereby further removing the understanding that could arise if

consequences of (intrinsic) decisions are communicated. It is difficult to quantify and measure extrinsic performance, although it may be easier to consider these in the abstract thought processes involved in design. It is a requirement for sustainable design that the consequences of intrinsic aspects are comprehensively understood and interpreted into extrinsic factors. Accordingly, assessment tools (which are in essence measurement tools) also need to be able to convey the link between specific design decisions (extrinsic) and their assessed outcomes (intrinsic). In terms of the scope aspects discussed earlier, assessment tools that do not include extrinsic performance considerations are seen as incomplete and therefore lacking in the range and extent of sustainability that can be achieved when these assessment tools are used for the purpose of providing sustainability guidance.

2.1.2 Building systems

The foregoing discussion introduced the concepts that, in terms of achieving sustainability, extrinsic performance considerations are as important as intrinsic considerations. In order to further identify differences between conventional and sustainable development practices and understand constraints that exist in both situations, the variety of influencing factors wherein buildings are created needs to be understood.

Historically, a building's aesthetic appeal and its symbolic properties as object were the pertinent aspects that informed design decisions, but when the broader scope of sustainability concerns need to be considered, another method of building design is required. In this respect the 'systems approach' provides a valuable point of departure in better understanding and dealing with the interconnectedness of the performance aspects, as discussed above.

The systems approach

Capra (1982:285) introduced the concepts of the systems view of life, recognising "*the essential interrelatedness and interdependence of all phenomena – physical, biological, psychological, social, and cultural*". He continues by differentiating between the classical view of life that is

focused on linear, sequential processes and the systems view of evolution that allows for mutually adaptive environments (1982:311). Lovelock and Margulis (Capra, 1982:307) continued this premise by introducing the Gaia Hypothesis which sees the entire planet as a living organism, supported by the myriad interrelated systems of life. In the context of sustainability and its over-arching intent of supporting continued life on the planet, these principles of the systems viewpoint are critical in the research context.

Buildings as systems interacting with other systems

If these systems principles are applied to construction industry developments, then a building can be seen as a complex system of functions and services which affects and is affected by its surrounding context. This context in turn consists of a range of systems, such as bio-physical, socio-cultural, socio-economic and socio-political systems which are key systems that are strongly interconnected with the building system (Irurah, 2002:90). As Irurah argues, *“this systems approach ... is rapidly emerging as the most valuable approach through which the design team can understand and respond to the various expectations of different stakeholders in the context of sustainable development and buildings”* (ibid).

The building system

Prior to Capra's publication, Handler (1970) introduced the systems approach to architecture. He starts by outlining the functionalist origins of architecture and then provides the diversity of functionalist meanings: utilitarian, constructivist, expressive, organic, efficacious (mechanistic) (1970:7 – 10) and then he continues by suggesting that *“to approach architecture in functional terms involves treating it as a system”* (1970:14).

As Handler discusses the architectural system he furthermore argues that *“the performance concept fits naturally into the systems framework of problem solving”* (1970:29). His basic systems framework (Figure 2.02) indicates the fundamental process formula of inputs and outputs and it also calls for prevention and/or correction of malfunctions through

feedback control. In addition, the performance standards are shown as process informants and as such, the intrinsic and extrinsic performance considerations discussed earlier would be inherently included within the systems view approach.

By looking at construction developments on a global scale, the GAIA hypothesis would therefore suggest that building systems have performance

impacts on the entire earth's systems and vice versa. In this sense, the conventional development approach can be seen in a classical, linear view of life whereas sustainable development recognises the need for whole-systems thinking. To underline this statement, Wilson et al. (1998:37) from the Rocky Mountain Institute argue that *"whole-systems thinking is a process through which the interconnections between systems are actively considered and solutions are sought that address multiple-problems at the same time"*.

Aspects surrounding feedback through assessment tool applications will be further discussed under section 2.3. What is important at this point though is the issue that in Handler's model, outputs do not remain ends in themselves, but they also inform the process at input level – a 'closed-loop' as it were. This aspect brings us to the next point in the building context discussion which is a building's life-cycle considerations.

2.1.3 The life-cycle approach

The product life-cycle

The principles of 'life-cycle' were introduced to describe the different processes involved in creating a product. (Irurah, 2002:91). In

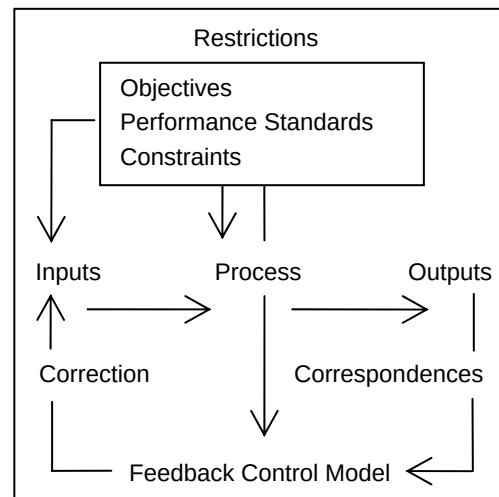


Figure 2.02 Basic systems framework (Handler, 1970:36)

conventional approaches, the product is the sole purpose of the manufacturing process where the in- and outputs (in particular) are merely by-products of the process and not considered useable. Following the growing concerns surrounding the impact of human development on the earth's supporting systems, cradle-to-grave analysis and similar life-cycle assessments were developed to measure, track and report on a product's or service's environmental impacts over its lifetime. In this context 'cradle' refers to a product's extraction from the earth and 'grave' its return thereto. Eventually the 'cradle-to-cradle' concept evolved where, at the end of a product's life, it is returned to its origins in a similar unharmed state as it was originally extracted. Resources are wasted in conventional approaches, but carefully harnessed and reused wherever possible in sustainable approaches. The same principles apply to buildings and their use of resources as is shown in Figure 2.03 and Figure 2.04.

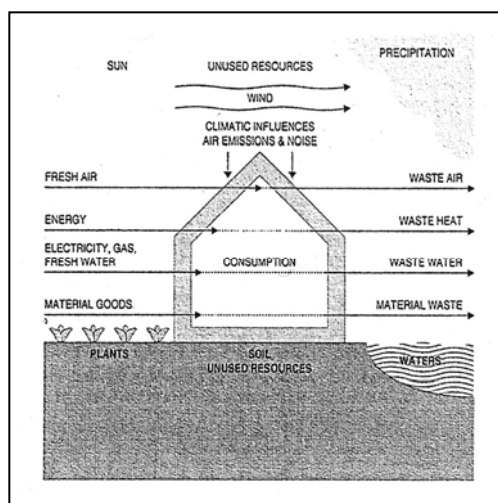


Figure 2.03 *Wasteful use of resources in a conventional building (CEC, 1999:39)*

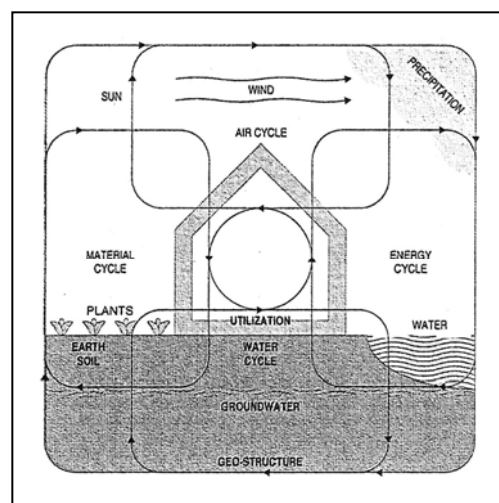


Figure 2.04 *Cyclical use of resources in a sustainable building (CEC, 1999:39)*

The building life-cycle

Accordingly, the impacts of buildings and their systems over their lifetime have also been analysed and distinct differences are identified between

conventional and sustainable approaches. The conventional building life-cycle is linear and straightforward with a narrow scope focus which starts at design, is followed by construction, operation and maintenance and ends at a building's demolition (Kim, 2004:796). In direct contrast, a sustainable building's life-cycle is more complex, as is shown in Figure 2.05. Here three distinct phases for building materials (i.e. the products) can be identified: pre-building, building and post-building (Kim, 2004: 797). The process where the sustainable building product is created has similar stages as those of its constituent materials. It is in the pre-building phase where project briefing, conceptualisation and design take place. It is also here where the critical decisions are made that dictate the entire outcome of the development. Similarly, during the building phase, the construction, operation and maintenance of the building project takes place. Finally, in the post-building phase, when a building has reached the end of its life and requires demolition, it is deconstructed and its components recycled, re-used or appropriately disposed of. It is this closed-loop approach that fundamentally sets sustainability practice apart from conventional practice.

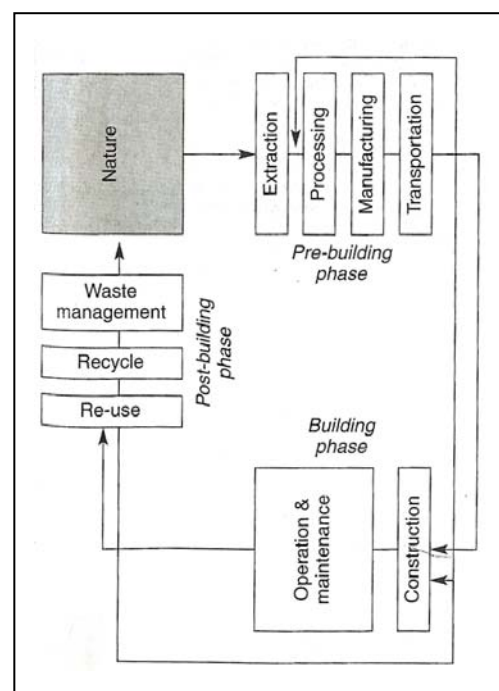


Figure 2.05 Sustainable model of building life-cycle (Kim, 2004:797)

The critical steps in a building's life-cycle are therefore identified as: brief → design → construction → operation → demolition. In conventional buildings and the processes that create them, there seems to be a 'disconnect' in the continuity between these phases. Cooper et al. (1998:1) argue that it is differences in approaches, whether focused on the building as product or its process, which may be perpetuating the conventional design and construction process problems encountered. In

addition, they also rank problems or changing requirements, design team, communication and cost control as the top problems in current project procurement methods (Cooper et al., 1998:2).

A building project typically ends when construction is completed. At that point, the development team that created the building hand over the built product to the building's owner and its tenants. Here again the conventional building practices are characterised by a clear distinction that exists between the process that creates the building and the building that results as a product of that process. The linear format of the conventional approach and the process vs. product distinctions are illustrated in Figure 2.06.

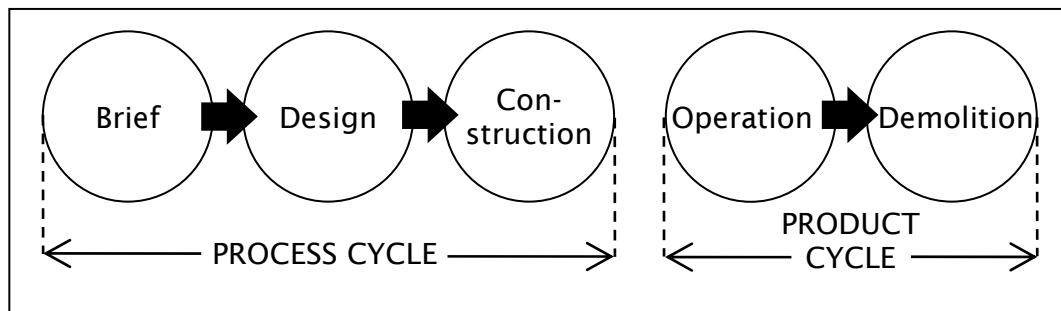


Figure 2.06 *Conventional building practice*

Cooper et al. (1998:2) draw from the manufacturing sector's 'process view' approach to suggest ways in which problems in the design and construction industry can be overcome. In their development of the Generic Design and Construction Process Protocol (GDCPP), they identify six principles needed to provide a basis of an improved building process (Cooper et al., 1998: 3 – 5). These principles are:

- whole project view which look at the whole project's life, from *"recognition of a need to the operation of the finished facility"*;
- consistent process which establishes a process of *"consistent application"* and adopts *"a standard approach to performance measurement, evaluation and control"*;
- progressive design fixity which allows for *"consistent planning and review procedure throughout the process"*;

- coordination which introduces a Process and Change Manager to respectively “*plan and co-ordinate the participants and activities of each phase, throughout the process*” and “*through [whom] all information related to the project is passed*”;
- stakeholder involvement and teamwork, proposing “*proactive resourcing of Phases*” to facilitate more effective team interaction; and
- feedback which suggests the ‘Phase Review Process’ as “*means by which project experiences can be recorded*”.

It is evident that these proposed improvements to the conventional design and construction process would have significant benefits in existing development practices. The aspects addressed in the GDCPP principles outlined above have even further-reaching implications if viewed in the research context which is focused on aspects that enable development teams to overcome the problems of conventional processes and enable a shift toward more sustainable development practices. Considering these aspects, the relationships between the different stages in the development process also change. By linking the string of linear activities outlined above into sustainability’s closed-loop cycle, a uniquely different view of the development process is illustrated and this is shown in Figure 2.07.

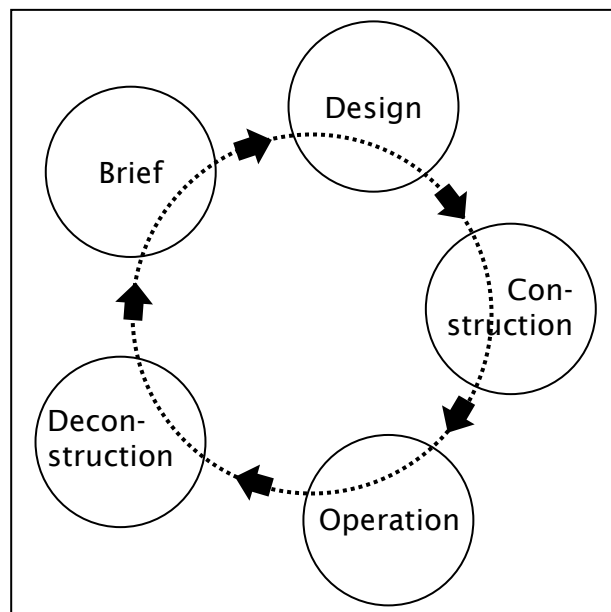


Figure 2.07 *Closed-loop approach in the sustainable building life-cycle*

With the conventional and sustainable building life-cycle models mapped, we will now focus on the factors that influence the different development stages and the characteristics of the relationships between these stages.

2.2 The design process

The preceding section provided a brief overview of the broader theoretical context wherein sustainable building takes place. Aspects surrounding building performance and the interrelationships between these aspects within the systems points of view were discussed. Once the building systems had been recognised, the aspects surrounding development impacts over the sustainable building's life-cycle were considered.

It is within the sustainable building's life-cycle that the design process plays such a critical role and at that point where careful consideration of building performance and the systems' interrelatedness is pertinent. Decisions made in the design stage have a significant impact on the outcome of the project. As Bogenstätter (2000:377) argues, *"programming and building specifications in early design phases determine up to 80% of the environmental pollution as well as the building operation costs"*. He continues by demonstrating how operating costs accumulate over a building's lifetime (refer to Figure 2.08).

In developments with sustainability objectives, design decisions are even more complicated when long-term impacts are also considered. With that focus in mind, we will now take a closer look at the nature of the design process and the factors that influence decision-making during a project's planning stages.

2.2.1 Development practices

From conventional to sustainable

Conventional development is not as defined a term as sustainable development is and often its consequences manifest as exact opposites of those that are intended by sustainable development. It is generally understood that one of the main pursuits of conventional development's commercial prospects is 'to make money'. Within this paradigm, decisions are made based on their impact on the 'bottom line' with social and environmental considerations being subjected to economic priorities.

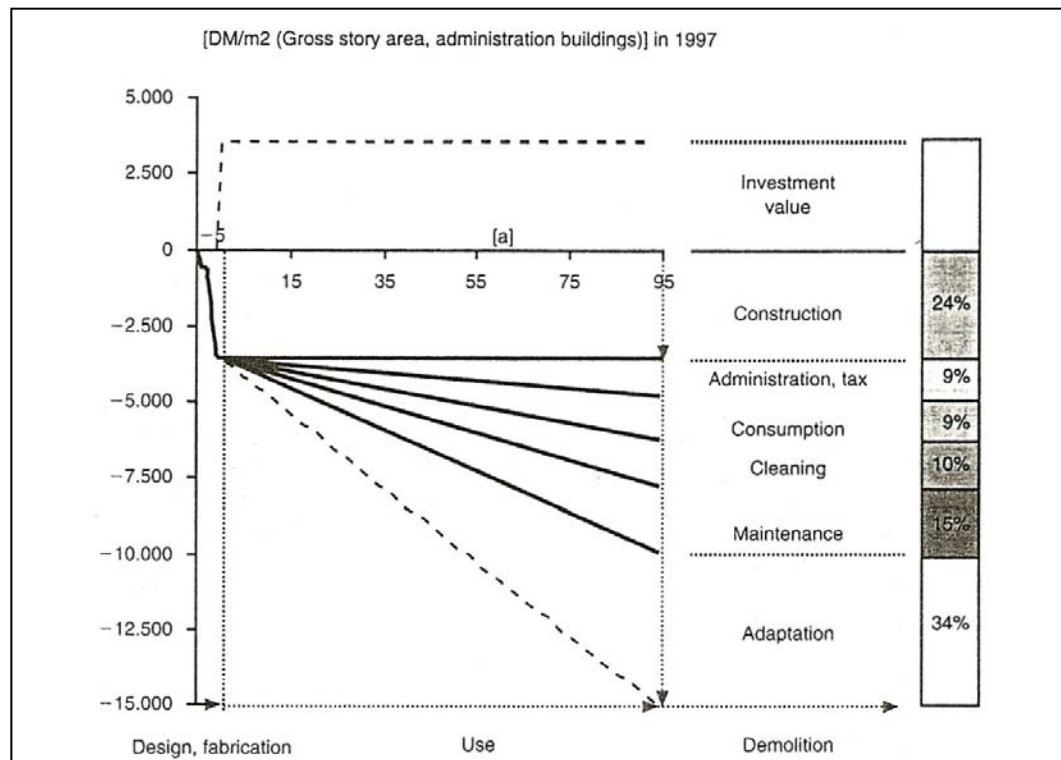


Figure 2.08 Investment, construction and life-cycle costs
(Bogenstätter, 2000:377)

Even in instances where the merits of green performance is recognised, these also suffer at the hand of clever marketing tactics that promote 'going green' without actually providing the depth of 'green' value that is required to change long-established destructive processes. Woolley (2000:44) points out that, *"despite recognition that environmental issues are important in construction, this has not led to any significant changes in practice ... the main difference is that the manufacturers and distributors will tell you that their materials are environmentally friendly. In other words, the green agenda creates a marketing opportunity."*

Here, Woolley warns against 'greenwashing' where products are marketed as environmentally friendly, without reference to established/recognised criteria that conveys the level of 'green' that has been achieved. A certain level of rigour and commitment is still missing in the pursuit of sustainability.

The quality of building and architectural value of developments are also compromised and sacrificed. Lipman (2003:xii) laments the loss of an

appropriate South African architecture: *“Gone or going are the unpretentious pre-industrial buildings ... Gone for what? Quick fix, unreliable and – above all else – cheap building materials, uncaring craftsmanship and inevitably, the blundering, aesthetically impoverished built surroundings which we all suffer”*. And Low (2004:25) argues: *“In this era of late western capitalism, fewer architectural practitioners appear to be interested in the architectural project as a mode of inquiry. For most South African professionals, architecture seems to be a commercial endeavour, whose mode of practice is governed by product, efficiency and economic utilitarianism”*. Woolley (2000:49) also notes that on a larger scale, the construction industry has been slow in its response to meeting objectives of the environmental agenda and he rightly adds that environmental issues would require legislation to encourage/enforce comprehensive, committed stakeholder involvement in meeting sustainable development objectives.

Development priorities and objectives

In stark contrast to the realities of conventional developments, sustainability goals are almost idealistic, their pursuits difficult to achieve in the frugal paradigm of a capitalist society.

The following is a summarised extract of some of the differences identified by Van der Ryn and Cowan (1996:26 – 28) which exist between conventional and ecological design:

Table 2.01 *Comparisons between Conventional and Ecological Design (Excerpts from Van der Ryn and Cowan, 1996:26 – 28)*

Issue	Conventional Design	Ecological Design
Design criteria	Economics, custom, and convenience	Human and ecosystem health, ecological economics
Response to sustainability crisis	Views of culture and nature inimical, tries to slow the rate at which things are getting worse by implementing mild conservation efforts without questioning underlying assumptions	Views of culture and nature as potentially symbiotic; moves beyond triage to a search for practices that actively regenerate human and ecosystem health

Biological, cultural, and economic diversity	Employs standardised designs with high energy and materials throughput, thereby eroding biological, cultural, and economic diversity	Maintains biodiversity and locally adapted cultures and economies that support it
Knowledge base	Narrow disciplinary focus	Integrates multiple design disciplines and wide range of sciences; comprehensive
Types of learning	Nature and technology are hidden; the design does not teach us over time	Nature and technology are made visible; the design draws us closer to the systems that ultimately sustain us
Level of participation	Reliance on jargon and experts who are unwilling to communicate with public; limits community involvement in critical design decisions	A commitment to clear discussion and debate; everyone is empowered to join the design process
Spatial scales	Tends to work at one scale at a time	Integrates design across multiple scales, reflecting the influence of larger scales on smaller scales and smaller on larger
Whole systems	Divides systems along boundaries that do not reflect the underlying natural processes	Works with whole systems; produces designs that provide the greatest possible degree of internal integrity and coherence

The differences extracted above pertain particularly to design and demonstrate the significant differences between conventional and ecological design focuses. Generally, ecological/environmental designs include a wider scope and depth of considerations when compared to conventional design.

Van der Ryn and Cowan (*ibid.*) also identify additional differences, such as energy source, materials use, pollution, toxic substances, ecological accounting, ecology economics, sensitivity to ecological context, sensitivity to cultural context, role of nature and underlying metaphors. These aspects would also have a large influence on the outcome of ecological/sustainable designs, but more so in terms of the content and approach as opposed to the design process under investigation here.

Understanding what sustainability calls for is a complicated and often subjective pursuit. At project outset, development targets are the critical

mechanisms that guide the design process and inclusion of sustainability objectives are fundamental to promoting sustainable architecture (Williamson et al, 2003:65). From a theoretical point of view, sustainable development objectives are all-inclusive, considering the whole range of impacts well into building operation and beyond. But, due to the inherent complexities involved in addressing different and interrelated sustainability problems, meeting simple checklist requirements would also not suffice. A certain level of idealism is required to honour and guide the sustainability choices that are being made and sacrificed as it is applied in real world scenarios. A comprehensive understanding of the trade-offs and opportunities for synergies are therefore also required. And in terms of the contradictions that often exist between different development objectives, Williamson et al. (2003:65) furthermore observe that *“dealing with these conflicts ... requires the explicit and implicit assumption of priorities, which is in turn largely determined by our view of the relative seriousness of the consequences of failure or shortfall”*. In different projects these consequences are dependent on the extent, scope and depth of sustainability that will be pursued in the particular development and these sustainability priorities are clarified throughout the decision-making process.

2.2.2 Decision-making

The development team

On conventional projects, the stakeholders typically consist of the client, the architect and engineering consultants with their respective expertise in civil, structural, mechanical or electrical systems. Team members are selected based on requirements derived from the particular project's development objectives and briefing discussions.

On sustainable projects, added social and environmental requirements call for additional expertise which is not typically included in the scope of services covered by the 'conventional' team. Here a much broader range of project stakeholders are approached to provide specialised input. In many instances a critical role is performed by an environmental

consultant who assists the 'conventional' team in their decision-making processes to facilitate sustainability integration.

Also, different development stages call for different role-players, inputs, etc.; each with different objectives that contribute to the way building performance is defined and the way the building is eventually designed. The range of stakeholders and participants in the sustainable development process may be involved in the planning stages when the building is being created or in the operational stages through their habitation of the space. And as Williamson et al. (2003:65) point out, accounting for all stakeholder requirements may cover up to 80% of the needs in a highly detailed brief, so this could have quite an impact on the adopted design course.

However, it is often the clients who dictate the nature and characteristics of the building and sustainability is, more often than not, integrated in the project according to their wishes. In this respect Bruce Fowlee (Rappaport, 2005:181) of Fox & Fowlee Architects points out when questioned about convincing clients about green building: "*... clients are always interested but sceptical because of the initial cost factors*". This introduces the question of an architect's ability/responsibility to influence a client's set of development priorities.

The role of the architect

In conventional projects, architects play a central and principal role in the decision-making process and even more so in sustainable projects. Although brief requirements dictate what needs are to be met in the design, these objectives are rarely explicit and it is largely up to the architect to interpret and develop them according to what is appropriate for the specific project (Williamson et al., 2003:66). But in this position, a (gifted) architect is uniquely able to provide the right solutions. And when it comes to sustainability it should follow that architects would integrate the best and most appropriate solutions in this development context as well. However, constraints exist that inhibit and prevent architects from doing just that – issues such as the extent of their client's

commitment to sustainability and their own level of sustainability education and know-how.

Factors surrounding architects' sustainability expertise and ability will be considered later, but what needs to be considered first is whether architects are interested in or feel responsible for integrating aspects of sustainability in their 'conventional' designs if their client is not explicitly committed to sustainability.

Wittmann (1997:89) surveyed architects' perceptions regarding energy efficient/ecological architecture and revealed that *"despite a common agreement on the benefits of energy efficient/ecological design ... architects do not appear to incorporate its features to a notable extent in their works"*. She continues to state that *"this disregard may be architects' lack of commitment towards energy efficient/ecological architecture"* (ibid.) and provides the following data to illustrate where architects' focus lie (refer to Figure 2.09).

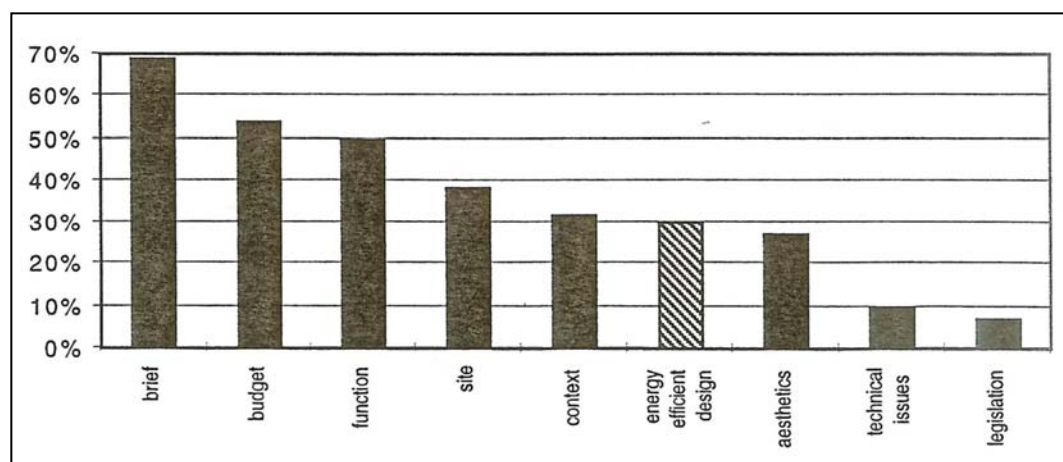


Figure 2.09 Factors architects consider to be most important when commissioned for a new project (Wittman, 1997:89)

Although this study was conducted almost a decade ago and sustainability awareness is now much more prevalent, these observations still provide valuable insights into (conventional) development priorities. Du Plessis (2002:8) summarises the truths of development objectives quite well, *"If sustainable construction is really [going] to make a meaningful difference to the future sustainability of the human species, it*

cannot afford to hold on to the current mental image of the built environment ... reducing the environmental impact of buildings starts with choices clients make. And these choices are guided by their value systems, as well as by the values of the professionals who advise them."

Conventional coordination

Another significant portion of decision-making takes place during the coordination process. In conventional projects, once architects have developed their initial concept for the building and obtained preliminary approval from the client to go ahead, the professional consultants get involved to provide their specialist input. In projects with sustainability pursuits, these specialists also include sustainability and environmental consultants.

CIRIA (1993:27) suggests that the design consultants (planners, architects, environmental consultants, building services and civil/structural engineers, landscape architects, surveyors and project managers) have *"the greatest influence on ensuring that the environmental impact of a scheme is minimised"*. They identify the following key roles for development professionals: to ensure that structures are energy efficient; resources come from sustainable sources, are recycled or recyclable; embodied energy in materials and products are low and their manufacture was environmentally considerate; materials in the construction and use of buildings are used (and specified) appropriately so as not to endanger occupants; and the development preserves natural habitats and is integrated with its surrounding environment (ibid).

In order to address these aspects, the coordination process and its successful management becomes critical. In conventional projects (where environmental factors are not a particularly high priority) coordination between professionals are sequential in its process, with consultants often working separate from one another. Architects design the building and preliminary drawings are issued to the engineers. The structural engineer calculates the structural requirements and provides data to the

architects in terms of structural supports and systems selected to be used in the building. Similar processes are undertaken by the civil, mechanical, electrical and other building services engineers.

Coordination often takes place between architects and the particular disciplines in an isolated fashion with one-on-one input rather than collective contributions across disciplines. Fowles (2000:103) attributes this division in thinking and divide between disciplines to the origins of science which distinguished between mind and matter, set man apart from nature and eventually led to the separation of thinking and doing. And in the construction industry these effects were also leaving their marks. Professionals designed buildings, conceptualised them, but were never actually involved in their making. He suggests that *“everyone was becoming preoccupied with their particular task, solving problems within the confines of their own perceived world”* (Fowles, 2000:104).

To add to the divisions in roles, problems are also encountered with knowledge continuity. Cooper et al. (1998: 4 – 5) argue that *“a complete project team rarely works together on more than one project”* and that their *“ability to learn from experience is also hampered by the continual formation and break-up of project teams”*.

The problems described above are persistent in many conventional project approaches today and further perpetuates unsustainable development practices.

The integrated design process

Sustainable projects require a significantly different coordination process approach which is commonly termed the ‘integrated design process’ or IDP. IDP characteristics have been widely documented as necessary critical tools to assist teams in their decision-making toward sustainability integration. Reed and Gordon (2000:325) even state that *“there is considerable agreement among those in the field of sustainable design that cross-disciplinary teamwork early in the design process is essential to achieve the successful integration on building, community, natural and*

economic systems". In drawing comparisons between conventional and integrated design processes, they have prepared the following illustrations (Figures 2.10 and 2.11) with reference to the opportunities that may exist for the integration of ecological design.

Although these illustrations are compiled from design professionals' perceptions and as such not based on fact, they nonetheless illustrate clearly two critical factors: that the integrated design process is vastly different from the conventional and that the earlier ecological/sustainable goals are considered in the development process, the larger the opportunity to propose and implement sustainability solutions that turn out to be cost-effective.

The critical differences between conventional and sustainable development practices in terms of objectives and team dynamics have been considered. In order to gain a deeper understanding of the design process, the last aspect of creating a building needs to be reviewed. This aspect is particularly concerned with the nature and purpose of design and the creation of architecture.

2.2.3 Architecture

The preceding discussions reiterated the fact that sustainability considerations need to be integrated as early as possible in the decision-making process to ensure the highest level of sustainability success. Therefore, what happens in the design process needs to be well understood if sustainability obstacles are to be overcome.

Design

Architectural design is a dynamic and complicated process, where a wide range of real factors and abstract ideas are considered to create a building. Without getting entangled in the stylistic trappings of the architectural language and the merits of diverse and meaningful design objectives, whether aesthetic or functional, practical or heuristic, we will rather focus on the common ground that is the design process as it is relevant here and, in particular, how the architect goes about creating a building.

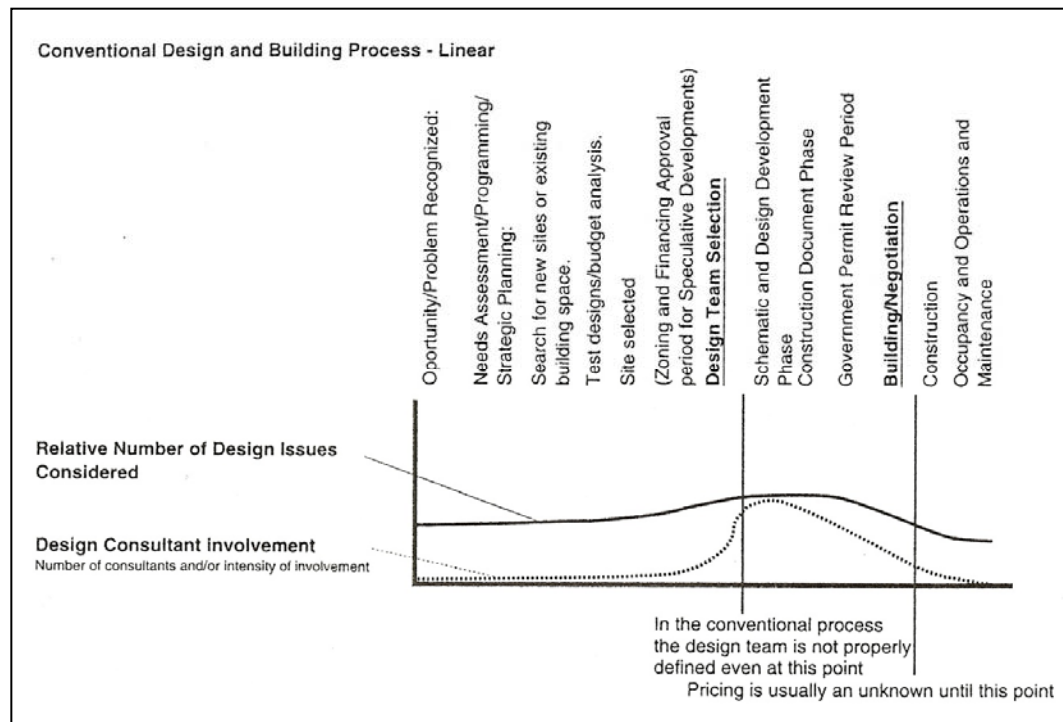


Figure 2.10 Opportunities for ecological design in the linear or conventional design process (Reed and Gordon, 2000:330)

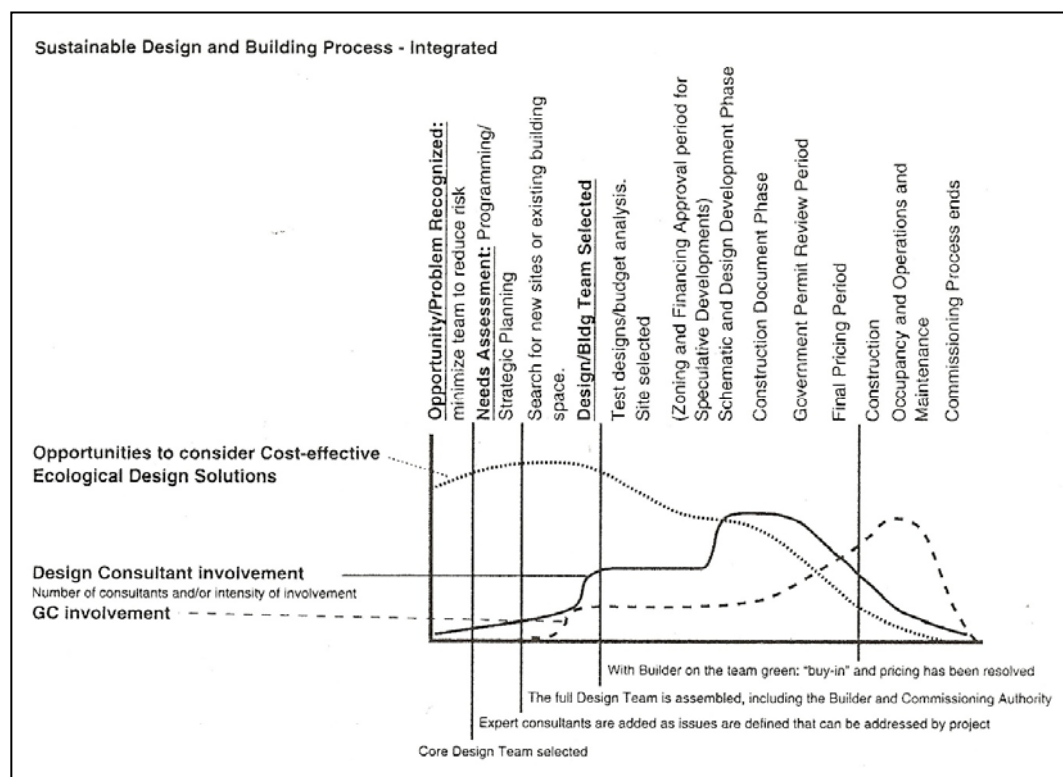


Figure 2.11 Opportunities for ecological design in the integrated design process (Reed and Gordon, 2000:331)

Wells (1999:25) quotes Rasmussen when he describes the complexities that an architect needs to deal with: *“the architect works with form and mass just as the sculptor does, and like the painter he works with colour. But alone of the three, his is a functional art. It solves practical problems. It creates tools or implements for human beings and utility plays a decisive role in judging it”*. The ‘trick’ of design then lies in this aspect: the artefact that is being created needs to fulfil both aesthetic and utilitarian functions.

This problem-solving approach to creating a building is also an entirely subjective and personal process for the architect. Schön (1985:16) even goes so far as to say that practitioners (i.e. the architects) *“make judgement calls of quality for which they cannot state adequate criteria [and] display skills for which they cannot describe procedures or rules”*. This intuitive process is characteristic of true design where architects develop ideas and create buildings with a variety of different approaches and tools, each uniquely adapted to suit their personal style and skills. Although it is difficult to define this personalised process in general terms, it is still possible to identify common steps and actions that all designers take.

Lawson (1990:26) provides the Markus/Maver map of the design process where the sequence of *‘analysis → synthesis → appraisal → decision’* is repeated at increasing levels of detail as the design is refined. He defines analysis as the *“exploration of relationships, search for patterns – order and structure the problem”*; synthesis where solutions are generated *“by creating a response to the problem”* and finally, appraisal is the *“critical evaluation of suggested solutions against the objectives identified in the analysis phase”* (Lawson, 1990:27). Once these steps have been taken, a decision is made which enables the design to progress to the next level of detail and the sequence is again repeated. Lang (1987:57) references a similar model of design (refer to Figure 2.12) which identifies four basic processes and each has reasonably similar attributes as the Markus/Maver map, except that it is preceded by the ‘first insight’. Both Lawson and Lang highlight the difficulties involved in doing creative work,

but it is Lang (ibid.) who points out that *“ultimately, however, the quality of the final product depends on the quality of the substantive knowledge at the designer’s disposal and his or her ability to use it creatively”*.

The research interest here lies not in being able to measure design quality or designers’ abilities, because that is a subjective opinion (the extent of which falls beyond the scope of this research project). Rather, the interest here lies in the designer’s knowledge and what constitutes ‘substantive’.

To answer this question we need to consider how architects obtain their knowledge, how they are educated, from where they draw inspiration and what tools they use to assist in the creative process.

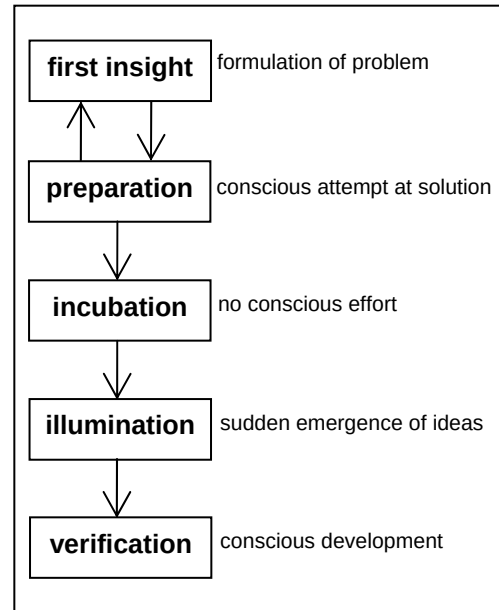


Figure 2.12 The five stage model of the creative process (Lawson, 1990:110)

Finding solutions to problems: the architect’s toolbox

Much has been written on the problem-solving characteristics of the design process. Lang (1987:61) references Alger and Hayes who identified three major activities in developing solutions:

- **review of historical information** where past data (in the form of paradigms, typologies, generic solutions and design prototypes) are investigated and adapted to resolve scenarios of the present problem;
- **individual creative effort** where checklists, interaction methods and psycho-analytical techniques are identified to enhance creative thinking; and
- **group creative effort** which refers to the team’s collaborative efforts and the coordination process discussed earlier.

So typically architects source information from previous examples that have some bearing on their current design and develop that data through their own process of creative inquiry and design coordination. The process of how architects deal with the data and how they have been educated in design are also fraught with its own obstacles and subjective interpretations. Schön (1985:63) explains that *“as the student begins to design, even though he is not sure how to do it and does not know what he needs to know in order to learn to do it, the studio master may help him in two ways: (a) demonstrate and the student imitates and (b) tell [the student] something about designing”*. This approach continues even when architects are in professional practice, but now that the student’s master is no longer available, they do research and refer to printed and published media as well as their own experience for direction.

There is also a range of tools available to architects to assist them in this decision-making process. Most of the design ideas are explored and demonstrated by way of drawings, whether free-hand or computer-generated. In some instances 3-D models are also developed and in this respect computer programs again provide powerful ways in which the intended uses of the future space can be explored. The level of inquiry would dictate which tools are most appropriate for which use and at what development stage of the project. And in sustainability projects even more sophisticated tools are applied to model more accurately the anticipated building performance. Wilson et al. (1998:185) refers to the following design tools that ‘green’ designers use: physical building models; three-dimensional CAD models; mock-ups; energy modelling programs (e.g. DOE-2, Energy-10, Power DOE, REM-Design, and HOT-2000) as well as computational fluid dynamics (where the tool predicts air movement). They also advise teams to model energy performance precisely and that *“the simulation results often differ from the designer’s intuition”* (ibid.).

It can be concluded that ‘substantive knowledge’ and its acquisition is a relative concept and process that can really only be described in a particular design situation. Although it is therefore not possible to

generalise, these characteristics nonetheless provide valuable insights into the issues that are continuously being addressed in the design process.

Integrating sustainability

Amongst other tools identified above, design precedents also act as tools to provide architects with practical examples of particular applications. Effective and useful design tools should therefore be able to assist decision-makers in generating a series of alternative solutions to particular design problems encountered – and particularly so when sustainability goals are to be integrated in the design.

Although many and varied examples exist of sustainability applications, constraints still exist in architects' ability to use this information in their designs. Drawing is a valuable tool to explore design alternatives and as Lawson (1990:18) explains, this is how the technique of drawing evolved: in order to represent (design) ideas, they needed to be drawn when they could not be built immediately. Wells (1999:24) attributes the predicaments of marrying aesthetics and function to "*a deliberate unrelatedness to the earth*", where architects are removed from the craft (i.e. a building's construction) through their pre-occupation with the art (i.e. the drawings and design). It is ironic that even through the use of one of their most necessary design tools, architects have become more removed from the product they are creating.

Drawing allows for freedom of expression of ideas where many alternative solutions could be investigated, but the drawback is that things which are not "*visually apparent*" would not come to the designer's attention (Lawson, 1990:18). To a large extent designers can therefore only draw what they know or see. In the interest of facilitating sustainability integration and the consideration of its 'softer issues' (of social and environmental performance), these requirements cannot be anticipated if architects do not possess the necessary knowledge, tools and know-how. Omissions of critical information can significantly influence the design process approach and a building's outcome. And Wilson et al. (1998:189) argue that "*usually there is not one right answer*

for how a building should be designed, or what features should be incorporated into it. There is a large palette of options. Making appropriate choices – factoring in environmental performance, conventional performance, and cost – depends on the skills, knowledge, and experience of the design team”.

2.2.4 Critical attributes of the design process

The foregoing discussion described the context wherein decisions are made to create a building. First the pertinent features of both conventional and sustainable development priorities were reviewed. Once project objectives are set, the team focuses on developing strategies to implement these targets. The discussion then looked closer into the decision-making process, describing the relationships between the different team members and the role of the architect in particular. Aspects of conventional and sustainable coordination process approaches were identified. With the research interest limited to the architect’s focus in the design process, the discussion then delved into the process of designing and ‘making architecture’. Here aspects such as the architect’s know-how, approach to problem-solving and ability to integrate new knowledge (e.g. sustainability) were investigated. All these factors provide insight into the characteristics of the design process.

From the above, four distinct components are identified as critical gateways in the design process. A project typically starts with target setting. In order to meet these targets (whatever the scope), the decision-makers use their education and expertise to develop strategies to solve the identified design problems. In managing the information between consultants, the coordination of the design process becomes a decisive aspect in decision-making. Finally, a variety of modelling and simulation tools are used to investigate and communicate the design intent.

Overall the preceding discussion identified some of the pertinent differences between conventional and sustainable development practices. The following table (Table 2.02) provides a summary of this discussion; in particular it highlights the critical attributes in the conventional design process as it pertains to these four components:

Table 2.02 *The critical attributes of the conventional design process*

Components	The conventional design process
Target setting	• only covers limited scope of economic drivers; • single bottom-line focus; • straight-forward design inquiry addressing functionality and basic tenant needs.
Education and expertise	• reliance on long-established knowledge with limited scope and focus; • repeated applications of previous experience; • tried and tested solutions.
Team coordination	• linear, sequential approach; • team members work in isolation from another; • consultant focus remain constrained within respective disciplines.
Modelling and simulation tools	• limited use of tools beyond known methods; • merely used to explore and communicate planning, aesthetics, working details; • traditional engineering calculations integrated in conventional system designs.

In order to shift from conventional to sustainable development practices, a shift in the process approach would need to take place. Table 2.03 outlines the critical attributes in the sustainable design process as it differs from the conventional design process with respect to the four identified components:

Table 2.03 *The critical attributes of the sustainable design process*

Components	The sustainable design process
Target setting	• includes broader scope of social and environmental considerations in addition to economic factors; • recognise and encourage interrelation between triple bottom-line drivers.
Education and expertise	• look beyond conventional practices to include innovative sustainability know-how;

	• broader focus than conventional to incorporate tangible and intangible contextual informants; • open to investigating new avenues to resolve unique problems; • integrate sustainability knowledge through appointment of environmental consultant or architect possess required know-how.
Team coordination	• inclusive and inquisitive process that enables identification of synergies; • integrated and multi-disciplinary; • wider range of input.
Modelling and simulation tools	• in addition to conventional employs simulation and modelling tools to assist in predicting sustainability outcomes of decisions • compare predicted and actual outcomes

These characteristics of performance and making decisions then bring us to the other core aspect of the research project: that of assessment tools and their role in assisting design teams in making appropriate choices.

2.3 Assessment tools

In design scenarios with sustainability goals, questions such as the applicability, the level of impact (whether economic, social or environmental), the effectiveness and appropriateness of proposed solutions often arise. As discussed in the preceding section, any design process involves a verification stage where decisions are assessed and their appropriateness tested against pre-determined development criteria. In complex design situations, particularly more so if sustainability goals are considered, verification and assessment procedures can become significantly more complicated. Some tools measure the impacts of existing practices and others evaluate potential impacts of new developments. The characteristics of the tools also vary between countries and climatic regions as their development agendas and impacts differ.

The ability to determine the impact and long-term consequences of decisions is imperative in the context of sustainable development. Sustainability assessment methods are promoted as vital tools that can assist teams in achieving sustainability and facilitates market transformation toward more sustainable construction practices. Cole et al. (2004:1, 2) point out that these tools have *“given focus to green building practice; enabled building performance to be described comprehensively and assisted in re-shaping the design process”*. And Kaatz et al. (2002:1) argues that *“[building environmental assessment tools] are believed to be a potent agent of change in the specific context of the South African construction sector”*. But before either the merits of assessment tools or their successful application in the design process can be considered, their characteristics, objectives and application environments need to be understood.

2.3.1 Overview

In section 2.1 a building's life-cycle was mapped and the differences between conventional and sustainable practices in terms of the extent to which contextual factors influence decision-making were discussed. That section ended by indicating that in order to shift toward sustainable practices, the gap between a building's process and product cycles need to be bridged. The then discussion focussed on the building process, decision-making and the nature of design. It specifically concentrated on the role architects play in a building's outcome, how they design and aspects surrounding their sustainability know-how and knowledge.

The next aspect of the research problem is concerned with the role assessment tools play in development practices. Figure 2.13 illustrates the process and product cycles of conventional development practices within the sustainability life-cycle sequence. It shows the points where discontinuity in the conventional cycles likely constrains the shift toward sustainable practices. The question now is whether assessment tools can (successfully) provide the mechanisms whereby this gap can be bridged.

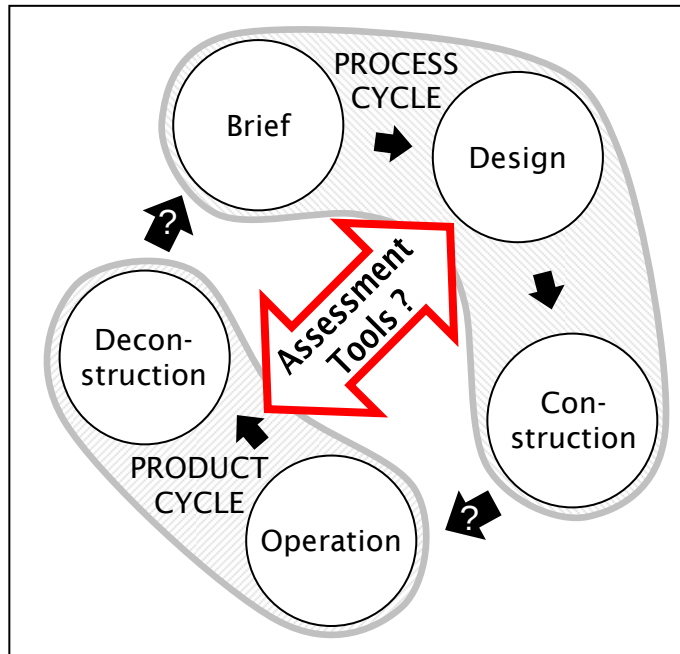


Figure 2.13 *The proposed role of assessment tools in bridging the gap between conventional buildings' process/product cycles*

Cole (2005:1934) differentiates between the assessment tool (AT) product and process (not to be confused with the process and product cycles of development practice described above). He uses these classifications to distinguish between the inherent characteristics of the tools themselves (i.e. the AT product) and

the application of the tools in development practices (the AT process). As is illustrated, assessment tools play different roles at different stages of a building's life-cycle and the tools under investigation here are generally applied in the design stages. As Cole (ibid.) points out, "*the majority of existing [first generation] building environmental assessment methods ... assess design intentions ... through prediction rather than actual real-world performance*".

The research project is here concerned with the 'AT process' and the discussion which follows will look more closely at this aspect. To provide context, the section will end with a brief overview of the 'AT product', i.e. the characteristics of some of the more prominent assessment tools in use today as it applies to the research problem and argument.

Assessment objectives

Originally, the main purpose of assessment was to determine the impact of existing developments on the environment and tools were developed

to measure this impact. By focusing on the performance of actual, implemented decisions they thereby mainly offer feedback. Later, assessment tools were being applied at the front-end of a project to assist decision-making teams by predicting potential impacts of intended designs, i.e. they were used to forecast possible outcomes. Simply put, performance assessment is data reporting, whether applied in pre- or post-construction stages. If the data is to be applicable/usable in design, then the data needs to be interpreted so that the knowledge can become intelligent know-how. The understanding and interpretation of the consequences of data-reported performance happens in decision-making processes when different (potential) outcomes are compared, evaluated and assessed in order to be able to select the most appropriate solution. It is therefore critical that assessment tools which are applied in the design process, provide mechanisms whereby this understanding (i.e. the evolution from knowledge to know-how) can be facilitated and design alternatives can be generated. Cole (1998:7) underlines this premise by stating that *“a performance assessment is only a means to an end – it is the ability to make informed decisions based on the outcome of the assessment that is most critical”*.

In this respect the expectation is that assessment tools which are used at the design stages should differ significantly from assessment tools applied at the operational stages – one predicts outcomes and informs the process, whereas the other measures actual outcomes and rates performance. If assessment tools that are intended for application in operation are (wrongfully) applied in design, problems may arise that provide a skewed view of potential impacts. Cole (ibid.) also warns about the limitations of first generation assessment methods, amongst them their ability of being used as design tools. He explains that the list of criteria, which is mostly concerned with environmental performance, *“communicate to building owners and design teams what are understood as being the most significant environmental considerations”* (Cole, 1998:10). He then suggests possible future developments of design tools that require more detailed information which *“will inevitably make the transition between building design and building assessment more*

seamless" (ibid.). Kaatz et al. (2004:8) go so far as suggesting that a building sustainability assessment model's "*scope should encompass all stages of the building process, from feasibility to deconstruction*". This requirement is also fundamental if assessment tools were to successfully bridge the gap between a building's process and product cycles as illustrated in Figure 2.13.

Kaatz et al. (2005:1776) furthermore argue that "*the most important test for effectiveness of any assessment tool is the extent to which it influences decision-making throughout the building process*". The question here is then whether/how effective existing building assessment tools are in facilitating sustainability integration in decision-making processes. Before this question can be addressed, a few other characteristics of assessment tools need to be considered first.

Tools that provide design advice

Williamson et al. (2003:71 – 75) differentiate between "*means-based*" and "*ends-based*" assessment advice where the former explains "*how to' design and build appropriately*" and the latter is founded in performance, i.e. meeting needs. They explain that means-based advice makes checklist-type recommendations that assume a level of universality in the applicability of proposed design solutions and argue the suspected lack of methodological guidance that is needed to apply solutions. Here they suggest that e.g. architects may find a visual image of heat flow more useful than the knowledge of specific U-values. Their argument is that the means-based advice would recommend a specific U-value to achieve a desired level of thermal comfort, but it does not convey how these targets can be met. They continue by arguing that even in examples which provide more useful images that can be understood by architects (such as the solar-efficient house), the "*environmental friendliness ... is likely to be judged according to whether [it] exhibits components of the solar-efficient model ... rather than its actual performance in operation*" (2003:72). Here people eventually start recognising 'green' features as symbols, without a clear understanding of what (if anything) is truly achieved in an environmental sense. The problem of a lack of accurate forecasting exists.

On the other hand, Williamson et al. (2003:73 – 75) argue that ends-based advice is intrinsically tied to the original sustainable development definition of meeting needs and that the idea of addressing needs resonates with building design thinking. Here *“performance-based advice and evaluation begins by defining desired or required performance in relation to objectives, leaving the means to achieve those performances to be chosen by the designers”* (2003:73).

Most of the assessment tools in use today focus more heavily on providing ends-based guidance, with reference to performance criteria, as it is relevant to the respective sustainability targets. The obstacles for designers, however, lie in finding ways to achieve those performances and interpret them for application in a particular project.

In this vein Williamson et al. (2003:75) continue by arguing that the obvious issues of conflicting requirements and requirement priorities are typically not addressed in these tools. They quote James Gross who ultimately questions: *“If the performance concept is so widely accepted ... if the methodology removes barriers to innovation, ... why isn't it universally applied?”* (ibid.). Their answer to his question is that the concept of universal application *“does not allow for the unique problem definition that is essential for good, sustainable architecture”* (ibid.). In other words, project-specific problems cannot be addressed with generalised targets. But, on the other hand, one cannot be expected to reinvent the wheel every time a sustainable building needs to be designed and therefore some level of guidance is required.

To address the tools' capability of providing means-based advice in the design process, Kaatz et al. (2005: 1776) provides valuable direction. They draw from references in the environmental assessment and construction management fields, to identify 3 specific functionalities for a building sustainability assessment tool that focuses on *process-related* aspects:

- integration
- transparency and accessibility
- collaborative learning

These considerations highlight potential constraints in existing assessment tools which may further inhibit their successful application in development processes. In both the means-based and ends-based design advice approaches discussed, issues of the applicability of performance assessments and questions surrounding the ‘how to’ of sustainable design (beyond mere target-setting) are highlighted.

Forecasting and feedback for a sustainable life-cycle

A wide variety of assessment tools are available to guide and advise decision-makers in design and Liu et al. (2005:1635) debate the apparent confusion that exists in trying to differentiate between them. In Figure 2.14, Liu illustrates the interconnection between the various assessments and indicates which are performance issues and which are decision-making issues. And in reference to the model shown in Figure 2.14, it follows that ‘performance issues’ would arise in the building’s product cycle, whereas ‘decision-making issues’ are typically addressed in the process cycle of conventional developments. In the model the arrows with question marks inside indicate that gaps exist between the process and product cycles, thereby underlining what is so clearly shown in Liu’s framework: performance and design decision-making issues lie at opposite ends of the development spectrum.

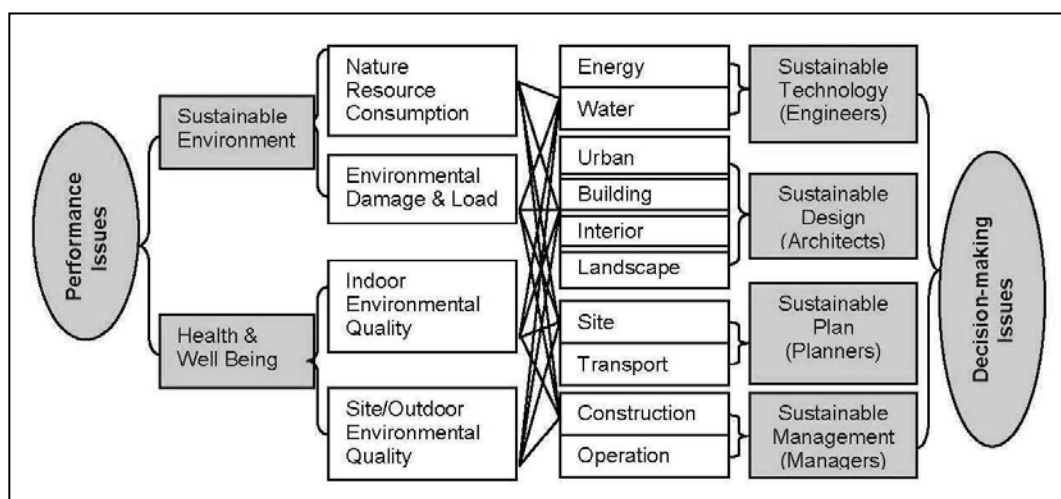


Figure 2.14 *The comprehensive generic framework for classification of GBA issues (Liu et al., 2005:1635)*

In order to improve performance outcomes (i.e. build better buildings) designers need to make informed decisions. And in order to better inform their decisions, they need to be aware of the actual performance of their buildings. If these issues do not cross-inform each other, it is obvious that the goals of sustainability cannot be successfully achieved.

In attempting to develop a regionally specific framework for Green Building Assessment (GBA) tools in China, Liu et al. (2005:1635) has compiled a framework to classify the range of GBA tools (refer Figure 2.15). The purpose of the framework is to separate the functions of the tools according to their potential functions/applicable areas. Decision-making assessment tools, support tools and education/training tools are applied in the Stakeholder and Building Activity categories (i.e. the process cycle) and “*designed primarily to optimise, select, check, predict and evaluate decisions*” (ibid.). Performance assessment tools are used in the Building Performance category (i.e. the product cycle) and “*designed for performance comparison and rating/labelling*” (ibid.). Again (as in Figure 2.15) the gaps between the process and product cycles are obvious, even when assessment tools play a role in the category activity.

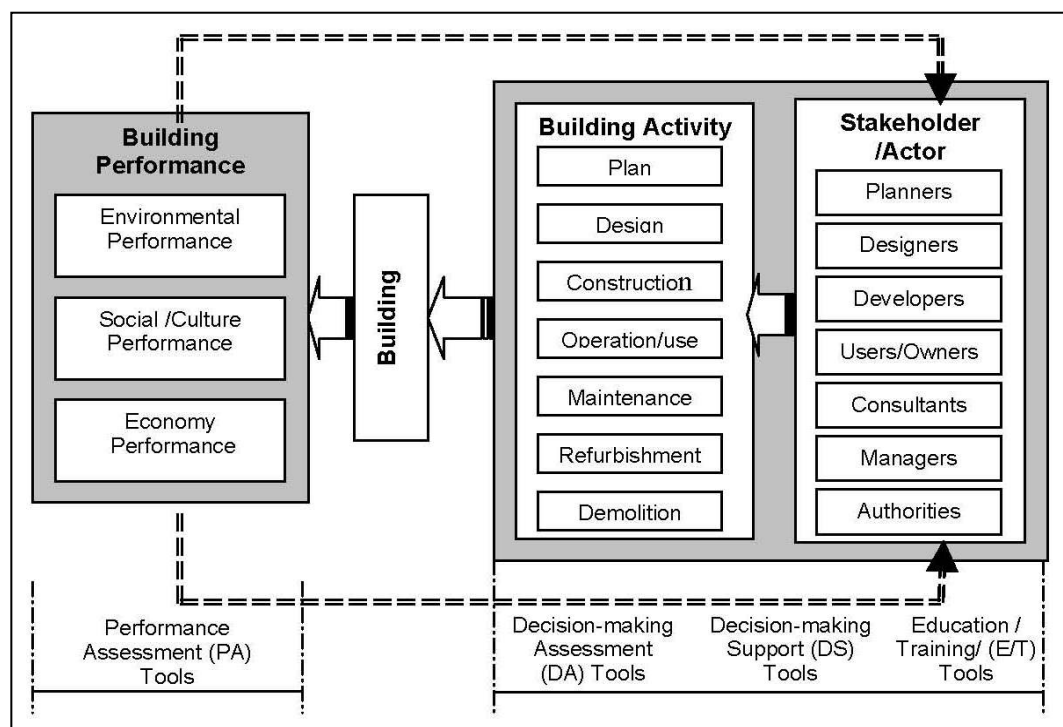


Figure 2.15 A new comprehensive framework for classification of GBA tools (Liu et al., 2005:1635)

A way to bridge these gaps is through comprehensive feedback and forecasting strategies. In debating the need to understand a building's changing role during its lifetime, Gorgolewski (2005:2814) suggests that *“any initiatives that extend the involvement of designers beyond the procurement phase and into the operating phase of the building help establish feedback loops that inform the way the building will evolve”*.

Although Gorgolewski approaches the issues of the sustainable building life-cycle from the built product perspective (i.e. a call for feedback) as opposed to the research's approach from the process perspective (i.e. a call for accurate and thorough forecasting), his recommendations to address sustainability issues are still relevant here. Gorgolewski lists six initiatives which could help buildings evolve and that could assist in closing the loop. These are:

- interdisciplinary design,
- ongoing building commissioning,
- building log books,
- post-occupancy evaluations (POE),
- design for dismantling, and
- design quality indicators.

Gorgolewski probably does not make reference to the role of assessment tools in facilitating feedback loops, because most of the assessment tools in use today are applied in the design of new buildings, i.e. they perform more of a forecasting role, as opposed to a feedback function. Post-occupancy evaluations are similar to (forecasting) assessment tools in that they are also concerned with evaluating building performance, but POEs rather focus on occupied buildings (Bordass, 2003:406).

The outcomes of the Probe (Post-occupancy Review Of Buildings and their Engineering) evaluation studies provide valuable insights into the obstacles that exist in bridging the gap between building process and product cycles. Bordass et al. (2001:153) argue that *“in a design situation, focus can too easily fall on the building as an end in itself, rather than the means to the occupier's ends”*. They explain that the consequence is a

building product that becomes fixed in plans and schematics, which loses its relatedness to the aspects of time, the building context as well as the client/user expectations and experience – the building becomes an object, not an artefact. The Probe team developed the ‘ends, means and feedback’ diagram (see Figure 2.16) which shows nine important principles where linking tools are placed in the middle and help to “*build bridges between the ends and the means*” (ibid.). Assessment tools should be able to fulfil the role of linking tools whether in their capacity to forecast or back-cast sustainable building outcomes.

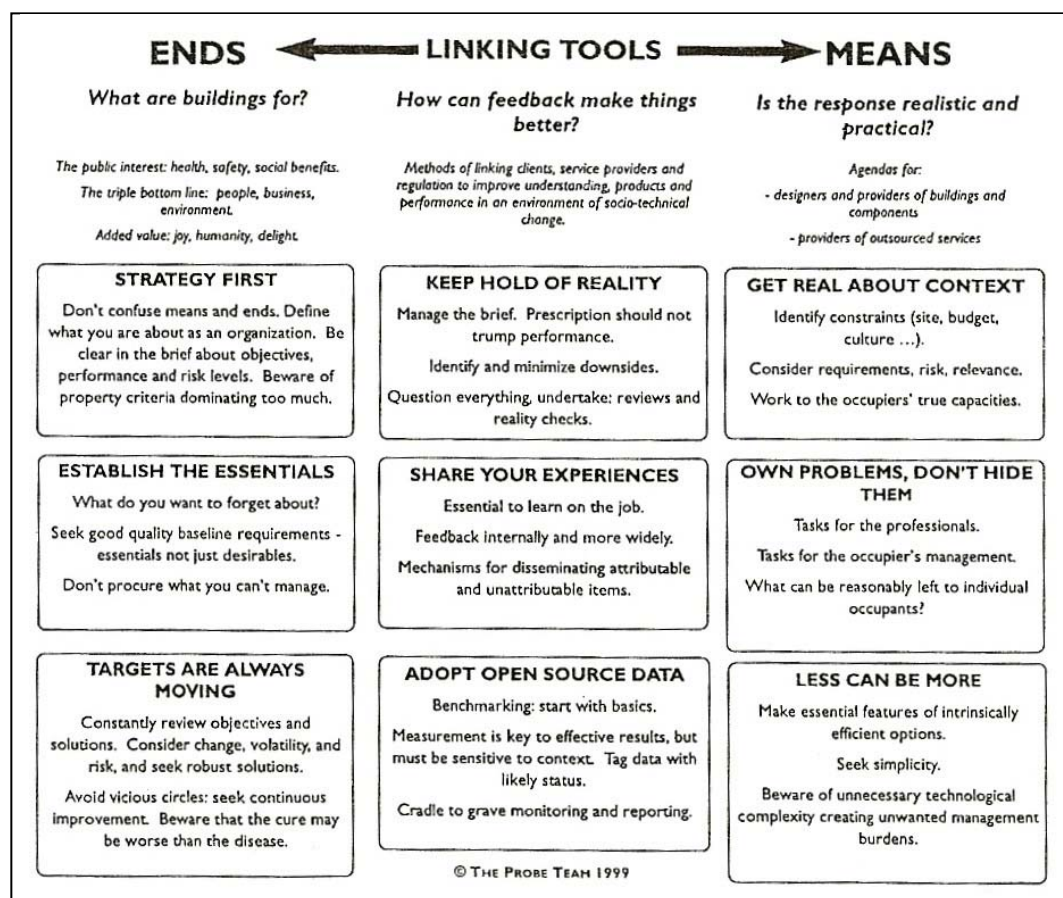


Figure 2.16 *Ends, means and feedback (Bordass et al., 2001:154)*

With the focus of assessment tools' ability to respond to process-related aspects, Kaatz et al. (2004:8) have been involved in the development of a specification for a building sustainability assessment model for the South African Built Environment and propose the following distinguishing characteristics to differentiate the proposed model from existing building assessment tools. They suggest that it should

- include sustainability principles and objectives in the assessment process;
- strengthen collective learning and capacity building through stakeholder participation;
- establish project values to reinforce local priorities;
- introduce a scoping procedure to draw assessment efforts to most significant issues identified;
- re-categorise assessment areas (away from economical, social, environmental) to draw attention to project-specific concerns
- develop sustainability indicators that refer to thresholds and timeframes; and
- use process mapping to synchronise assessment with project and building lifecycles.

These aspects further highlight potential constraints in existing tools that hinder their application in design processes and identify inhibiting factors in their ability to successfully facilitate sustainability integration.

Communicating AT outcomes

One way to forecast possible building outcomes is to look at the outcomes of similar types of projects. Again, assessment tools are ideally suited to provide the required data and communicate project outcomes to design teams faced with the obstacles of trying to implement sustainability goals for the first time. More and more ‘sustainable’ case study examples are being published, some with their accompanying assessment outcomes. It is unclear whether and to what extent these case study examples actually assist architects in their designs and even more so in terms of determining whether these examples communicate the adequate level of data that is required to make informed design decisions. On the other hand and as discussed previously, it is virtually impossible to determine empirically what inspires an architect’s design and therefore one may never be able to formulate the ‘perfect’ way in which to facilitate decision-making.

Designs are communicated through a wide variety of media where drawings, models and photos are the foremost visual tools used by architects to communicate their ideas. Similarly, the resources architects seek to trigger their imagination are more often than not visual. With the constraints of trying to understand and describe an entirely subjective process, one practice seems to prevail in all design processes and that is the use of case study examples to stimulate the development of new ideas.

Bothwell (1997b:2.01) proposes David Rennie's 10/100/1000 principle as a model format for case study reporting in which an "*eight page case study*" is presented in such a way that the designers are able to extract different levels of data as is required at the different stages of the design (refer to Figure 2.17). For example, level 10 would communicate a project's general information and is used as reference at the conceptual stage of the current design; level 100 would go into further depth as the new design is being refined and level 1000 would provide the in-depth technical level of data to describe how the specific sustainability strategies were implemented, thus substantiating the performance of untested technologies.

Here also assessment tools have a critical role to play in the way in which case study outcomes are communicated. Ideally, through the use of these types of case study reporting methods, design teams would then not only have access to a wide range of sustainability applications, but they would also have an independently verified and accurate measure of the level of sustainability achieved in the various referenced projects. If these two aspects could be combined in the manner in which assessment tools communicate design outcomes, their role in successfully facilitating decision-making would be further enhanced.

The foregoing discussion has focused on the general intent and purpose of assessment tools, their role in building practices, different application environments and the manner in which assessment outcomes are communicated. We will now look at some of the assessment tools which are most widely applied in the industry.

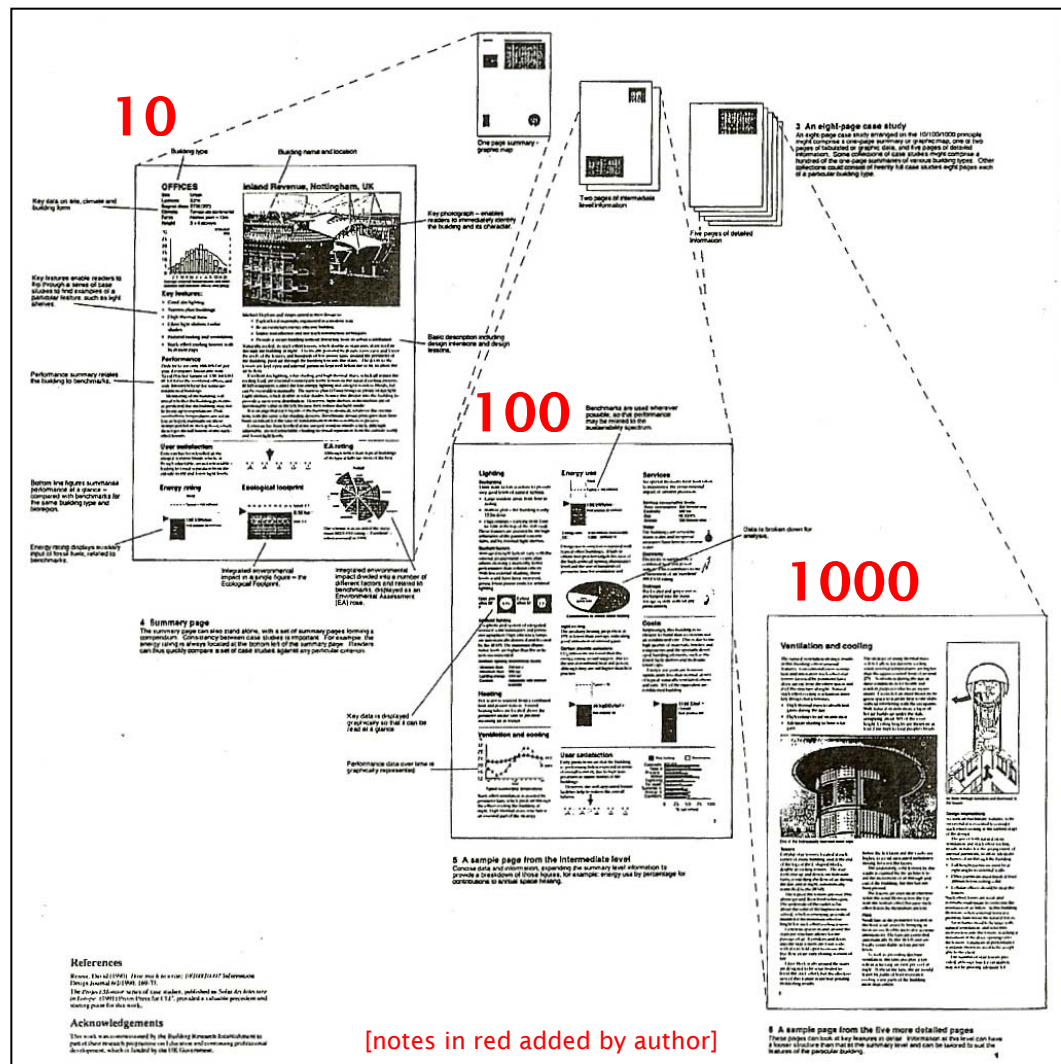


Figure 2.17 A model format for case studies using common indicators of sustainability (Bothwell, 1997a:1.11)

2.3.2 Types of assessment tools

The British Research Establishment Ltd. (BRE) in the UK introduced the BRE Environmental Assessment Method (BREEAM) in 1990 and since then many other similar building performance assessment tools have been launched in countries across the world. The US Green Building Council (USGBC) launched the Leadership in Energy and Environmental Design (LEED®) green building rating system in 1993 and it is still widely in use in North America. In recent years more regionally applicable tools have emerged, e.g. CASBEE in Japan, TGBRS in India, NABERS in Australia (Cole, 2004:1), BEAT in Denmark and the Sustainable Buildings Assessment Tool (SBAT), which was developed for application in the South African context.

The following is a brief background summary of some of the best known assessment methods/tools in use today. The discussion will also look at their most common application environments (whether in the process or product cycle) and in particular the manner in which the tools facilitate decision-making as it is relevant to the research problem.

BREEAM

BREEAM is a 'family' of environmental assessment methods widely in use in the United Kingdom and the BREEAM International Bespoke is specifically tailored for applications outside the UK (BRE, 2007a:20). Within the BREEAM family of assessment methods there are different tools that are applicable on different building types and different aspects of a building's life-cycle (BREEAM, 2007a:1). For example, 'BREEAM Offices' are applicable to office buildings in particular; 'BREEAM Envest' is specifically applicable in the design stage and 'BREEAM Buildings' is relevant in a building's operational stage (ibid.). Envest is a life-cycle assessment (LCA) and software tool; by inputting building design data, the tool assists in decision-making by providing feedback on which aspects have the greatest environmental impact and whole life-cycle costs (BRE, 2007b:1).

Assessment credits can be obtained in the categories of management, health and well-being, energy, transport, water, materials, land use and ecology as well as pollution. The manner in which these aspects are addressed in a particular project is assessed with a corresponding weighted rating score. The final score ranges between pass, good, very good and excellent (BRE, 2007a:4). At the end of a favourable assessment a project receives BREEAM certification.

The Environmental Assessment Consortium (EAC) consists of industry experts in environmental and energy efficient design who are registered and licensed BREEAM consultants (BREEAM, 2007b:1). Development teams who intend to have their projects BREEAM certified would typically appoint a BREEAM consultant from the EAC to advise them in the decision-making process. In this manner the assessment process is

independently managed and third party verified. A pre-assessment checklist is available to design teams to kick-off the assessment process, but the BRE strongly recommends that an assessor is consulted to assist in the assessment process. They also suggest that *“design teams are using [BREEAM] as a tool to improve the performance of their buildings and their own experience and knowledge of environmental aspects of sustainability”* (BRE, 2007a:6). BRE also recommends that *“where a design-stage assessment is commissioned, a Post-Construction Review is carried out to ensure that the end result achieves the design’s aspirations”* (ibid.).

Figure 2.18 is a snapshot of the view of the Energy section of BREEAM Offices’ pre-assessment checklist indicating the credit reference, what is assessed and the corresponding points achievable.

 BREEAM		BREEAM Offices 2006	
		Design & Procurement Pre-Assessment Estimator	

ENERGY		Points	Design & Procurement
Credit Reference			
E01	Where the building demonstrates a percentage improvement above the requirement for CO ₂ emissions as set out in the 2006 Building Regulations. +1% +2% +4% +6% +8% +10% +12% +14% +18% +22% +30% +40% +50% +60% ≥70%	0.76 1.52 2.27 3.03 3.79 4.55 5.30 6.06 6.89 7.67 8.33 9.09 9.85 10.61 11.35	
NOTE: These point scores are not cumulative, simply award the appropriate points score corresponding to the predicted level of achievement.			

Figure 2.18 Snapshot view of the Energy section of the BREEAM Office pre-assessment checklist (BRE, 2007a:41 Appendix A)

LEED®

LEED is a green building rating system widely used in the United States and Canada with LEED India recently introduced. In America the US Green Building Council (USGBC) administers the certification process. LEED has been adapted to Canadian standards and 'Canada LEED' is managed by the Canada Green Building Council (CaGBC). The LEED assessment method also consists of a suite of tools that assists design teams in environmental and energy-efficient design. Amongst others, LEED-NC is applicable in new construction and major renovation projects and LEED-EB outlines criteria for environmental performance in existing buildings (USGBC, 2007a).

The basic structure of LEED consists of five categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality. A sixth category allows for innovation in design or operations. Within each of the categories the prerequisites have to be met and minimum credits need to be obtained in order to qualify for LEED certification. The number of credits which are achieved thereafter provide the final level of certification and range from certified, silver, gold to platinum status. Figure 2.19 is a snapshot of the view of the Energy and Atmosphere section of LEED-NC assessment checklist indicating the credit reference, what is assessed and the corresponding points achievable.

Energy & Atmosphere			17 Points
☒	Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required
☒	Prereq 2	Minimum Energy Performance	Required
☒	Prereq 3	Fundamental Refrigerant Management	Required
☐	Credit 1	Optimize Energy Performance	1 to 10
☐		10.5% New Buildings or 3.5% Existing Building Renovations	1
☐		14% New Buildings or 7% Existing Building Renovations	2
☐		17.5% New Buildings or 10.5% Existing Building Renovations	3
☐		21% New Buildings or 14% Existing Building Renovations	4
☐		24.5% New Buildings or 17.5% Existing Building Renovations	5
☐		28% New Buildings or 21% Existing Building Renovations	6
☐		31.5% New Buildings or 24.5% Existing Building Renovations	7
☐		35% New Buildings or 28% Existing Building Renovations	8
☐		38.5% New Buildings or 31.5% Existing Building Renovations	9
☐		42% New Buildings or 35% Existing Building Renovations	10
☐	Credit 2	On-Site Renewable Energy	1 to 3
☐		2.5% Renewable Energy	1
☐		7.5% Renewable Energy	2
☐		12.5% Renewable Energy	3

Figure 2.19 Snapshot view of the Energy and Atmosphere section of the LEED-NC assessment checklist (USGBC, 2007b)

A reference guide for each of the LEED rating systems can be purchased from either the USGBC or CaGBC and therein the details of how the green building criteria can be met, are outlined. Any person is eligible to assist the team in obtaining LEED certification, but the USGBC and CaGBC recommend that such a person is a LEED Accredited Professional (LEED AP). A LEED AP is *“an individual who has passed the exam and possesses the knowledge and skills necessary to participate in the design process, to support and encourage integrated design, and to streamline the application and certification process”* (USGBC, 2006:5). One credit point is also available under the Innovation category if a LEED AP is part of the development team.

SBAT

The Sustainable Buildings Assessment Tool (SBAT) was officially launched in South Africa in 2004. The tool is broadly modelled on the BREEAM structure, but simplified in some areas and adapted to be regionally applicable. Gibberd (2003: Appendix 14, p.5) recommends that *“the tool should ideally be used on a building that has just been completed”*, although it is most often applied in the design stages of a development.

With the relatively recent release of the tool for public use and the stark differences in sustainability priorities between developed and developing countries, the implementation of sustainable practices as well as the uptake of the tool has been comparatively slow. At the 2004 regional Sustainable Buildings conference, a version of SBAT, ‘SBAT-lite’ was used as part of the evaluation process to determine the sustainability performance of built environment projects submitted for the Sustainable Building Best Practice Awards (CSIR, 2004:1). The ‘Sustainable Building CD - User Manual’ is available online and provides background on sustainable development objectives, the use of SBAT (‘how to’ and applicability) and the Sustainable Building Life-cycle (SBL) approach (CSIR, 2003a:1).

SBAT is divided into the three main categories of sustainability: economic, social and environmental. Each of these categories consists of five sub-categories. Under the economic category the local economy, efficiency,

adaptability, ongoing costs and capital costs are evaluated. In the social category, occupant comfort; inclusive environments; access to facilities; participation and control; education, health & safety are addressed. And in the environmental category, assessment criteria for water; energy; waste; site; materials & components are outlined (Gibberd 2003:140). Figure 2.20 is a snapshot of the view of the Energy section of SBAT's assessment checklist indicating the credit reference, what is assessed and the corresponding points achievable. The total score is mapped as a rose pattern within the spreadsheet calculations.

No formal certification process or benchmarking level is established in the SBAT application. The use of the tool is voluntary and versions of the tool are available from the CSIR.

Building Performance - Environmental				
	Criteria	Indicative performance measure	Measured	Points
EN 2	Energy			0.0
EN 2.1	Location	% of users who walk / use public transport to commute to the building	0	0.0
EN 2.2	Ventilation	% of building ventilation requirements met through natural / passive ventilation	0	0.0
EN 2.3	Heating & Cooling	% of occupied space which has passive environmental control (no or minimal energy consumption)	0	0.0
EN 2.4	Appliances & fittings	% of appliances / lighting fixtures that are classed as highly energy efficient (ie energy star rating)	0	0.0
EN 2.5	Renewable energy	% of building energy requirements met from renewable sources	0	0.0

Figure 2.20 Snapshot view of the Energy section of SBAT's assessment checklist (CSIR 2003b:3)

SPeAR®

The Sustainable Project Appraisal Routine (SPeAR®) was developed by ARUP, an engineering consultancy based in the UK. *"ARUP developed a tool to demonstrate the sustainability of a project, process or product to be used either as a management information tool or as part of a design process"* (ARUP, 2007). The tool is not available to the public and a limited amount of information about the tool is publicly available. The tool is therefore developed for ARUP's exclusive use, with their in-house consultants possessing the expertise to assist development teams in the sustainability decision-making process.

ARUP suggests that SPeAR can assist in all stages of a development project's decision-making (ibid.). The SPeAR assessment framework appears similar to SBAT in that it is set-up in a spreadsheet layout (although more complicated) with the final outcome also mapped in a

circular diagram (Raman, 2005:10 – 11). As such the tool does not provide a score, but rather the results of subsequent processes can be compared to prior results of the foregoing stage (as is shown in Figure 2.21). The figure also shows the four quadrant categories of SPeAR, that of environment, societal, economic and natural resources. Within each of these, sub-categories are listed. These are:

- Environment: air quality and microclimate; land use; water (1); ecology and cultural heritage; design and operation; transport (3)
- Societal: health and welfare; user comfort / satisfaction; form and space; access; amenity; inclusion
- Economic: social benefits and costs; transport (4); employment / skills; competition effects; viability
- Natural Resources: materials; water (2); energy; land utilization; waste.

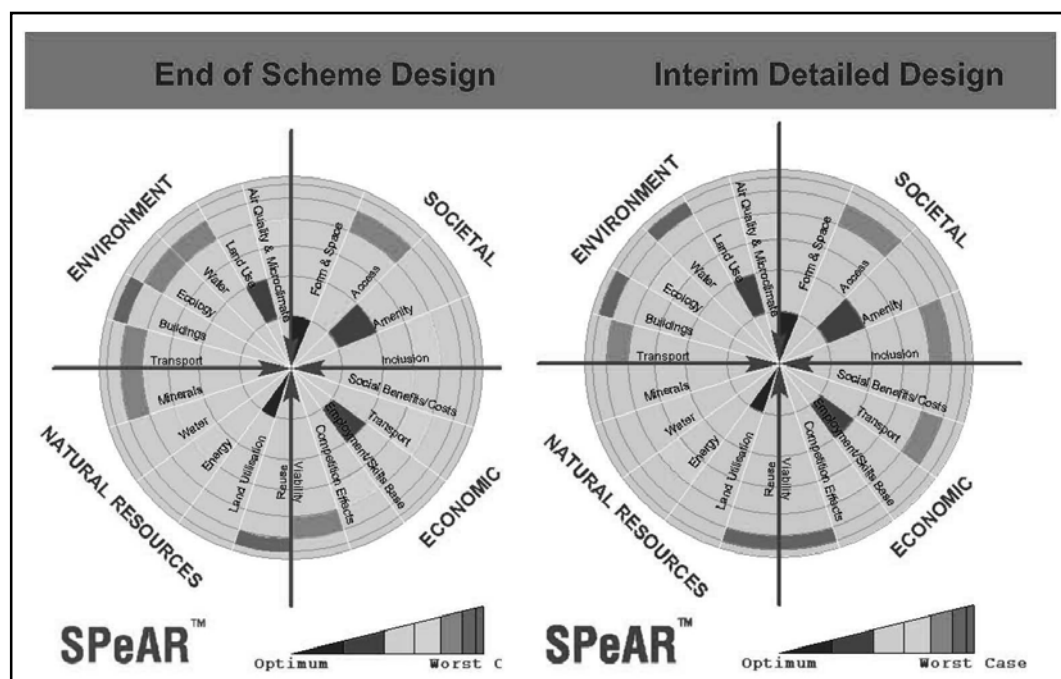


Figure 2.21 Comparison between Schematic Design assessment outcome and Interim Detailed Design outcome (Raman, 2005:15)

SBTool

In 1998 the Green Buildings Challenge (GBC) and the Green Buildings Tool (GBTool) was launched as “an on-going international process focusing on the development and testing of a new system of assessing the

environmental performance of buildings” (GBC, 2002). This process is administered by the International Initiative for a Sustainable Built Environment (iiSBE). Countries from across the world were invited to use and apply the GBTool and provide feedback at the international Sustainable Building conferences which followed in Maastricht, 2000, Oslo, 2002 and in Tokyo, 2005. The iiSBE consolidated the foregoing process and launched the Sustainable Buildings Tool (SBTool) toward the end of 2006. The new SBTool has a wider scope than the original GBTool in that it includes reference to social, economic and cultural aspects. It is also better suited to easier adaptation to local conditions and incorporates all the cycles of the building’s life-cycle (iiSBE, 2006:3 – 9).

The high-level SBTool categories are site selection, project planning and development; energy and resource consumption; environmental loadings; indoor environmental quality; service quality; social and economic aspects as well as cultural and perceptual aspects. Figure 2.22 is a snapshot of the view of the Energy and Resource Consumption section of the SBTool’s master list of assessment parameters indicating the category reference number, what is assessed and where in the construction phase it is active.

Master List of SBTool Parameters		02 September 2008			
		Phase active			
		P-Dsn	Dsn	C&C	Ops
B Energy and Resource Consumption					
B1 Total Life Cycle Non-Renewable Energy					
B1.1	Annualized non-renewable primary energy embodied in construction materials.				
B1.2	Annual non-renewable primary energy used for facility operations				
B2 Electrical peak demand for facility operations					
B3 Renewable Energy					
B3.1	Use of off-site energy that is generated from renewable sources.				
B3.2	Provision of on-site renewable energy systems.				

Figure 2.22 Snapshot view of the Energy and Resource Consumption section of the SBTool’s Master List of assessment parameters (iiSBE, 2006:11) [notes in red added by author]

This master list merely outlines the scope of the SBTool assessment method. Within each of these building phases, a separate assessment procedure is laid out wherein a large and detailed amount of building data is added. Figure 2.23 provides a more detailed snapshot of the view of some of the sub-sections which require completion under e.g. the B1.1

Assessments of [Project Name]		Active uses	Office	
			Retail	
			Day care	
New Construction	Design Phase	Generic		
B Energy and Resource Consumption		1.9	22%	0.41
		2.2		0.47
B1 Total Life Cycle Non-Renewable Energy		1.9	18%	0.35
		2.8		0.51
B1.1	Annualized non-renewable primary energy embodied in construction materials.	Active	25.0%	
	Embodied energy from external program, GJ/m2 * yr	N.A.	0	
	Embodied energy using SBTool approximations, GJ/m2 * yr	0.11	0	
Occupancy 1	Office			
Assessor's notes		Assessor value MJ/m2*yr.	Score	Wtd. Score
Score assigned by Assessor			-1.0	-0.25
Data and score submitted by designer		72	-1.0	-0.25
Negative		59	-1.0	-1
Acceptable practice	The predicted embodied energy for materials used in the structure and building envelope, as determined an acceptable LCA-based estimating method :	53		0
Good Practice		37		3
Best Practice		27		5

Figure 2.23 Snapshot view of section B1.1 of the Energy and Resource Consumption section in the Design Phase (iiSBE, 2007:spreadsheet 'AssB') [notes in red added by author]

heading. This spreadsheet view also provides some indication of the depth of assessment which is undertaken. The SBTool spreadsheet is downloadable from the internet and an accompanying introductory brochure on how to use the tool is also available. The assessment process is set up so that the architect can input the initial building data and it *"only becomes a rating tool when a third party calibrates it for their region by setting weights, context and performance benchmarks"* (iiSBE, 2006:4).

Although there are merits to having a tool that can be internationally referenced, assessment tools which are suited to the regional context are more appropriate and therefore more commonly in use. Cole (2005:1936) even suggests that *"developing a standardized universally applicable method, is now recognized as problematic"*. He continues by suggesting that there are structural features in regional assessment tools

which “*differentiate them from the first generation of tools [and] they collectively suggest a transition towards a generation of tools that may enable assessment of the extent to which buildings can contribute to supporting sustainable [as opposed to only environmental] patterns of living*” (ibid.). It seems that the new version of the SBTool has addressed these concerns. The extent to which it is actually applied and adapted as intended in the future will reveal whether these goals have been successfully met.

2.3.3 Critical attributes of assessment tools

The foregoing discussion described the context wherein sustainability assessment tools are applied in built environment developments. First the concepts of the potential role of assessment tools in bridging the gaps between a building’s process and product’s cycles were introduced. Then, in order to identify the appropriate application environments of assessment tools, assessment objectives and the characteristics of ‘design advice tools’ were investigated. Aspects surrounding predictive and actual reporting capabilities of assessment tools were reviewed. Requirements and constraints in reporting formats of assessment outcomes were also considered. The discussion concluded with a brief review of the most commonly applied assessment tools in use – with particular emphasis on the sustainability scope covered by the tools, their application environments and assessment frameworks.

In reference to the proposed research argument, the intent here lies in identifying the features that would enable assessment tools to successfully facilitate sustainability integration in the design process. In Section 2.2.4 four distinct components were identified as characteristic of any design process. It follows then that the manner in which this type of assessment tool would relate to these four distinct components, becomes important if the application of the tool is to be successful. And their inherent characteristics in facilitating sustainability integration are just as relevant. In Table 2.04 these aspects are summarised as they relate to the four

design process components identified. In particular, the critical attributes that assessment tools would need to possess to ensure their successful application in the sustainable design process are outlined as well.

Table 2.04 *The suggested critical attributes of an assessment tool when applied in the sustainable design process*

Components	Assessment tool applied
Target setting	• provide full scope of sustainability goals; • adjustable to regional context; • applicable on different building types, throughout the building's life-cycle; • qualitative, as well as quantitative criteria.
Education and expertise	• links to sustainability information sources and wide range of sustainable design strategies; • suggest design alternatives through 1-100-1000 level case study examples; • identify synergies and trade-offs of applications.
Team coordination	• facilitate identification of all potential project stakeholders together; • state who/where critical inputs by specific team members are required; • access to multi-disciplinary guidelines.
Modelling and simulation tools	• seamless interface/relation with sustainability modelling software • evaluate/interpret data-outputs within project-specific applications.

2.4 Summary

The foregoing discussion highlighted the pertinent aspects that surround the research problem under investigation. Critical attributes of the design process and of assessment tools are outlined. A wide variety of factors influence a project's sustainability outcome and the relationship between the main research components is complex and problematic.

In order to move forward and resolve the research problem, this relationship needs to be well-defined. The following chapter takes an in-depth look at the research parameters and an investigative framework is proposed whereby the case studies can be examined.



3 RESEARCH PARAMETERS

The research argument is an attempt at explaining the complexities between these factors that perpetuate unsustainable practices. In order to test the research argument and find reasons for the existence of the research problem in the real world, it is suggested in Chapter 1 that the case study method is used. But before the discussion of the researched case studies and their outcomes can take place, the specific lens with which the case studies are to be investigated needs to be described. The research approach outlined in Chapter 1 proposes first that the research-specific theory is determined in order to identify research parameters. By determining research parameters it would then be possible to analyse each of the case studies in relation to the predetermined theory, i.e. a measurement standard is established whereby the case study outcomes can be compared. In this sense, ‘apples are compared with apples’ and the results can be extrapolated for generalisation instead of being wholly trapped in the typical case study-method constraints where the unique circumstances of each case study make generalisation impossible.

This pre-determined theory needs to include all the pertinent aspects that inform the research problem and should also clarify the relationship between the various components of the problem and its sub-problems. An investigative framework is proposed to illustrate these aspects and the interrelationships between them. The rationale behind the formulation of this investigative framework follows.

3.1 Developing an investigative framework

3.1.1 The design process

In the preceding chapter the significant aspects intrinsic to any design process and which are used to inform decision-making are identified. These aspects are broadly categorised under the following attributes:

- development targets set;
- the expertise of the development team’s consultants;

- the nature of the coordination process; and
- the modelling tools that are used.

Conventional vs. Sustainable design practice

The above attributes are dealt with in both conventional and sustainable processes, but it is evident that in sustainable design processes they are addressed in more depth and with more rigour. In short, sustainable process targets include social and environmental objectives beyond the conventional/intrinsic performance economic drivers. The sustainable project team possesses a broader range of expertise and knowledge to address the wider scope of sustainability concerns. Consequently, the sustainable coordination process is much more integrated than the conventional, with disciplines working closely together to address the complexities of deriving multiple synergistic solutions within problem areas. Finally, sustainability pursuits require the use of specialised simulation and modelling tools (which are not usually applied in conventional processes) to verify potential outcomes of sustainable design intentions/options. Therefore, the steps that are typically taken in the design process to shift from conventional to sustainable development practice, can be illustrated and is shown in Figure 3.01:

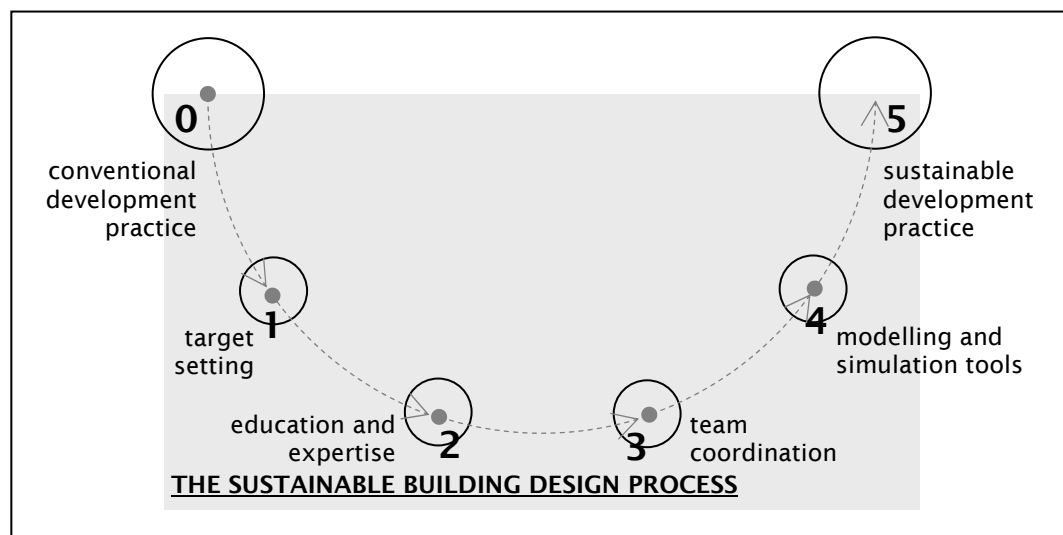


Figure 3.01 Critical points in the design process with shifts from conventional to sustainable development practices identified

3.1.2 Assessment tool applications

As argued earlier, assessment tools can play a significant role in the shift toward more sustainable development practices. The use of assessment tools is optional if sustainability is to be pursued, but if successfully applied, these tools may provide the critical ‘shortcuts’ needed by conventional teams to implement their sustainability objectives. Simply put: the use of assessment tools functions as a gateway on the road to sustainability and is therefore to be positioned between conventional and sustainable practices and can be mapped in Figure 3.02:

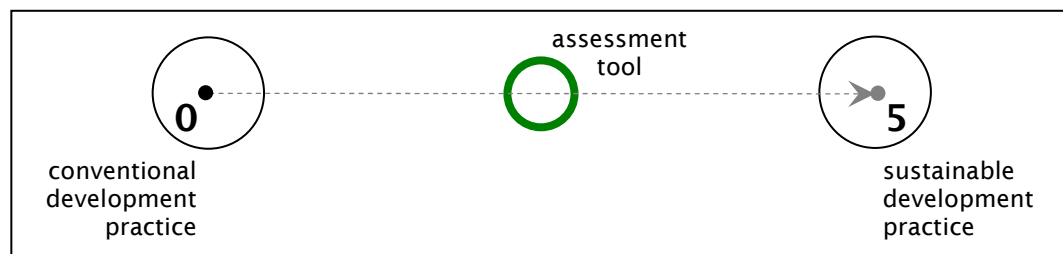


Figure 3.02 *An assessment tool intends to provide a shortcut in facilitating the shift from conventional to sustainable development practice*

Attributes of assessment tools

Another aspect relevant in the discussion surrounding the research problem lies with the characteristics of assessment tools themselves. The research argues that in order to successfully facilitate sustainability integration in conventional design processes, assessment tools need to consist of critical components and be truly comprehensive. In reference to the four previously mentioned attributes identified in the design processes, assessment tools would need to respond and relate to the design process in the following ways:

- they need to facilitate setting sustainable development targets;
- assessment tools need to provide and/or assist in the provision of education and expertise of the development team’s consultants – sustainability know-how needs to be integrated in the tool;
- the tools need to encourage an integrated coordination process between consultants, and

- they need to provide mechanisms whereby the use of specialised tools and outcomes are linked to the assessment functions.

In this sense the incorporation of the above factors in assessment tools can be mapped as shown in Figure 3.03:

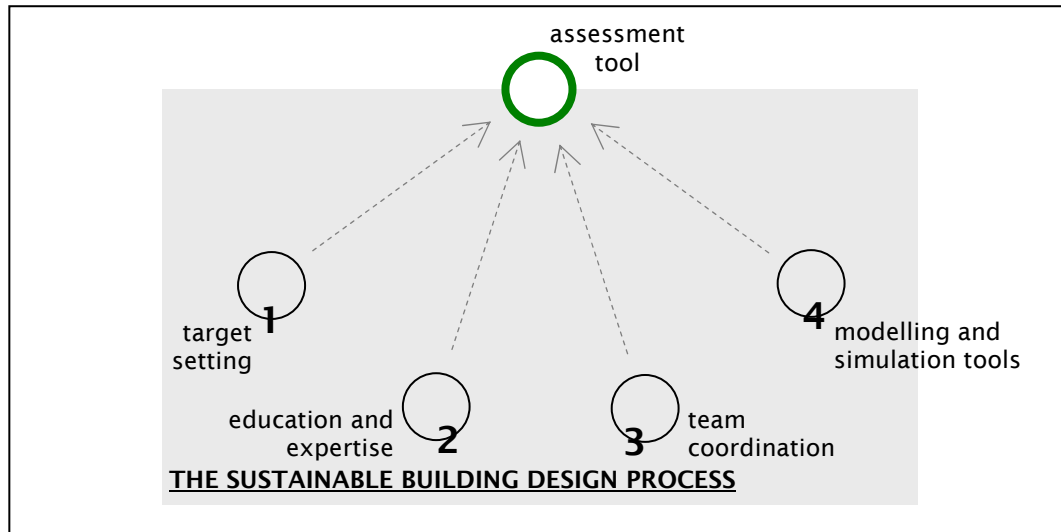


Figure 3.03 Critical attributes that need to be incorporated into an assessment tool in order to successfully facilitate sustainability integration in the design process

3.1.3 Demonstrating sustainability integration

The three illustrations discussed above, each comprises a particular aspect of the research problem. When all the above aspects are superimposed on one another, the relationships between the different research components become clearer (as is illustrated in Figure 3.04). This is the investigative framework that will be used throughout whereby the case study outcomes can be referenced. The manner in which this referencing takes place will be outlined in the following section.

The argument is that in ideal theoretical circumstances the comprehensive assessment tool possesses all the identified critical attributes to successfully facilitate sustainability integration and enable the shift from conventional to sustainable development practice.

Consequently, the application of the assessment tool in (what becomes) the sustainable design process is seamless and provides the shortcut that

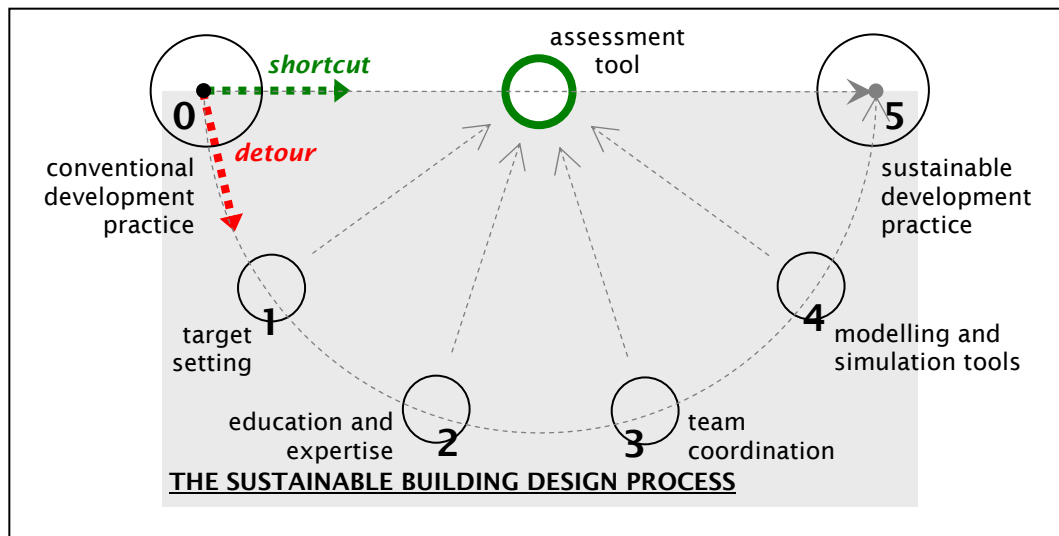


Figure 3.04 Models of the DP and AT application overlaid

is needed to arrive at the desired sustainable outcome (shown in green in the Figure 3.04 framework).

Alternatively, in circumstances where sustainability is still pursued, but without the application of assessment tools, conventional design process approaches would still address the critical aspects in terms of targets, education, coordination and tools to also arrive at the intended sustainable outcome. However, a lot more work is involved if the appropriate tools and guidelines are not available and therefore this route results in taking a 'detour', as is illustrated in red on the framework in Figure 3.04.

3.2 Establishing theoretical parameters

Now that the relationships between the pertinent aspects which inform the research problem have been illustrated and visually mapped, the research theory is established. From here the theoretical parameters need to be defined. In order to do this, two hypothetical case studies are created: Case Study 0 (CS-0), the design process of a conventional office building and Case Study 5 (CS-5), the design process of a sustainable office building. These two case studies function as the opposite reference points on the continuum of conventional/sustainable development practices. The following discussion defines the design

process and assessment tool application characteristics within each of the (hypothetical) case study realms. In order to develop this definition, the case study's respective approaches are viewed through the 'lens' of the defined investigative framework.

3.2.1 Case Study 0: the conventional office building

The following discussion of the conventional office building is both a summary of the critical attributes identified in the preceding chapter and an interpreted generalisation of what constitutes a conventional office building in order to establish a reference point on a theoretical baseline.

The design process

Target setting. Generally, in conventional office buildings development targets mainly surround tenant needs (i.e. which facilities need to be provided), building aesthetics and size, rentable areas as well as cost of the development.

Furthermore, if a developer is involved they would manage the budget and construction process on behalf of the tenant where objectives of reducing costs play an even greater role. In this scenario the single bottom-line of economic factors drive decision-making and typically the extent of social and environmental aspects which contribute to triple bottom-line sustainability are not considered when setting conventional development targets.

Education and expertise. The conventional development team's member each possesses knowledge that is specific to its field of specialisation, with little concern for the aspects which inform the other disciplines involved in the project. To a large extent it is up to the architect to marry these independent aspects together in the drawing and coordination review.

In one step further the consultants may also specialise in a specific building type, so often and through repetition they have arrived at a recipe for the design of a specific building type. In this case, a formula for designing office buildings have been developed which predicates e.g.

the structural grid layout, the floor-to-area ratio, amount of workstations per floor etc. It is evident that in such cases factors such as building orientation, user comfort or energy use are of lesser concern. All these factors and the lack of sustainability know-how contribute further to what can be perceived as a narrow-minded focus and approach applied in attempting to solve conventional design questions.

Team coordination. The scenarios surrounding the limited focus of the conventional team's consultants set the stage for the coordination process that follows. Here consultants are called upon to perform specific tasks which fall within the realm of their discipline of specialisation, with the roles in the team predefined and the extent thereof predetermined.

Typically, the architect designs the building, initially requesting some direction from the structural engineer about the building's structural grid and layout. Once the planning is finalised with input provided by the developer/tenant, the mechanical and electrical engineers add the necessary services within the pre-established design, requesting minor design adjustments where necessary, as the design is finalised. The coordination process is governed by the architect who performs the role of principal agent. Focused input is provided by the consultants at regular intervals when drawings are issued and/or when meetings take place.

Modelling tools. In order to communicate the design intent, architects use a variety of tools to explain and illustrate the building design. In projects with conventional focus, typical tools used by architects consist of presentation sketches and planning layouts which later evolve into comprehensive computer-generated working drawings and details as the design is finalised and construction is undertaken. Similar computer-generated drawings are prepared by the respective consultants.

It is strictly a process of documenting what needs to be built, depending on tried and tested applications and overly-cautious conservative estimates of anticipated outcomes. Rarely are the potential outcomes of predicted design decisions questioned, much less are the actual

outcomes tested. Little-to-no forecasting/feedback exercises are undertaken (with the use of e.g. simulation tools) to measure a building's predicated/actual performance.

An assessment tool applied

It can be reasonably assumed that the (hypothetical) conventional office building defined here does not pursue sustainability goals. As such, conventional design processes are not concerned with the sustainability aspects of a building's performance and therefore the conclusion is that (sustainability or environmental) assessment tools would not be applied in conventional development practice scenarios.

Outcome

With reference to the investigative framework that was outlined earlier, the manner in which the different components are addressed in the design process is illustrated in Figure 3.05. In this case study (CS-0), the project's design process did not shift beyond the scope of conventional

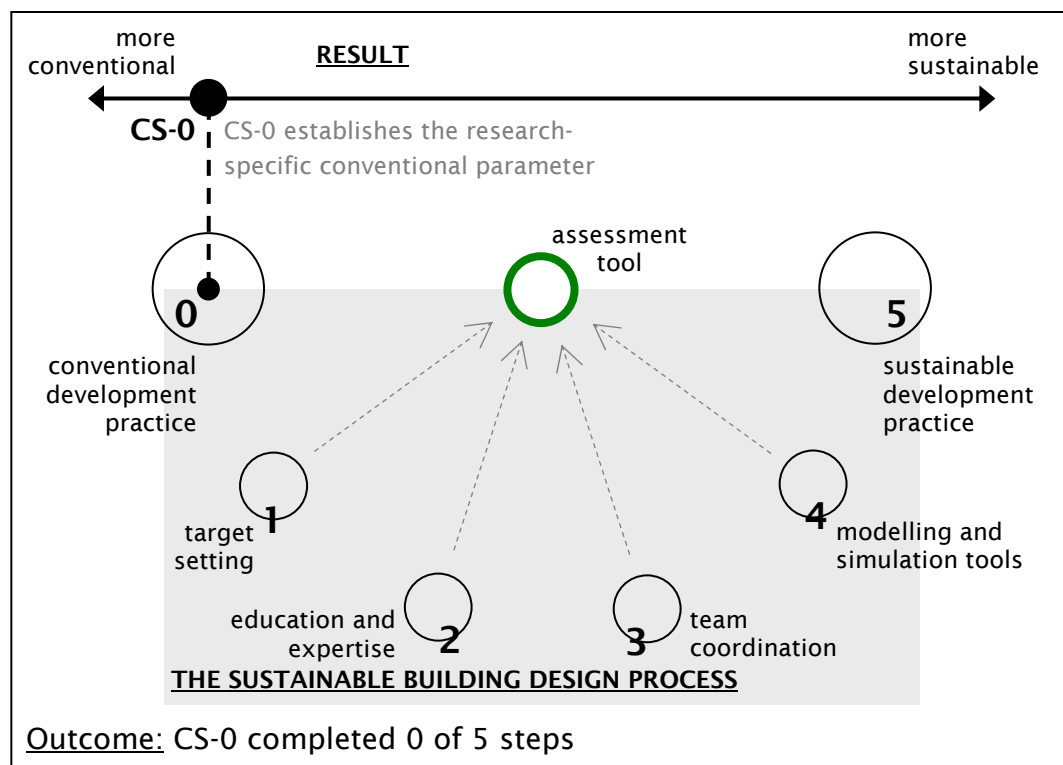


Figure 3.05 *In the context of the research, the conventional office building is an unsuccessful sustainability outcome*

decision-making approaches, nor did it apply any assessment tools to facilitate sustainability integration. CS-0 therefore remained at step 0 in the shift toward sustainability. A 'result' bar is added to the framework to indicate the case study's outcome and its position within the continuum of sustainable development.

The elaborate definition that is provided above describes the conventional office building, its associated design process approach, the omission of sustainable assessment tool application and lack of sustainability integration. This description established the theoretical parameters on the conventional side of the design process spectrum. The following discussion looks at the sustainable office building which lies on the opposite (sustainability) side of the spectrum.

3.2.2 Case Study 5: the sustainable office building

The following discussion of the sustainable office building is also a summary of the critical attributes identified in the preceding chapter and an interpreted generalisation of what constitutes a sustainable office building in order to establish the other reference point on the theoretical baseline.

The design process

Target setting. In sustainable building practice, development targets would include the whole range of sustainability objectives as it is understood in the specific building's design context. At the outset considerable time is taken to determine what sustainability would mean in this particular project.

Typically social and environmental factors would receive an equal amount of attention as is given to economic drivers and commitment is made early on to meet as many of the pre-established goals throughout the design process as can be reasonably achieved. These targets generally comprise a checklist of overarching ideals and in some instances (where appropriate) may go into quantifiable levels of specific measurable performance levels and standards to be pursued. Typically the 'soft'

issues contained within some of the social components of sustainability would be targeted as descriptive goals, whereas the 'hard' issues of some of the environmental aspects are targeted with measurable performance levels to pursue.

In sustainable office buildings, factors for consideration include, inter alia, reducing energy consumption and establishing water efficiency beyond the baseline, occupant comfort and well-being as well as concern for the building's relationship with its contextual surroundings.

Education and expertise. In order to meet and implement the set sustainability targets, the professional team in a sustainable development project either already possesses the required inherent sustainability knowledge or they would appoint an environmental consultant to facilitate sustainability integration. Their sustainability knowledge enables decision-makers to propose a range of appropriate sustainable design alternatives to consider when resolving specific (and often newly unique) project problems.

Alternatively, the environmental consultant is ideally equipped to facilitate the creation of sustainable solutions to resolve issues which often range across the different disciplines represented in the team.

Team coordination. The inherent sustainability expertise that now exists in the design team changes the manner in which the different consultants interact with one another. The design process is much more integrated, allowing for overlapping of design questioning and solving of more complex design problems which often arise in sustainability project scenarios.

Where an environmental consultant is appointed, this person would contribute in the coordination process and act as link between the different disciplines. His/her role assists in creating the integrated decision-making think-tank that is needed to arrive at synergistic sustainable solutions.

Modelling and simulation tools. Sustainability teams naturally use modelling and simulation tools in addition to conventional tools to facilitate sustainability integration during the decision-making process. With the fundamental interest in meeting sustainability targets, the successful outcome of decisions is critical and the earlier this is established, the better.

Typically, teams use simulation and modelling tools to provide ways in which the targeted building performance can be predicted and measured. These tools calculate a building's anticipated energy use, thermal comfort, tracks the sun's movement to model daylight, verify window sizes, roof overhangs, etc. Occupant surveys and tenant consultations assist in determining user needs and experience, considerations which fall within the social realm of sustainability.

An assessment tool applied

Similar to the manner in which the generalised descriptions of both the conventional and sustainable design processes are provided, so are the discussion of sustainability assessment tools which follow here informed by the content from the preceding chapter, as well as suggested critical attributes which assessment tools require in order to function as design tools that successfully facilitate sustainability integration.

Facilitating target setting. A variety of tools and mechanisms are in use that assist decision-making teams in identifying sustainability goals. At the conceptual stage of a project where sustainability targets are being set, the sustainability assessment tool functions as a checklist. Here critical factors are identified which are to be pursued as the decision-making process intensifies. At this point the mechanisms of the sustainability assessment tool are simple to use and limited obstacles exist in the application of the tool to facilitate sustainability integration.

Integrated sustainability know-how. The aspect of knowing how to implement sustainability in a particular scenario is critical in the decision-making process. Whether the decision-making team is knowledgeable in sustainability practices or not, the sustainability assessment tool needs to

have an inherent mechanism whereby the required practical sustainability know-how can be referenced and accessed.

Facilitating coordination. Where assessment tools successfully provide seamless sustainability direction, the integrated coordination process follows naturally. At this point the sustainability assessment tool provides guidance to the team as to the different roles and expertise that is required to meet sustainability targets and when specific input and coordination is required. It also indicates potential synergies and trade-offs between disciplines, thereby anticipating potential conflicts in areas where disciplines might clash or overlap. Throughout the process the sustainability assessment tool provides performance indicators of the potential outcome of decisions as tracked in lieu of set conceptual targets.

Relating with modelling tools. The primary function of assessment tools is to assess building performance. In its enhancement toward becoming a design tool that successfully facilitates sustainability integration, the sustainability assessment tool is able to correlate outcomes of modelling and simulation tools and software. With this attribute the sustainability assessment tool provides quantified and qualified responses to the (cold) data outputs derived from the modelling software used. The interpreted assessment outcome can therefore be more easily understood by the decision-making team. For example, instead of merely stating the calculated anticipated energy consumption, the sustainable assessment tool is able to qualify the data by describing a performance range wherein the consumption patterns can be referenced to determine whether original sustainability targets can be met.

Outcome

In this case study (CS-5) of a hypothetical sustainable office building, the critical criteria in terms of targets, team, coordination and tools have been met. Moreover, these aspects are intrinsically imbedded in the sustainable assessment tool applied in the decision-making process, thereby providing the necessary shortcut whereby the integration of sustainability is successfully facilitated. The design process approach in

CS-5 therefore proceeds directly from step 0 to 5, without taking any detours and is accordingly mapped in Figure 3.06. The sustainable design process components of (targets, expertise, coordination and tools) are embedded in the sustainability assessment tool and its application automatically incorporates them in decision-making.

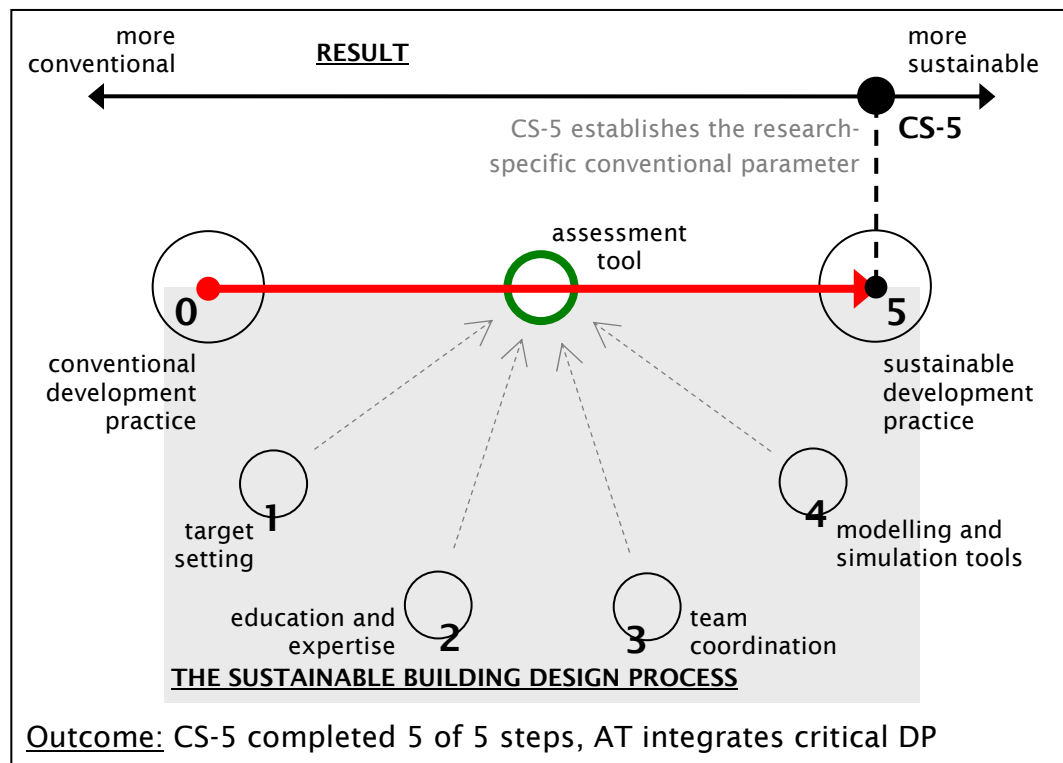


Figure 3.06 Successful sustainability outcome in the context of the research problem

3.3 Resolving the research problem

3.3.1 Deriving research findings

The main aspect under investigation is the design process with conventional and sustainable approaches on opposite sides of the development spectrum. Supplementary to this is the (optional) application of assessment tools to facilitate the design process shift toward more sustainable practices.

The conventional and sustainable office building Case studies defined above, hereby form the opposing reference points and theoretical

parameters against which the selected case studies' outcomes can be measured. The primary purpose of mapping the critical concepts that comprise the research problem in this manner is to have a mechanism whereby the researched case study outcomes can be compared. Due to the unique circumstances that surround each case study, it is neither possible nor appropriate to compare them with one another. In order to derive answers from a uniform and unbiased basis of evaluation (i.e. a pre-defined point of departure to compare 'apples with apples') each case study's outcome(s) is referenced against the theoretical construct and the pertinent aspects under investigation.

The selected case studies (CS-1 to CS-4) have each investigated and implemented sustainability practices to a larger or lesser extent (with or without the application of assessment tools). Thus the intent is that, by developing the investigative framework, the respective case studies' design process outcomes (i.e. the eventual buildings) can be illustrated as ranging between the theoretical reference points of the conventional and sustainable development practices. As such, the points of reference provide the parameters whereby each case study outcome can be related and contextualised within the research theory.

In order to better illustrate how the investigative framework is used forthwith in the research context and to explain how specific case study outcomes are mapped on the framework, a simple case study example will be briefly defined and discussed.

3.3.2 Case Study X: a simple example

Design process and assessment tool application

In this case study (CS-X), sustainability targets were set at the initial briefing stages and an assessment tool was used to facilitate this process. The assessment tool used by the design team provided a means whereby the team could access the required sustainability know-how to make decisions and develop the building design. Moving to the coordination stages, the tool did not have the requisite critical attributes to be able to

assist the team in addressing the relationships between disciplines and therefore the team had to derive their own ways in which integrated decisions for sustainability could be made. At this point the team encountered problems in continuing the pursuit of the predetermined sustainability objectives and therefore the project did not make any further progress toward sustainability.

Outcome

The design process approach in the CS-X example is mapped in Figure 3.07.

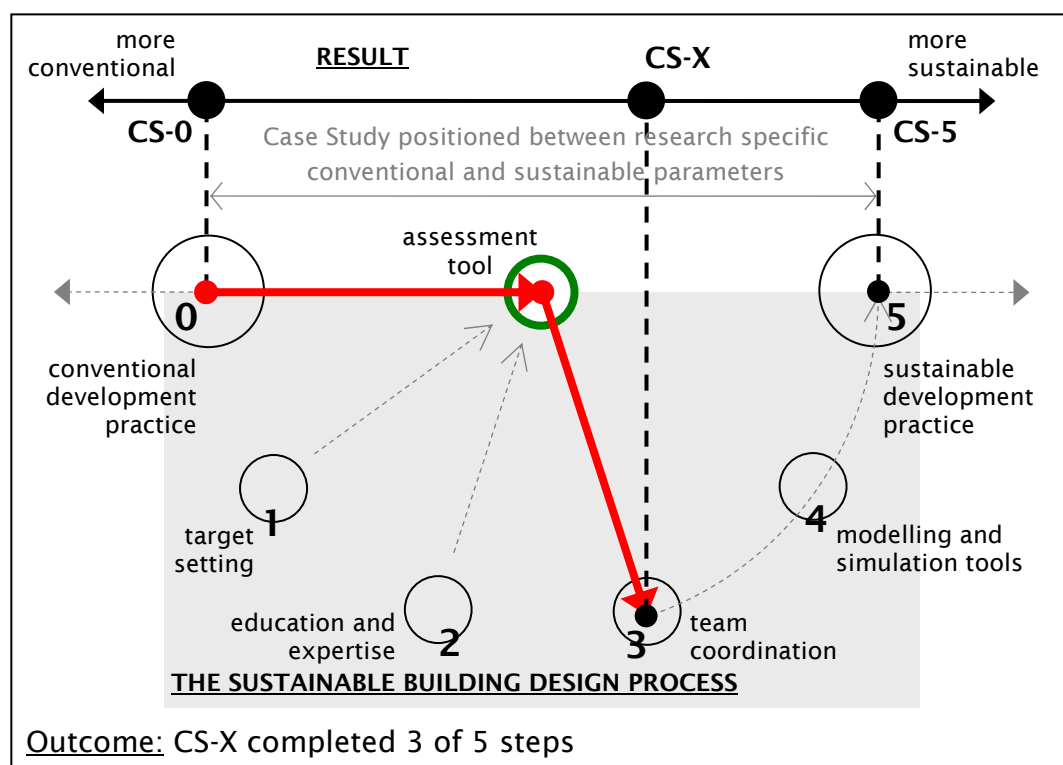


Figure 3.07 Hypothetical Case Study X's sustainability outcome mapped on the investigative framework

By using an assessment tool to shift from conventional to sustainable development practice, a shortcut is taken – this is shown in step 0 to AT. The AT in use provided the required guidance during the design process to facilitate sustainability target setting and contribute in the provision of sustainability education and expertise – these aspects are shown by the dotted grey arrows which indicate that steps 1 and 2 are integrated in the AT. At coordination stages the tool was not able to assist integrated

decision-making – this aspect is mapped from AT to 3 on the framework. At this point (step 3) the project's progress toward sustainability terminates as the team falls back on tried and tested conventional coordination approaches.

On the 'result' bar the outcomes of hypothetical Case Studies CS-0 and CS-5 are indicated. By mapping the outcome of Case Study X on the result bar as well, the extent to which the project has shifted from conventional to sustainable development practice is also shown.

3.4 Conclusion

The foregoing discussion explained the aspects that inform the research problem and illustrates by means of an investigative framework, the relationships that exist between these aspects. From there research parameters are defined and then theoretical reference points (Case Study 0 and Case Study 5) are established on the conventional-sustainable development continuum. By illustrating the parameters and reference points, a mechanism is created by which specific case study outcomes can be mapped and referenced in relation to the research theory.

Consequently the respective case study outcomes (as viewed through the 'lens' of the investigative framework) can be analysed in relation to the over-arching research argument to determine whether the applicable assessment tools can successfully facilitate sustainability integration in design processes. To this end four case studies are selected and will now be reviewed.



4 CASE STUDY DATA

The following discussion is laid out in a format similar to that of the preceding discussions of the hypothetical Case Studies 0 and 5. In each of the four actual case studies featured, the design process approach is discussed first. Specific focus is placed on the aspects of target setting, education and expertise, team coordination, modelling and simulation tools. Thereafter the application of an assessment tool is discussed, with particular focus on how the tool relates to the four critical design process components identified. The primary information gathered for each case study is presented in the Appendices section and referenced here.

4.1 Case Study 1: new office building for DST

The new office building for the Department of Science and Technology (DST) is located on the campus of the Council for Scientific and Industrial Research (CSIR) in Pretoria, South Africa and was under construction in 2005. The tenant is DST and the building was developed to suite their needs, which included a ‘green’ agenda. The CSIR’s Internal Services division performed the role of client/developer and suggested the use of the Sustainable Buildings Assessment Tool (SBAT). The building was designed by BILD Architects in partnership with Terra Ether Architects.



Figure 4.01 *Architectural model of the DST building*

In the building’s design the architects intended to blend the new building with its existing surroundings and designed it in such a manner that the architectural language would express a sense of ‘science and technology’. The ‘corporate street’, or atrium, houses the public/reception functions and runs in a north-south direction alongside a glazed western façade. The idea behind the positioning of the atrium was to create a space that shelters the more private offices from the

noise of the highway traffic to the west. The architects decided to glaze the western facade, allowing the building to open toward the south-western views of the site, thereby enhancing the intended public feeling of the space. From this communal area, four north-facing office wings branch off into more private work spaces.

The architects developed a set of targets for a 'high performance green building'. The treatment of the western façade was a specific focus of the design. The atrium is passively ventilated to manage the heat gain and adjustable louvers in the west façade allow the outside air to move naturally and cool the internal space. Other environmental features investigated in the design of the building, included the use of 'light shelves', which guide indirect natural light, adjustable lights and light fittings, rainwater harvesting and greywater re-use, a stormwater attenuation pond and development on a brownfield site.

Case study selection criteria

This project was chosen as the first case study because it satisfies the main case study selection criteria as identified in Chapters 1 and 3:

- it is an Office building in South Africa where sustainability goals were considered in the design stage;
- it was possible to source primary research data through an interview with the architect(s) where the design process approaches in the project were discussed; and
- an assessment tool was used in the design process to facilitate sustainability integration.

With these project characteristics, this case study satisfies all the pertinent aspects which the research aims to investigate. In the following sections the project-specific design approach and assessment tool application is examined and its outcome towards sustainability mapped on the research framework.

4.1.1 The design process

Target setting

In this development sustainability objectives were included from the outset of the project and accordingly included in the design brief. The architects compiled a provisional outline of what comprised a 'High-Performance Green Building'. The following four quotations were used to guide decision-making:

- *"reducing the impact of development on the natural environment"*
- *"sustainable design and development is good design"*
- *"a successful high-performance 'green' building is achieved through a team approach by setting project goals"*

The following goals were identified: (a) to develop a vision statement, (b) to develop goals that reflect the vision, (c) to develop the goal(s) into defined, achievable design criteria, and (d) to prioritize the design criteria.

- *"sustainable design recognizes the building's relationship to and impact on the larger context of community and region"*

This larger context consisted of site selection and site systems, enclosure systems (thermal comfort), visual comfort, mechanical systems (thermal comfort), indoor air quality, interior systems (functional and spatial criteria), acoustic quality, lighting systems and selection of building materials.

These preliminary 'green design' targets were developed by the architects at the briefing stages of the project, without the use of SBAT. SBAT was introduced into the process at a point when the conceptual design of the building had already taken shape and facilitated more specific target setting during the design development stages. The application of SBAT in this project is discussed in more detail in Section 4.1.3.

Education and expertise

The bulk of the work that the architects had done prior to this development has been conventional in nature, i.e. 'green' or sustainable aspects are not typically considered as a specific brief requirement in the

conventional design process. The architects explained that once the 'green' agenda had been set by the tenant/client, they still needed to educate themselves as to what a 'green' building was and then 'how' those 'green' aspects were to be implemented. They emphasised that resistance was encountered in aligning commercial development goals with sustainability pursuits, highlighting their perception that the extent to which sustainability is integrated in a project is mostly driven by the client's objectives.

In developing the preliminary 'green design' targets, they mainly used the internet (i.e. the world-wide web) as a resource, researching and referencing Australian and American examples of 'good practice'. Later, when SBAT was introduced to the project, its use and application was presented and explained to the design team by the CSIR Boutek (who developed SBAT) in a workshop held at the architects' offices. Thereafter the architects did their own preliminary assessment of the building design using SBAT.

The architects define 'green' in the DST building as follows: that energy saving is the top priority and that all the other design aspects relate back to energy saving objectives in order to save (non-renewable) resources. In terms of future projects, the architects indicated that the 'green' learning process they had undergone in this project made them more aware of the sustainability aspects that need to be considered in design.

Team coordination

At the project outset the professional consultants were briefed about the sustainability/'green' objectives of the client. It was required of each consultant that they conduct their own research into the sustainability opportunities in their respective disciplines which generated enthusiastic and pro-active buy-in from the team. Some of the recommendations that were discussed were: fly-ash alternatives in the concrete mix; the trade-offs/synergies in passive (e.g. evaporative cooling) vs. mechanical ventilation systems and the long-term benefits of installing energy-efficient light fittings. Interim coordination meetings were also held between the architects and CSIR Boutek to aid in developing sustainability

solutions, but many of the concepts had already been decided on in the earlier stages of the project and could not be changed.

The tenant (as end-user) also participated in the design decision-making process through a series of presentations that were made by the architects to staff members. Consideration was given to contractors who could meet the brief's sustainability requirements. Recommendations for waste management during construction were also included in the specification documents.

From the architects' point of view, coordination processes in conventional projects are as integrated as the coordination in sustainability projects. In their opinion the success of coordinating a project is not driven by the project-specific sustainability objectives, but is rather dependent on the team leader and the nature of the communication in the team.

Modelling and simulation tools

The architects described their design process as 'normal intuitive', meaning that they 'sensed' when they are doing 'right' (i.e. for the particular building's design) and once pursued, that line of decision-making was then back-tracked and tested against the original principles to check that all (or as many as possible) of the aspects were being addressed. They further suggest that the design process is not a step-by-step procedure but rather a back-and-forth exercise of continuously verifying decisions against principles that had been set, thereby balancing all targets against their priority weightings. The architects also highlighted the internet and e-mail as valuable resource tools that facilitate 'green' decision-making, distribution of information and communication in the team.

The glazed western façade of the building is a unique design feature, which, in the context of 'green' and energy-efficient design, requires some consideration. Here the architects specified solarvue glass (to reduce heat gain) as well as automatically adjustable blades that screen the façade as the sun angle changes. The atrium space behind the façade is naturally ventilated: the design intent being that the outside air

provides a cooling effect to the inside as it is drawn across a water feature (which is situated below the length of the west façade). The sizes of the openings at the bottom of the window wall were calculated to provide sufficient air movement, but the intended cooling effect in the atrium space is based on ventilation principles and not specifically calculated/simulated.

Through the implementation stage of the project many of the envisaged 'green' features of the building were abandoned due to feasibility and cost constraints. When selecting energy-efficient products, the architects decided to choose products that were then available in the market, opting rather to minimise the risk to the client and tenant of specifying untested, untried products that may not perform as intended. The result is to default to the conventional application.

In summary, no specific or sophisticated design or simulation tools were used in the DST design process to guide sustainability decision-making. The design approach that the architects applied to the DST building design appears to be similar to their other conventional project approaches with the exception that some 'green' aspects were considered.

4.1.2 An assessment tool applied

Facilitating target setting

The initial sustainability or 'green' design targets were developed by the architects without the use of any assessment tool. When the Sustainable Building Assessment Tool (SBAT) was introduced to the design process during design development, the architects did the initial SBAT assessment of the building design, following the introductory SBAT workshop. Once the coordination process was underway the CSIR's Boutek team did their own re-assessment of the design to review the potential sustainability innovation opportunities. The outcome of the architect's initial SBAT assessment of the building design is shown in Figure 4.02.

The SBAT assessment shows relatively high ratings for the social and economic components of the design. Considering that the concept

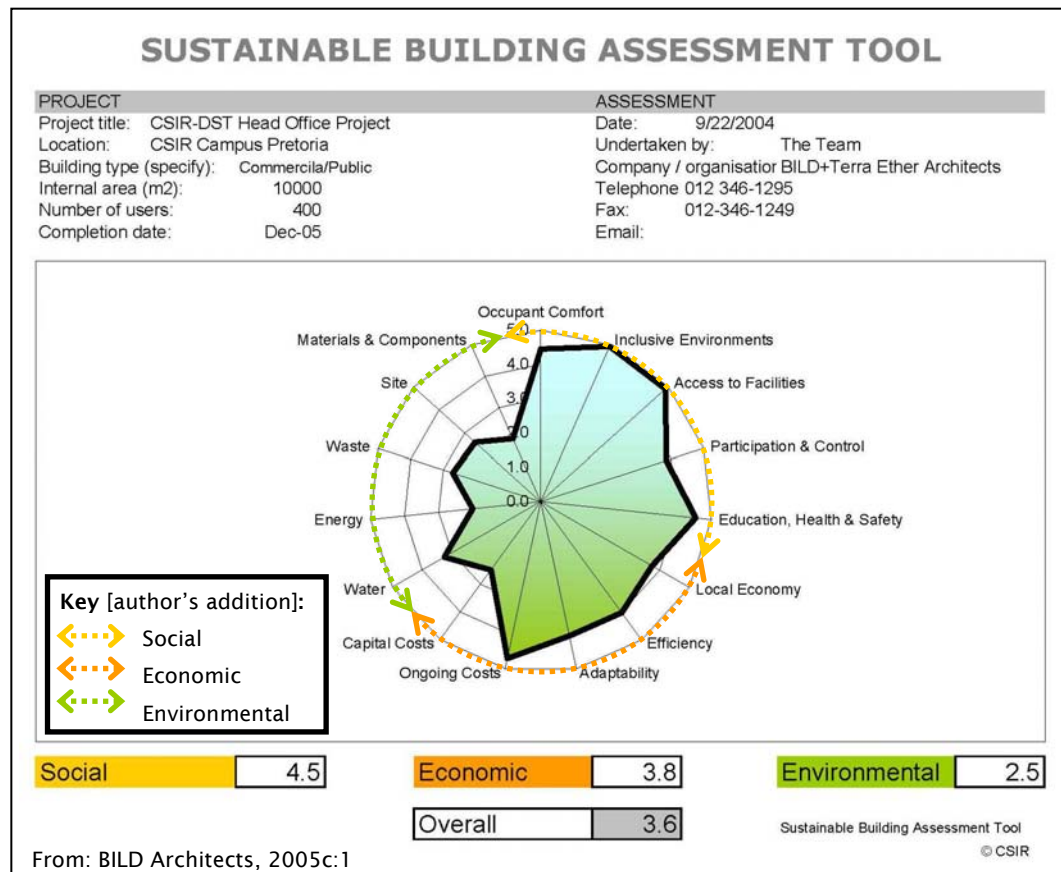


Figure 4.02 SBAT assessment of design targets for DST Office

targets of the design focussed more on the 'green' aspects of the building, one would expect higher ratings than what SBAT shows for the environmental components of the design, but this result may be an indication of the extent to which environmental factors were incorporated into the actual design.

The architects commented on the fact that the graphic representation of the SBAT assessment outcome is easy to read and shows clearly where the design shortcomings lie and they were therefore able to identify where the design focus should be if sustainability improvements needed to be made.

Integrated sustainability know-how

The SBAT outcomes indicated to the design team where the environmental shortcomings of the design lay, but the architects were nonetheless at a loss as to how to design more sustainably. SBAT provides a summary

description of each of the sub-category criteria (refer to Appendix B.2), indicating, for example, that conventional energy use depletes non-renewable resources and suggests reducing energy use or the use of renewable energy alternatives. In the SBAT spreadsheet where (for example) energy performance is calculated, the following aspects are measured that, in combination, influence and comprise the building's total energy use: the building's location and user accessibility; energy-efficient ventilation, heating and cooling strategies; the use of energy-efficient appliances/fittings or renewable energy. Although these criteria and descriptions convey to the architects what aspects are relevant in terms of the building's energy performance, SBAT does not provide further information as to 'how' to meet these specific energy performance targets.

It is here where it is problematic for architects to attempt to design to meet specific targets if they don't know what alternatives are available or how to implement them. In this case study, the architects overcame the obstacles by conducting their own supplementary research to develop sustainability solutions that were feasible and appropriate to the project and many of the sustainability initiatives were provided from their own intuitive knowledge.

The role of an assessment tool is to assess building performance and when it is applied in the design decision-making process some level of sustainable design direction is expected (whether the expectation is reasonable or not). The crucial factor is that the tool fails the design team when this basic sustainability know-how (in the form of clues toward different potential design applications) is not integrated in the basic mechanisms of the tool.

Facilitating coordination

The architects indicated that SBAT was used to set project targets, but it played no significant role in the subsequent project processes. It can therefore be concluded that SBAT did not facilitate decision-making during project coordination. The architects also expressed difficulties in marrying commercial and sustainability objectives and this may have

influenced the limited extent to which sustainability goals were feasibly pursued through detailed decision-making/technical processes.

The characteristics of SBAT in facilitating coordination processes can nevertheless still be considered whether or not it was applied in the DST project. The integrated design process (IDP) requires committed and equal interaction by all participating decision-makers to promote sustainability practices. In order to generate an assessment outcome, SBAT requires that calculations are done for many different aspects of the building, suggesting input from all the professional consultants. However, SBAT does not indicate which of the sub-categories are affected by the different design disciplines, thereby hindering its ease of use in the coordination process.

Furthermore, performances within certain sub-categories have an impact on other sub-category criteria. In order to address these requirements comprehensively, a reasonable understanding of sustainability and integrated decision-making across the different disciplines is crucial; e.g. lighting decisions impact the building's cooling and heating. By indicating these synergies and trade-offs between disciplines, consultants are further enabled to make informed decisions toward meeting project-specific sustainability goals.

Relating with modelling tools

The intuitive nature of the design process of this project lent itself to more informal 'rule of thumb' applications that were dependent on the experience of the professional consultants on the team. According to the architects, no specific or sophisticated design/simulation tools were used in the design process to facilitate decision-making.

Generally the spreadsheet in SBAT requires that percentage calculations are entered for each of the criteria aspects listed under each of the different sub-categories. SBAT automatically assumes that each of the 5 criteria points under the sub-categories carry equal weight in terms of its contribution toward sustainable practices. Also, the simple conclusion is

then, that in order to increase the overall rating, one would merely need to increase the extent to which a specific approach is applied. In many instances this is a difficult task, as design teams often lack the sustainability insight to know where these ‘all-or-nothing’ applications are most beneficial. And this ‘more is better’ approach does not require SBAT to relate with/interpret the data of modelled calculations and therefore the tool lacks the mechanism whereby simulated/modelled results are assessed within the sustainability context of targets set.

4.1.3 Outcome

The pertinent factors in the discussion of the nature of the design process and the use of SBAT in the DST project, are mapped on the research framework in Figure 4.03, and can be summarised as follows:

- ‘Green’ considerations were part of the initial project brief. At the project outset the architects set ‘green’ development targets using the internet as resource.
 - this process is mapped as step 0 to 1 on the research framework
- SBAT was later introduced to the design process and facilitated refinement of initial project targets to encompass all aspects of sustainability, attempting to go beyond the initial ‘green’ or ‘high-performance’ targets.
 - the next step on the framework is therefore mapped from 1 to AT
- Once the sustainability development targets had been set, the architects and other consultants researched ‘green’ design alternatives and appropriate sustainability solutions without the use of SBAT.
 - this step in the process is mapped from AT to 2 on the framework
- The coordination process in this project resembles the ‘conventional’ approach where each consultant applied design solutions (whether ‘green’ or not) in isolation within their specific discipline and again without the use of SBAT.
 - this is mapped as step 2 to 3 on the framework
- As the detail design developed, some ‘green’ technologies were incorporated, but without the use of energy modelling or design

simulations, nor was any assessment done to determine whether the implemented technologies will deliver the intended results

→ as such the shift from conventional to sustainable design on this project did not progress beyond the coordination process steps and is therefore not mapped any further on the research framework

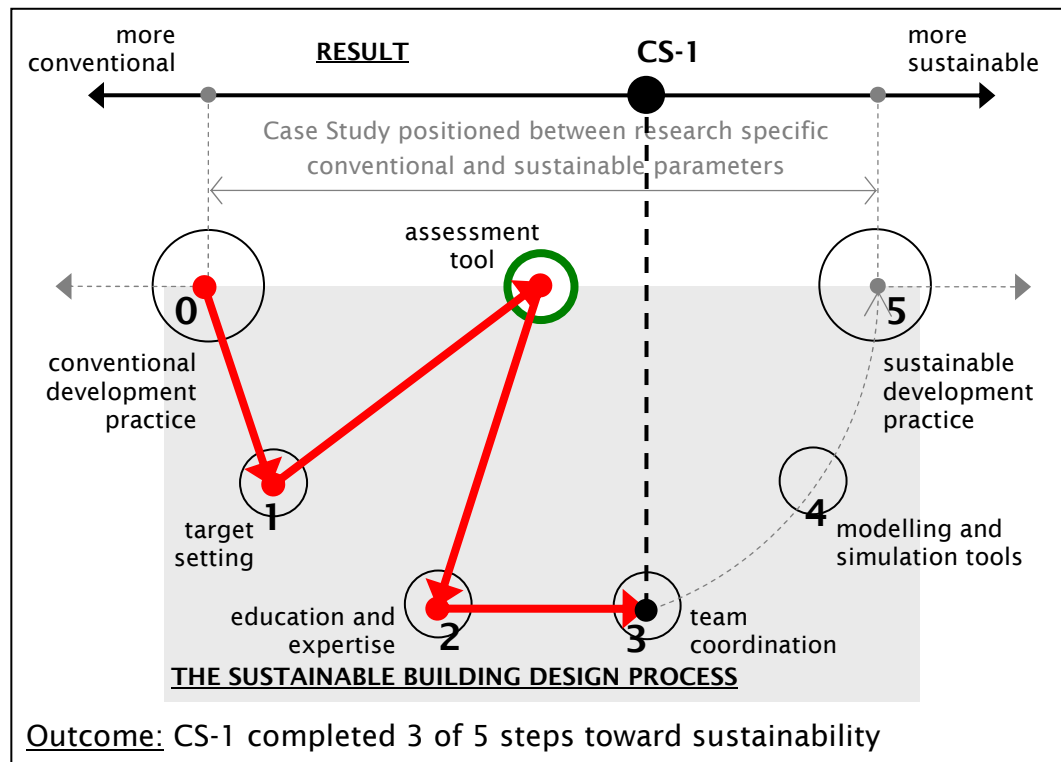


Figure 4.03 CS-1 design process mapped on the research framework

Other outcomes from this case study discussion revealed that the architects believed that the ‘green’ or sustainability agenda is largely client-driven. They also indicated that meeting commercial objectives required a trade-off with sustainability goals, i.e. these pursuits are opposing, not synergistic. Another obstacle that was noted, relates to the architects’ perceived ability to police ‘green’ technologies, i.e. where different team players have different development priorities. This point also relates to each team member’s understanding of what sustainability is in a particular project and the level of sustainability commitment of the team.

A point for consideration also arose in reference to the nature of the coordination process. The architects on this project believed that there is

no noteworthy difference between the conventional and integrated design coordination processes. This comment can be interpreted in two ways: one, that sustainability and its objectives are misunderstood by the development team and two, that integrating sustainability does not require significant changes from the conventional approach.

To move forward, the relationship between the design process and the application of an assessment tool in another case study needs to be reviewed to be able to draw research relevant comparisons and conclusions. Ideally, another case study where SBAT was used during the design stages need to be considered, but such an example was unfortunately not available for investigation. In its place an office building where another green building assessment framework was used, was selected. This building is the MTN Head Office in Johannesburg.

4.2 Case Study 2: new office building for MTN

The new head office for MTN (a cellular telephone service company) is located in Johannesburg, South Africa and was constructed in two phases. Phase 1 was built in 2002 and Phase 2 completed in 2005. MTN is the tenant and a commercial property developer provided structured finance and developed the property to suit the specific tenant's needs. The mechanical engineering consultant suggested that the project be registered with the Green Building Council (GBC). Boogertman Architects designed both phases of the project.



Figure 4.04 West elevation of the MTN Building

This building has similar internal atria and north-facing office wing features as the preceding case study but is significantly larger in size. In the MTN's Phase 1 building (see plans in Appendix B.2), the atrium is located on the western side of the building and meeting cubicles are positioned as 'bird's nests' at different elevations along the glazed western façade. From here cellular offices, meeting rooms, the central call centre and the red walls of the service core are visible. The open plan offices are located to the east of the central atrium, which is planned around a smaller internal atrium. A cafeteria is located at the atrium's ground floor level and connects to the bridge which leads to the Phase 2 building.

In Phase 2 the cafeteria is again located at ground floor level in an enclosed internal atrium space, but here it opens onto the northern views of the site. The building's main circulation routes converge in the atrium space with meeting rooms and open-plan office areas leading from there to the east and west portions of the building.

The most significant difference between the two phases of the building lies in the planning of the high-density office spaces to accommodate the optimal amount of computer work stations. In Phase 1 the service core is situated in the centre of the space surrounded with open plan offices. In Phase 2 the service cores are positioned to the end of the space with uninterrupted open-plan offices on the floors.

According to the architect, some of the 'green' technologies that are incorporated into the building, are the use of greywater collected from the cooling towers and used for irrigation and to flush toilets. Double glazing was also installed on all the façades of the building and a Building Management System (BMS) monitors the building's operational performance.

Case study selection criteria

This project was selected as the second case study because it also satisfies the main case study selection criteria:

- it is an Office building in South Africa where sustainability goals were considered in the design stage
- it was possible to source primary data by conducting an interview with the architect(s) to discuss the design process approaches taken in the project
- an assessment tool was used in the design process to facilitate sustainability integration

The project also has the unique characteristics that the sustainability goals and the use of an assessment tool were not introduced by the tenant/client.

It should be noted that references are made by Gibberd (2002:5) and Darroll (2002:2) that SBAT was used for target-setting purposes on an MTN building, but at the time that the case study data was collected this information was not made available. For the purpose of the research the information provided by the architect is used as reference. (If SBAT was in fact used, the research outcome, as mapped on the research framework, should not be different because the *use* and *usefulness* of assessment tools (not *which* tool) are being investigated.)

4.2.1 The design process

Target setting

The original development brief did not include any specific requirements for sustainability consideration. According to the architects, the tenant was open to 'green' initiatives and also that the developer was aware of 'green' concepts. However, there was a concern that the implementation of sustainability components could be problematic when trying to justify additional costs in an already competitive commercial market. The architect also argued that, although initial (sustainability) cost increases can be salvaged at operation, it is a problem, in that the tenant receives that saving and not the developer, who incurs the costs in the first place. In such scenarios the outcome is that conventional solutions are chosen over sustainable ones so as to minimise the risk of additional cost to the developer.

In the early stages of design development, a 'Green Building Checklist' was completed (attached in Appendix B.2). Some of the sustainability aspects covered in this checklist relates to noise, proximity of users to natural light, the optimal building footprint, disability access, space reuse potential, accessibility to public services, waste management, grey water use and ventilation.

Education and expertise

The architects are well-known in the industry and have successfully completed many conventional office developments. From what could be determined, sustainability considerations are not normally included in the commercial development agenda of projects in which they are involved.

It is therefore reasonable to assume that the architects did not possess more than a general and basic knowledge of what 'green' constitutes in buildings. The architect explained that in the early planning stages of projects when feasibility studies are being done, much of the design work is done at risk. Architects are therefore required to make the most efficient use of their time which leaves no time to do additional research. By implication, incorporating sustainability requirements would require that the architects acquire education in appropriate sustainability design solutions or alternative 'green' technologies available, should these need to be integrated early on.

The mechanical engineers on the project, who suggested registration with the GBC, had some background on 'green' practices in their field of specialisation. However, the scope of this research project only extends to the viewpoints and experiences of the architects and therefore the levels of sustainability expertise of the other consultants were not further investigated.

Where possible, sustainability items were prioritised in the checklist and incorporated into the building design with some input provided by the mechanical engineers and, to a lesser extent, by the other consultants. From what can be concluded from the checklist, these items do not require significant 'green' education when prioritising and the architects

did not mention that any additional sustainability research was conducted to incorporate the priority items into the design. Aspects surrounding the checklist will be discussed in further detail in the Section 4.2.2.

Team coordination

Different task responsibilities were also allocated on the green building checklist for the various consultants with regard to the range of sustainability items that were to be addressed in the project in their respective disciplines. Sustainability goals were discussed in design and coordination meetings, but, from what could be determined, its application did not facilitate an integrated design coordination process between consultants as is typical in sustainability-driven projects.

Where 'green' solutions were discussed, the quantity surveyor made cost comparisons between 'green' and conventional/standard applications, which generally showed results in increased initial costs for 'green' solutions. The outcome was often a return to conventional applications. In addition, some of the energy efficiency initiatives implemented on the project were to a large extent driven by cost constraints. The mechanical engineer calculated the optimal floor to façade area ratio to reduce as far as possible the potential heat gain over the extent of the façade. The result is a square plan shape which also allows optimal layout for maximum amount of computer workstations. Incidentally, no environmental consultant was appointed on the project to aid in 'green' decision-making.

In terms of tenant input, the architect expressed difficulties in getting the building user to participate in the process, stating that often, when feedback is obtained from the building users at operational stage, it is more inclined to be complaints/criticism. This is actually a typical flaw of conventional processes where the process of providing and obtaining structured feedback to the design team is uncommon.

Modelling and simulation tools

No reference was made in the interview with the architect that any specific modelling tools (beyond the conventional) were used to integrate

‘green’ aspects into the building design. It was noted that the mechanical engineers were responsible for doing the necessary calculations to, amongst others, determine the impact of the heat gain through the glazing and for providing input to the architects in the design of the glazed façade, whether in sizing or glazing type.

4.2.2 An assessment tool applied

Facilitating target setting

In the interview the architect referred to registration with the GBC and provided the green building checklist that was developed for the project (included in Appendix B.2, p.vii - viii i), which served as an assessment tool only to the extent that green building aspects could be prioritised to facilitate decision-making. The GBC developed the GBTool, a ‘green’ building assessment framework. When comparing the spreadsheet checklist obtained from the architects with the GBTool, the checklist bears little resemblance to the GBTool’s assessment framework.

The architect indicated that the green building checklist objectives set in Phase 1 were re-applied in Phase 2, although (from what could be determined) no new ‘green’ checklist was prepared. According to the architect the green building checklist provided the relevant consideration items during the design process to facilitate target setting, but it didn’t change the process approach that followed.

Integrated sustainability know-how

The scope of the implemented green building checklist is not limited to ‘green’ (or environmental) performance aspects of buildings, but also includes social and economic aspects of sustainability. For the purpose of the discussion, the checklist received from the architect has been reformatted and sorted to show which of the items fall under which category and what priority rating these aspects were given (refer to Appendix B.2.01 – 2.03):

- there are 44 aspects listed under the social category, 29 (or 66%) of which received an ‘essential’ priority ranking;

- under the economic category of 34 aspects, 12 (or 35%) were ranked 'essential', and,
- of the 27 aspects listed under the environmental category, none (0%) were ranked as 'essential'.

In terms of sustainability know-how integrated in the tool, the checklist lacks the level of depth that is required to review available sustainability alternatives. The checklist merely provides relevant consideration points, but does not provide further sustainability guidance as to how these points could be integrated in the design. The list also reflects a heavier focus on social aspects with environmental factors having a seemingly lesser importance. Although it can be argued that it is not the purpose of the checklist to provide sustainability solutions, it is still reasonable to expect that it would aid the consultants in implementing prioritised targets and provide some level of sustainability guidance.

Facilitating coordination

By listing the different consultants' names under a responsibility category on the green building checklist, it assumes a single discipline action item which is actually a reflection of a coordination process approach similar to that of conventional decision-making processes. The architects also mentioned that some level of additional coordination (beyond that of the conventional) took place between the architects and mechanical engineers in the façade and floor configurations to address efficiencies in terms of energy, ventilation, space-use, etc. One of the sustainability synergies arising from this interaction was the re-use of greywater in the toilets which is collected from the cooling towers.

Relating with modelling tools

Significant calculating is required in the use of the GBTool, but again the scope of the green building checklist used on this project was limited and did not require the use of design tools beyond the conventional. The architect made no reference to the use of any simulation and/or modelling tools to facilitate their sustainability decision-making.

4.2.3 Outcome

The design process approach on the MTN building and the sustainability outcome through the use of the green building checklist is mapped on the research framework in Figure 4.05.

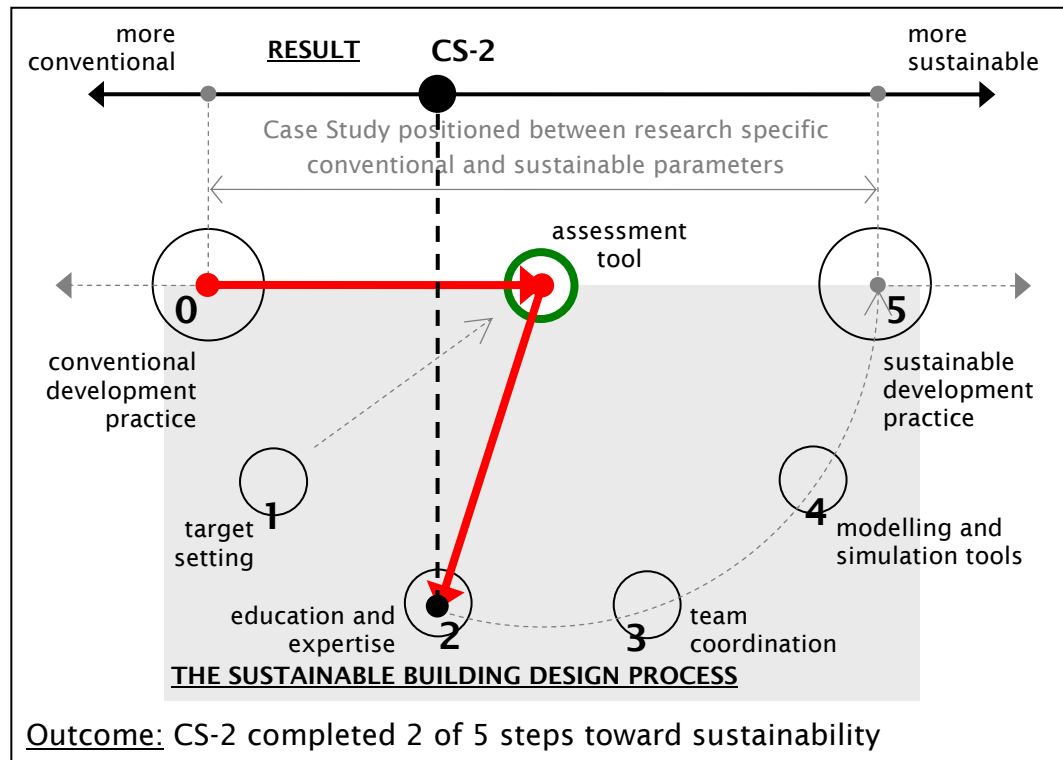


Figure 4.05 CS-2 design process mapped on the research framework

The process approach can be summarised as follows:

- sustainability considerations were included in the initial project brief: at the project outset sustainability goals were prioritised through the use of a green building checklist
 - this process is mapped as step 0 to AT on the research framework, where the development targets form an integral part of the assessment tool (in this case the checklist is the tool)
- some of these development targets were implemented through conventional approaches and input was provided by the mechanical engineers (who possessed some environmental background)
 - this step in the process is mapped on the framework from AT to 2

- no reference was made to further sustainability research undertaken by the architects to meet development targets beyond the conventional; the coordination process also resembles a 'conventional' approach to team interaction
 - on this project the shift from conventional to sustainable came to a standstill at the education/expertise stage and therefore no further steps are mapped on the process framework.

In this case study (as in the previous one) the architects expressed difficulties in reconciling conventional and sustainability development objectives, here specifically from a cost point of view, where known conventional applications are more cost effective than unfamiliar, untested sustainability solutions.

Another interesting point which arose in the interview discussion relates to the issue of managing costs: increased initial expenses for long-term operational benefits of sustainability improvements is borne by the client, who is wary of spending money where they themselves do not reap the benefits. They also questioned whether it is possible to measure and quantify the often 'soft cost' benefits of sustainable solutions to a client, who measures all design decisions against the economic bottom-line.

The variables of target setting, education/expertise, coordination and design tools were discussed in the preceding case studies and their process outcomes are similar, with reasonably similar results. The last variable in the equation of shifting from conventional to sustainable practice lies in the application of assessment tools. Therefore the following case study investigates the shift toward sustainability *without* the use of an assessment tool. This building is the Munich Re-Insurance Head Office in Johannesburg.

4.3 Case Study 3: new office building for MRe

The new head office for Munich Reinsurance of Africa (MRe) is located in Johannesburg, South Africa and was constructed in 1998. The client is the developer and also occupies the building. Munich Re invited short

listed architects to submit concept design proposals for their review. Stauch Vorster MOM Architects were selected to design the building and they also approached the client to consider green building principles. The MRe building has been widely published (Knoll, 1999:17 – 21, Winch and Giesen, 1999:82 – 88) and in 1999 received an Award of Merit from the South African Institute of Architects, wherein the judges cited one of the strengths of the design were *“the concern for environmental control”* (SA Architect, 2000:30). In the design of the MRe building the architects focussed on many core ‘green’ principles, such as its orientation, the benefits of double glazing, optimising natural lighting, thermal massing and insulation, passive ventilation, indigenous landscaping, sunscreens as well as dual-flush toilets.



Figure 4.06 *South façade of Munich Re-Insurance Centre*

The building is oriented toward the north overlooking a natural landscape of highveld ridge and planting where invader species were replaced with indigenous flora. The main access to the site is located toward the south, along a busy road and a water feature at the building’s entrance masks traffic noise. Two internal triple-volume atria are located on ground floor level, separated by the central circulation core of lifts and a feature staircase. The offices are located on three floors along the perimeter of the planted atrium space, where indirect light filters in from the south windows at clerestory level. Three levels of underground parking are also provided below the building. Externally the facades are clad in locally sourced natural sandstone and selected for its simple aesthetic appeal and reduced maintenance requirements. A Building Monitoring System (BMS) was installed.

Case study selection criteria

In the strictest sense this project only satisfies two of the three main case study criteria, which are:

- it is an Office building in South Africa where sustainability goals were considered in the design stage
- it was possible to source primary data by conducting an interview with the architect(s) to discuss the design process approaches taken in the project

The third case study selection criterion, namely that an assessment tool needs to be used in the design process to facilitate sustainability integration is not satisfied. However, this project was designed at a time when sustainability pursuits were rare and long before assessment tools were commonly in use. Considering these constraints, it was included here as a case study for the following reasons:

- a simple and straight-forward assessment process was undertaken during the design stages to facilitate decision-making;
- the building is widely recognised in the South African context for its comparatively outstanding environmental attributes: 'green' features which are also unique for an office building.

4.3.1 The design process

Target setting

At the project outset, the architect undertook a needs assessment exercise that concluded it was appropriate to introduce 'green' philosophies to the client. The client considered the architect's suggestions and subsequently welcomed their 'green' ideas. The architect's approach was to select the most appropriate design course and then to discuss it with the client, by explaining why it is the most suitable route to take. In this way the architect was able to facilitate the design decision-making process, whilst providing the clients with the rationale that lay behind decisions made during presentation discussions.

The architects defined a 'green building' as *"a building designed around a number of core philosophies related to the impact that the building will have on local and global environments"* (Winch and Giesen, 1999:82).

Some of the key points identified are:

- the building is viewed primarily as a low-energy building;
- provide good internal environmental conditions;
- reduce embodied energy costs;
- eliminate health risks;
- rationalise design solutions;
- simplify building operating systems; and
- install efficient monitoring systems.

Although the architect had proposed the incorporation of ‘green’ ideas, they were more or less at a loss as to how to implement these technologies. No assessment tools were known to the architects at the time to aid green/sustainability target setting processes.

Education and expertise

The architects had not designed a ‘green’ building before this one was developed, although some basic design principles, e.g. orientation and façade treatment, form part of their everyday design considerations. Therefore the architects had to start from scratch to source regionally relevant ‘green’/sustainability ideas/principles. With the limited applicable resources available at that time, the architects referenced mostly publications, specifically concentrating on some Australian examples. In terms of the need for self-education, the architects also mentioned the increased demands that were made on their time to study ‘green’ technologies and find appropriate solutions whilst the building was being designed.

It is furthermore the architect’s view that the basic philosophies of ‘green’ are relatively simple and as a consequence they took a very pragmatic approach to the implementation of the ‘green’ technologies in the building’s design. They also pointed out that no specifications existed (at the time the building was designed) for e.g. energy calculations and that even if these were available, the nature of the design approach is not scientific, which inhibits the extent to which scientific requirements can be incorporated in the early conceptual design stages.

Team coordination

The architects were selected through an interview process from a group of about five architectural companies and were the first consultants appointed to the team. The project manager was appointed first which was followed by the appointment of the architects and other professional consultants with suggestions made by the architects. The consultants were selected based on the basis of identified project core needs, amongst them their commitment to 'green' aspects and demonstrated environmental awareness.

Requirements included in the tender were the contractor's commitment to quality, responsible management of the many and diverse sub-contractors that were needed for the project, a clerk of works to supervise quality in order to reduce maintenance issues later.

Early on in the design process, the consultants discussed 'green' vs. 'low-tech' goals and objectives to determine what can be practically achieved and what is economically feasible. Value-engineering Workshops were introduced, where all the consultants, the client and any other interested parties could contribute to realise the project's fundamentals. A series of approximately eight workshops were conducted as part of the building's decision-making process. The VEW process consisted of an 'old-fashioned' multiple-choice questions and answers session, with the different criteria of a 'green' aspect discussed rated between 1 and 10. In these sessions many synergies between disciplines were also recognised and there is sufficient evidence to conclude that this was an integrated team process.

Modelling and simulation tools

According to the architect no specific 'green' modelling tools were used. At the project outset the architect had specific design intentions which were realised through the project's coordination process. No sophisticated computer tools or software were used to aid decision-making processes, except for the value-engineering workshops (VEWs).

An example of how the VEWs decision-making process for passive ventilation served as a 'green' design tool was explained by the architect as follows: an access floor was needed to purge the air at night and there was also a need to return the air through the ceiling. The quantity surveyor argued the constraints in costs to install both systems, and the architect argued that suspended ceilings are needed for aesthetic and acoustic reasons as well as fire protection (sprinklers), so neither system could be omitted. The mechanical engineer determined that if both systems were installed, the return air could be installed 'very cheaply'. After a multiple-choice evaluation was completed by all participating team members to reach the appropriate conclusion, the simple answer would then address the combined concerns of all interested parties.

4.3.2 An assessment tool applied

In the strictest sense of the term, the value engineering workshops developed for this project is not an assessment tool and as such no formal assessment tool was used. Nevertheless, the process does provide a mechanism (however rudimentary) whereby design decisions can be evaluated and rated and whereby appropriate design avenues could be selected. For the purpose of the research the pertinent aspects relevant to the application of the VEW as 'tool' in the key areas of target setting, providing sustainability know-how, facilitating team coordination and its relation to design tools, are briefly discussed.

Facilitating target setting

From what could be determined, the project goals and 'green' targets were derived by the architect at concept stage and mostly from reference material. As such, the main design direction was already established by the time that the VEWs were introduced, although detail decisions still needed to be made. In this project the 'green' design targets had been set without the use of an assessment tool.

Integrated sustainability know-how

As no assessment tool was used, the requirement of whether sustainability know-how is integrated in the tool cannot be determined. It

should be noted, however, that the discussions of the value engineering workshops provided a mechanism whereby sustainability know-how within the different disciplines can be debated and whereby synergistic solutions can be generated.

Facilitating coordination

Again, with the absence of an applied assessment tool, the inherent 'ability' of an applied assessment tool to facilitate the coordination process cannot be evaluated. Nevertheless, the above-mentioned discussion and examples are evidence enough that the VEWs contributed a great deal in facilitating sustainability-related coordination between the often isolated disciplines of the consultant team and creating an integrated design process.

Relating with modelling tools

The manner in which assessment tool outcomes can be related to the use of modelling tools, is also relevant criteria in determining the 'successful' application of assessment tools in design decision-making processes. In this instance, no assessment tools were used and therefore have no bearing on the impact of their use with (conventional) design tools.

The VEWs in this project process was inherently integrated and interpretative in its relation to design. Considering the successful outcome of many of the 'green' technologies debated in the VEWs, it can be assumed that these outcomes naturally tie to the design decision-making processes and tools used.

4.3.3 Outcome

The design process approach on the MRe building and the sustainability outcome is mapped on the research framework in Figure 4.07 and can be summarised as follows:

- 'green' (not sustainability) considerations were included in the initial project brief, without the use of an assessment tool
 - this process is mapped as step 0 to 1 on the research framework

- once the development targets had been set, the architects embarked on their own research to develop 'green' strategies
→ this step in the process is mapped on the framework from 1 to 2
- during design development, value-engineering workshops (VEWs) were introduced to develop synergistic solutions, wherein all decision-making stakeholders participated
→ the integrated design process and the evaluative framework of the VEWs went hand-in-hand and is therefore illustrated as integrated in the assessment process, i.e. mapped on the framework, from 2 to AT (thereby providing a shortcut from step 3)
- from coordination, some 'green' technologies were implemented with the use of simple modelling tools
→ the shift from conventional to sustainable on this project progressed to the point where simulation and modelling tools were introduced and therefore the last step on the research framework is mapped from AT to 4.

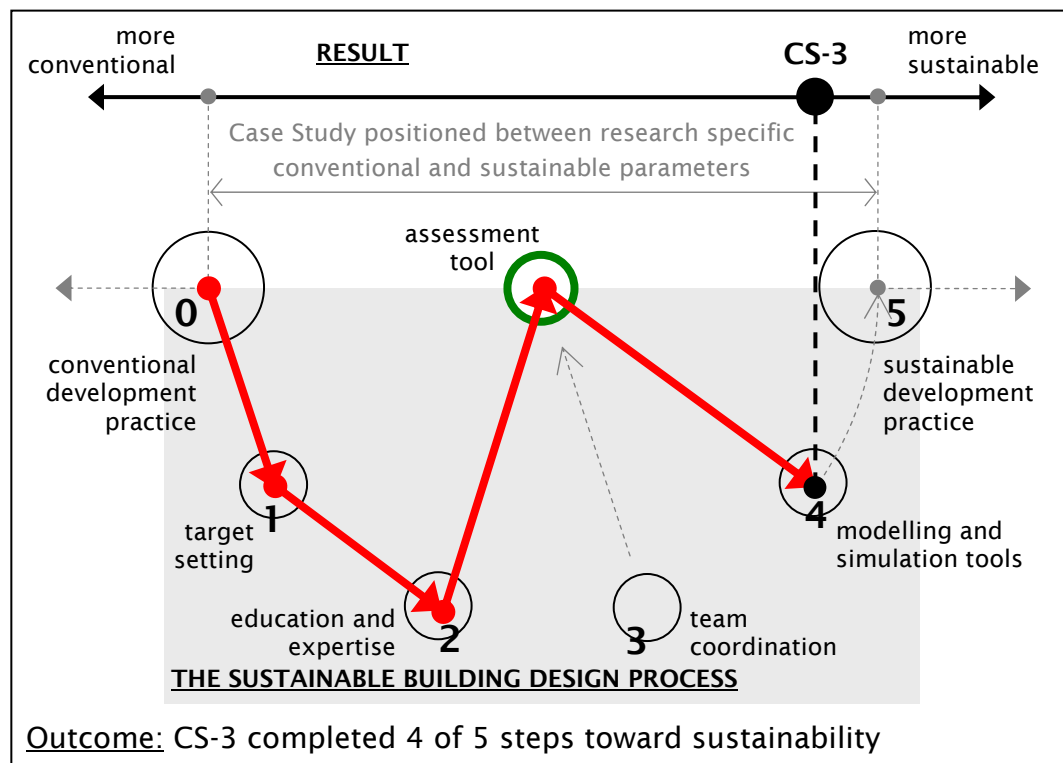


Figure 4.07 CS-3 design process mapped on the research framework

One of the interesting aspects that set this case study apart from the others, lies in the fact that the client was both the developer and occupant of the building. Therefore 'green' benefits that would provide long-term benefits to the occupant at increased short-term costs to the developer could be easier implemented because occupant and developer were one and the same. This is one way in which this obstacle as identified in the previous case studies can be resolved.

The final selected case study investigates the shift toward sustainability, use of an assessment tool in the design process and the client/developer/tenant dynamics are similar to the first two case studies. This building is widely recognised as a flagship for sustainable office buildings – it is the new Head Office for BP in Cape Town.

4.4 Case Study 4: new head office for BP

The new head office for British Petroleum (BP) is located in Cape Town, South Africa and was built in 2004. The building was developed by a commercial property developer for the tenant, BP, who had very specific sustainability objectives for their new premises.

Six architectural practices were invited to submit entries for the design of their new offices and KrugerRoos Architects's design was selected as the winning entry. The architects appointed Green by Design as sustainability consultants and entered into a BEE joint venture with Joshua Conrad

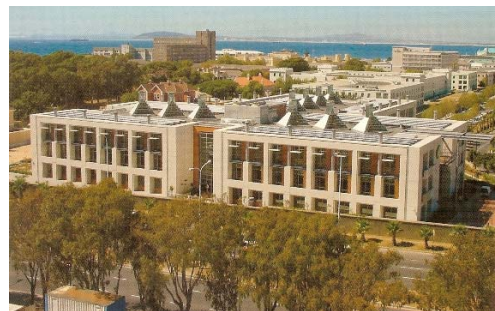


Figure 4.08 Aerial view of BP's Head Office (Noir and Roos, 2005:36).

Architects. Prior to the launch of the competition, BP appointed ARUP (London) to prepare a sustainability brief for the project. They developed the 'Resource-efficient design brief' (the RED-brief) which *"called for an environmentally-sensitive-building, addressing all aspects of sustainable and energy-efficient design"* (Digest of South African Architecture, 2006:136). Noir (2003:233) indicates that the early conceptual design of

the building plan “*resulted in a ‘finger’ configuration with the components of the building informing a ‘high- street’*”. Eventually the concept design of the building’s massing changed design of their competition entry was to develop a design framework where the actual design that followed was a building that was designed with the client’s participation. There are many unique sustainability features in this building, some of which are more easily recognisable than others. The prominent roof ‘lanterns’ allow light into the internal atrium/street and provide passive exhaust of warm air (Noir and Roos, 2005:39). The facades are particularly interesting in that they are composed of a ‘kit of parts’ which consists of light shelves, a glazed window section and a wall element. These components are placed in different compositions on the different facades based on their orientation to the sun, allowing light and shade where needed.

Other environmental features include the following:

- photovoltaic and solar water-heating panels are installed on the roof which contribute to significant energy reductions (compared to conventional);
- implementation of an environmental management plan during construction;
- indoor climate control which adapts to the extremes of the outdoor temperatures, allowing for use of passive extraction and economy cycles when possible;
- rainwater is collected from the roof and stored in a huge greywater storage tank which allows for the re-use of stored greywater for toilet flushing and irrigation in the dry summer months; and, finally,
- consideration for resource efficiency in the selection of materials.

Case study selection criteria

This project was chosen as the last case study, because it satisfies the following main case study selection criteria identified in Chapters 1 and 3:

- it is an Office building in South Africa where sustainability goals were considered in the design stage;

- it was possible to source primary research data through an interview with the architect(s) where the design process approaches taken in the project were discussed; and
- an assessment tool/framework was used in the design process to facilitate sustainability integration.

This case study satisfies all the pertinent aspects which the research aims to investigate. Similar to the previous discussions, the project-specific design approach, as well as the application of an assessment framework is examined and the process outcome towards sustainability is then mapped on the research framework.

4.4.1 The design process

Target setting

In addition to the brief's space and parking requirements, an important factor was the design's response to BP's 'beyond petroleum' culture (Darroll, 2003:30), which calls for a 'beyond the conventional' office environment – economically sustainable, innovative and resource-efficient.

At the point where the architects became involved in the project, other consultants had already prepared the 'resource-efficient design' brief for BP. This brief was commonly referred to as the RED brief, and had been compiled by ARUP. According to the architects, the brief included inter alia, socio-economic aspects of sustainability, influenced the selection of the professional consultants as well as materials, passive energy considerations for the building and also required the implementation of a building management plan/environmental management plan for contractors to be included in tender conditions. ARUP was not involved in the design process that followed and once appointed, the architects discussed the RED brief with ARUP in detail. In order to meet the stringent sustainability targets of the project, the architects decided to appoint an environmental consultant as specialist advisor to them and the consultant team. As such, the pre-design brief was adapted, developed and elaborated on in the process and project which followed.

Thereafter in conjunction with the environmental consultant, the architects summarised the RED brief into a reference document listing the building's efficiency requirements. This document was used throughout the design process to track and demonstrate to the team that all the target issues identified in the original ARUP brief, were addressed. A total of 49 target issues were identified; some of these consisted of (amongst others) energy, resource, materials use, water, disruption in construction, staff well-being, support of local industry, etc. Noir (2003:234) highlights some more of the main aspects of the brief, such as thermal zoning, response to local climatic conditions, roof as dynamic skin, solar benefits, cooling, indoor air quality, natural ventilation, thermal desk and cold ceiling as well as a Centre for the Environment.

Education and expertise

The architect indicated that everyone on the consultant team undertook extensive research work to incorporate the sustainability and efficiency measures in the building, e.g. for materials, energy use, etc. and they noted that they sometimes felt overwhelmed by the immensity of the task involved in addressing aspects they never before had come across.

In terms of the building finishes they had to determine what was sourced from a sustainable origin and decide what was most appropriate to use in the different applications. Sustainability targets were weighed up against cost and decisions were made accordingly, with trade-offs considered where needed, e.g. aluminium windows may be an expensive resource, but is one of the few window framing materials that can survive the harsh sea-side climate. And in another application, all the carpets in the building are recycled, even though they were quite costly.

Many design alternatives to meet the set sustainability targets were investigated, but not implemented. For example:

- in terms of cooling, the use of rocks for cold storage was investigated but it was realised that in the Cape region where the building is located the temperature differences between day and night are too narrow to use a rock store effectively;

- for water cooling, the team also investigated using sea water from the harbour sea basin, but opined that it may cause ecological disturbance because the harbour area is an 'entity', a closed system;
- eventually, the most appropriate design was the 'VAV' (variable air valve) air-conditioning system, which operates when additional heating/cooling it is needed and the specialised façade design allows circulation of air through the facades.

In other instances where specific design solutions were proposed that the team considered would contribute significantly to efficiencies, extensive additional studies were undertaken to prove to the client (i.e. both the developer and occupant) that it was economically feasible to implement. A good example is the construction of the 1,450m³ greywater storage tank. After the research and calculations had been done, the prediction suggested that only 20-25% of the water used in the building would be from municipal supply. A conventional building uses 100% municipal supply and the potential cost savings was sufficient to demonstrate to the client that it was worth spending the money to install the storage tank.

Team coordination

The architects explained that they experienced the design and coordination process as distinctly different from previous (conventional) processes. In this project they also led the team and performed the role of principal agent and coordinator, but instead of leading through prescription, the consultants rather played the leadership role and advised the architects what the different system design requirements were. Many coordination meetings were held where these systems were discussed and requirements of every discipline were incorporated into what became the eventual design. It was an inclusive, rather than a dictated process. Specific features of the building, such as the depth of the façade, the sizes of windows, the 'kit-of-parts' and 'lantern' skylights on the roof were all direct results of the interactive coordination.

In their role as coordination facilitator in an integrated design process, the architects are uniquely equipped to understand each of the respective

consultants' system requirements. In this manner, they are able to remain objective and focus their creative energy on identifying potential synergies between, what often appear to be, opposing goals of the different disciplines. The architects pointed out that by prioritising the targets on their reference list they were also better able to differentiate where their design attention should be focused. They made reference to the fact that confrontations between disciplines occurred in the coordination meetings because aspects in the different systems overlapped and in some instances interests clashed. Ironically, these circumstances were intensified by the short construction programme demands, but although the increased pressure could have contributed to team conflicts, it ultimately forced resolution and maintained the project momentum.

All consultants were also required to enter into joint ventures with BEE firms which addressed an aspect of socio-economic sustainability.

Modelling and simulation tools

The architects' skills as designer enabled them to integrate all the different system requirements and bring these together aesthetically. They explained that the brief required sensitivity to the historic urban context wherein the building was to be placed, whilst at the same time they needed to provide expression to the efficiency features. It was their responsibility to balance the aesthetic, so that it fits in on a historical level (in terms of window sizes, massing, etc.) with the subtle presence of the efficiency installations.

As explained earlier, the architects needed to understand each of the systems in the building so that they were able to identify potential synergies and make the final decisions where certain issues required resolution. Here the integrated design process can be seen as a critical design tool that aids decision-making.

In terms of design tools used, the architects' design decision-making process typically evolves from identifying what the design informants are, i.e. the client's needs (the accommodation list), the site

characteristics (topography, environment, etc.) and monetary parameters (cost, budget, etc.). Once these informants have been identified and defined, they develop a diagram which is used as tool to develop the specific building's design. They point out that other architects approach the design process entirely differently and that each designer's process is unique and subjective.

From the conceptual level, where the primary idea of the building came into being, to the detailed level of implementing specific sustainability targets, tools and calculations were used by the different members of the team to facilitate decision-making. Actual specifics of these tools were not available for inclusion here, but Noir and Roos (2005:41) make reference to the modelling exercises undertaken to demonstrate potential energy and water savings should certain systems be implemented. The slides included in Appendix B.4 show schematically the rationale behind the control of the building's indoor climate as well as the energy and daylighting design approach.

4.4.2 An assessment tool applied

Facilitating target setting

ARUP developed the RED brief to meet BP's 'beyond petroleum' objectives. As sustainability consultants, ARUP also developed an assessment tool, SPeAR which is discussed briefly in Chapter 2 of this document. In the interview with the architect it was not possible to determine whether ARUP used SPeAR to prepare the RED brief and an interview with ARUP fell beyond the research scope. From what could be determined ARUP's involvement in the project only extended to the brief development and initial briefing meetings with the architects.

The architects did not make reference to their use of SPeAR in their subsequent decision-making processes. However, the target list of 49 items prepared by the architects and sustainability consultant, seemed to be a very valuable assessment tool that facilitated decision-making throughout the design process. This document was used as a 'monitor'

or tracking document by the team throughout the design process to demonstrate that all the target issues/aspects required in ARUP's original brief were addressed. Unfortunately, neither the RED brief nor this target list was made available for inclusion in the case study documentation.

Integrated sustainability know-how

The target document developed from the original conceptual brief comprised of the following aspects:

- it illustrates what the indicator is,
- what the indicator's priority is,
- who on the team is responsible for achieving it, and
- who reviews it to verify that it was achieved.

Some of the 49 target issues identified were energy, resource, materials use, water, disruption in construction, staff well-being and support of local industry.

It is evident that the entire team, from project conceptualisation to implementation during construction, committed to the integration of sustainability in all facets of decision-making. The architects' target list was a synthesis of the original, abstract sustainability concepts, translated for implementation, which enabled the consultants to better grasp their role on the team, and also assisted enormously in the overall sustainable building process.

Facilitating coordination

The architect explained that the consultant team met continuously throughout the building's design process and with the use of the target list was able to track which of the indicators were achieved (in % ratings) in pre-contract, during contract and post-contract stages.

In this sense, the target list also assisted design process decision-making during project coordination, where, according to the architects, consultants were able to see how/where targets were achieved in the detailed implementation stages.

Relating with modelling tools

From what could be determined through the discussion with the architects, it seems that the target list (as assessment tool) provided direction to some extent in terms of what (e.g. energy/water use targets) should be pursued. As such, the detailed simulation and modelling calculations were done independently from the assessment process, although it seems that results from both processes were referenced to one another in decision-making meetings. An example of this is where the design targets of e.g. energy use show potential savings and the building systems were designed accordingly. Once completed, these aspects will be monitored and tested to verify that they were actually able to achieve the predicted savings.

4.4.3 Outcome

The design process approach and use of the target list as assessment tool in this project is mapped on the research framework in Figure 4.09.

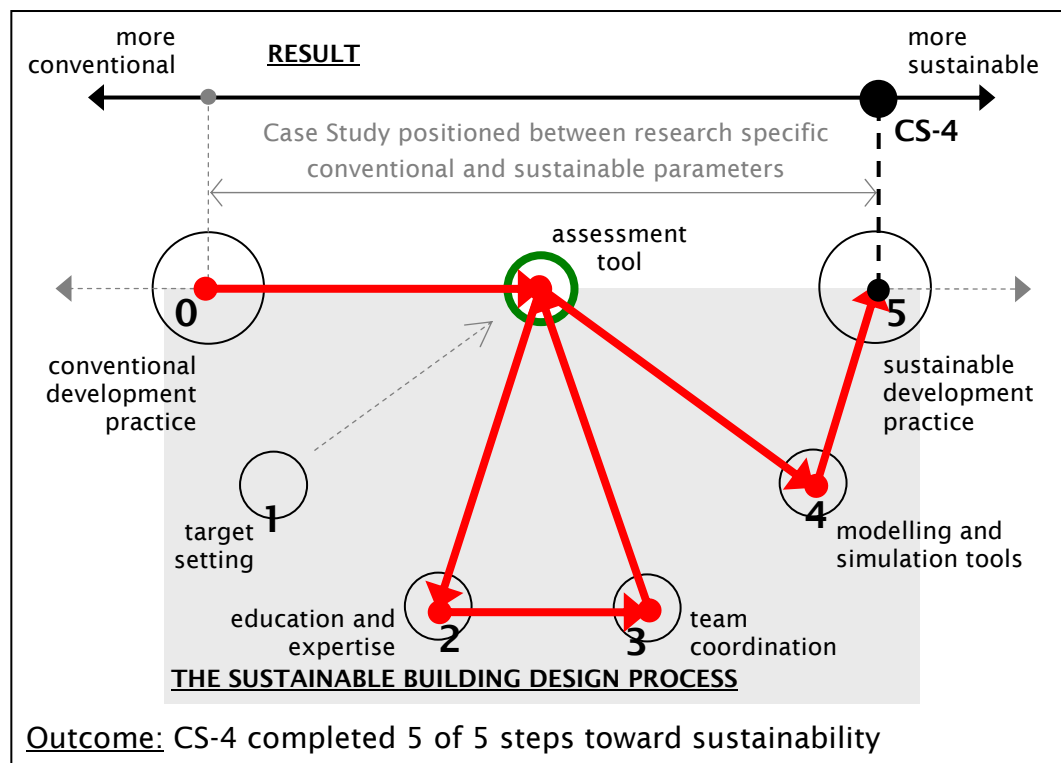


Figure 4.09 CS-4 design process mapped on the research framework

The process approach and can be summarised as follows:

- Sustainability considerations were integrated in the competition brief prior to the architects' involvement, possibly with the use of (or in reference to) ARUP's SPeAR assessment tool. These brief targets were later incorporated into a target list which was used as assessment tool throughout the design process to inform decision-making.
 - this process is mapped as step 0 to AT on the research framework and step 1 is 'skipped' where the targets were integrated in the assessment tools used
- Once the sustainability targets had been established, the design team undertook extensive research to meet the project's sustainability requirements. These investigations were conducted without the use of the assessment tools.
 - the next step on the framework is therefore mapped from AT to 2
- The coordination process in this project was truly integrated with the consultants working together and synergistically to arrive at optimal sustainability solutions.
 - this step in BP's design process is then mapped as step 2 to 3 on the framework
- During the integrated design process, the target list was used in coordination meetings to track sustainability progress and verify that these could still be met.
 - the next step is therefore mapped from 3 to AT on the framework, where the assessment tool is used for reference purposes, although the mechanism of the tool itself does not facilitate integrated coordination processes
- During detail design the team used design tools to model potential outcomes to meet development targets, where the assessment tools alone could not facilitate decision-making.
 - this step is illustrated from AT to 4 on the framework
- Having satisfied all the aforementioned critical criteria for sustainable building, this project has successfully completed the sustainable building design process
 - the final step is then mapped from 4 to 5 on the framework

In this case study, design decisions were similarly driven by cost and budget constraints as in other featured case studies. With the quantity surveyor's assistance and with shrewd selections of less costly finishes as alternatives to the conventional, the architects were able to still meet the client's aesthetic expectations, thereby covering the marginally increased costs of passive energy measures. In many instances the development targets indicated potential savings that could be made, thereby intrinsically providing an argument *for* the technology.

The architects also emphasised how the sustainability learning curve, through which they had gone on this project, was subsequently informing design decisions in some of their later projects, when these were at concept stage. Here the architects suggest that sustainability requires a different way of thinking about buildings, their layouts and façade treatment. They also observed that it has been their experience that clients are becoming willing to get involved in implementing sustainability goals.

4.5 Conclusion

The foregoing discussion described the pertinent characteristics of each of the case studies as they relate to the critical components identified in the investigative framework. Now we will look at how these compare to the theoretical parameters set by hypothetical Case Studies 0 and 5.



5 THE RESEARCH OUTCOME

In Chapters 1 and 2 the research context is introduced. The main problem identified, is that assessment tools fail to facilitate sustainability integration when applied in the conventional design process.

Contributing sub-problems surround facilitating sustainability integration, the nature of the conventional design process (as opposed to the sustainable design process) and the inherent issues and obstacles which exist in the application and mechanisms of assessment tools. In order to resolve this problem, the research argues that assessment tools fail to facilitate sustainability integration when applied in the conventional design process because they are not design tools. Sub-arguments which support the premise of this argument relate to how design tools facilitate sustainability integration, the constraints which exist in conventional approaches and substantiation of assessment tools' failed applications within the context of the research problem.

The case study method is introduced as approach to test the research argument. In chapter 3 an investigative framework is proposed wherein the relationship between the various sub-aspects of the research problem is illustrated. Theoretical parameters in the form of conventional and sustainable case study reference points are defined. Four selected case studies are introduced in Chapter 4. The discussion described each individual case study's design process approach and assessment tool application and mapped the outcome on the investigative framework.

To recap:

Case Study 0 (CS-0) did not move beyond the scope of conventional and remains at step 0.

Case Study 1 (CS-1) set 'green' development targets by, inter alia, using the internet. SBAT was later introduced into the design process, but the team researched 'green' design alternatives without the use of SBAT. The coordination process resembled conventional approaches and

consequently the overall sustainability outcome is shown as terminating at step 3.

Case Study 2 (CS-2) prioritised sustainability goals by using a green building checklist. Some sustainable development targets were implemented, with environmental input provided by the mechanical engineers. However, the lack of sustainability education undertaken in the sustainability process terminated the project's sustainability progress at step 2.

In Case Study 3 (CS-3), 'green' considerations were included in the initial project brief and the architects undertook their own research to develop 'green' strategies. Value-engineering workshops (VEWs) were introduced to develop synergistic solutions wherein all decision-making stakeholders participated. 'Green' technologies were implemented, but no simulation or modelling tools were used to verify performance outcomes. In this case study their progress toward sustainable development practice ended at step 4.

In Case Study 4 (CS-4), sustainability considerations were integrated in the competition brief, with its targets later incorporated into a target list that informed decision-making throughout the process. The design team undertook extensive research without the use of assessment tools and the coordination process was truly integrated. Throughout the decision-making process, the target list was referenced to track sustainability progress. Detail tools were applied to model potential outcomes. This case study completed all 5 steps toward achieving sustainable development practice.

In Case Study 5 (CS-5) the critical criteria in terms of targets, team, coordination and tools are met and these aspects are intrinsically embedded in the assessment tool used.

The combined results of all these case study outcomes are presented in Figure 5.01.

The following is an analysis of the outcome of each of the case studies *in reference to* the research theory in order to determine whether the

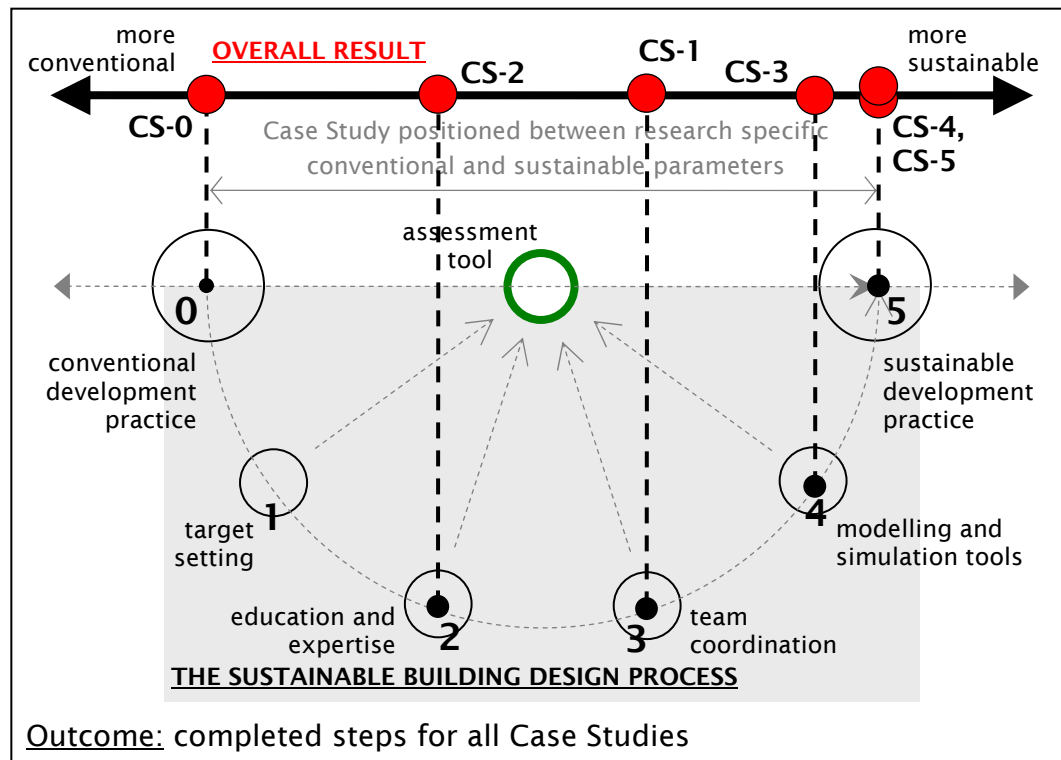


Figure 5.01 All case study outcomes mapped on the investigative framework

research argument is the correct justification for the identified research problem. Where the preceding chapter provided a data description of the case studies in isolation of one another, the following is an analysis of the data in terms of the four critical process components of targets, expertise, coordination and tools. Here the different approaches applied in each of the case studies are reviewed in reference to the theoretical parameters established in the hypothetical case studies.

5.1 Design process comparisons

5.1.1 Target setting

Outcomes of the hypothetical case studies

The theoretical parameters of Case Study 0 (CS-0) suggest that in conventional practice development targets are predominantly dictated by tenant needs, which are in turn largely driven by economics. These aspects are reflected in the building design's planning, function, layout and building component selection. Should a developer be involved to

guide target setting, then objectives to reduce costs play an even greater role. Typically social and environmental factors take a backseat to economic priorities in the CS-0 design process.

On the opposite side of the spectrum, the theoretical parameters set by Case Study 5 (CS-5) incorporate the whole range of sustainability objectives as is appropriate in the particular context of the specific building's design. Environmental targets are typically adapted to be regionally responsive and demonstrate a concern for the building's relationship with its contextual surroundings. Social priorities include (amongst others) an interest in occupant comfort, well-being and stakeholder involvement beyond the conventional (CS-0 in this case). Finally, the economic targets underline the premise of sustainable development, which recognises that all these factors are interlinked and synergistic if appropriately addressed.

Outcomes of the actual case studies

In Case Study 1 (CS-1), aspects of sustainability objectives were included in the development priorities from the outset. The architects' original 'High-Performance Green Building' characteristics are more environmentally than socially focussed. (To a large extent it can be assumed that the building's economic performance was implicitly implied as a foremost decision-making driver.) These development targets were further refined with the subsequent use of SBAT. The corresponding assessment outcome indicates a larger emphasis on economic and social factors, with lessened emphasis on environmental indicators.

Case Study 2's (CS-2) original development brief did not include any specific sustainability requirements although the developer and client (tenant) were open to and aware of the 'green' debate. The 'Green Building Checklist' was introduced as the design process developed, but in its application it appears that the sustainability targets were not taken significantly further than its initial concept. One of the concerns raised in implementing sustainability initiatives was related to costs. The architects explained that although life-cycle costs are salvaged during the

operational stage, those savings are not received by the party (i.e. the developer) who incurs the additional up-front costs.

In Case Study 3 (CS-3) the architect determined that it was appropriate to introduce 'green' philosophies to the client at the project's initiation. Although the client was open to implementing 'green' ideas, the architects experienced difficulties in finding appropriate 'green' technologies. This may have been largely due to the fact that in 1998 incorporating sustainability pursuits was quite uncommon, with limited sustainability knowledge and resources available. From the information that was gathered during the interview discussion it appeared that the development priorities focussed more on environmental factors with social aspects being concerned largely with occupant comfort.

The development priorities in Case Study 4 (CS-4) were determined even prior to the appointment of the project consultants and included conventional requirements that are economically sustainable within an innovative and resource-efficient office environment. The architects, with the assistance of their environmental consultant, developed the initial project targets into the RED brief of 49 targets. This brief included socio-economic aspects of sustainability; influenced the selection of professional consultants, materials, passive energy considerations for the building; and required the implementation of a building management plan and an environmental management plan during construction.

Summary

In the shift from conventional to sustainable development practice, the selected case studies each considered different ranges of sustainability targets. In all case studies the commitment to economic performance was paramount and interest in 'green' building was expressed, which set them all beyond Case Study 0's conventional theoretical parameter. And the tools used in three of the four case studies indicated that targeting social aspects of sustainability were also a priority. Generally, it appeared that the exercise of setting sustainability targets (with or without the use of assessment tools) was not perceived as a significant difficulty in the design process.

Other interesting issues also came to light which were not (and could not have been) defined in the context of the theoretical parameters.

Firstly, in the realm of ‘target setting’ the research is here only concerned with establishing whether it is possible to set sustainability targets and then how it can be done. Some of the questions which would follow in further research, would surround the ‘what’ and extent of targets set.

Another issue pertains to who bears the costs of implementing sustainability decisions. In both CS-1 and CS-2 the architects argued that it is difficult to convince a developer of the merits of long-term sustainable benefits, if the economic benefits cannot be realised in the short term whilst the developer is still involved in the project. In CS-3 this obstacle is naturally overcome when the developer is also the tenant and problems associated with increased short-term expenses are resolved by long-term operational savings. The team dynamics in CS-4 are similar to the first 2 case studies with both a developer and tenant involved. In CS-4 this issue is resolved through innovative decision-making and teamwork where other methods of achieving sustainability objectives are devised, without compromising the project budget.

Here the question emerges as to the role that ownership plays in integrating sustainability in the decision-making process, i.e. product ownership (the building as material/physical entity) and also process ownership (the moral/ethical responsibility to develop sustainably). It can be argued that ownership is also born from understanding issues, in this case sustainability issues. And understanding emerges from decision-makers’ knowledge of the issues and know-how of how to address these issues. This brings us to the next critical attribute, namely that of the design team’s education and expertise.

5.1.2 Education and expertise

Outcomes of the hypothetical case studies

Now that sustainability targets have been set, the design team is faced with the challenge of developing solutions to meet these goals. In the

theoretical parameter of the conventional Case Study 0 (CS-0), it is suggested that the team relies largely on its established knowledge base. Their scope is largely limited to the knowledge specific to their field of specialisation with the focus of addressing design challenges narrow-minded in comparison with sustainability approaches. Design solutions are generally drawn from tried and tested applications and previous experience. Little to no research is undertaken to develop new/innovative solutions.

In direct contrast, the design team's approach in the theoretical parameter of the sustainability Case Study 5 (CS-5) is open-minded and founded in a search for innovative, context-appropriate solutions. From project initiation the professional team either already possesses the necessary inherent sustainability knowledge, or they appoint an environmental consultant to facilitate their access to the relevant sustainability knowledge. In the ideal circumstances of this case study, the environmental consultant's sustainability abilities are merged with the architect's to further facilitate solution-generation through the integrated design process. This knowledge enables the team to provide a range of appropriate sustainable design alternatives when grappling with issues of how to address targets set.

Outcomes of the actual case studies

In Case Study 1 (CS-1) the architects noted that the major portion of their work is conventional in nature. It is their perception that sustainability is mostly driven by the client's objectives and that the 'green' agenda is generally set by the tenant/client. In CS-1, when the architects needed to address their client's development objectives, they first needed to educate themselves on what a 'green' building is and then 'how' those 'green' aspects are to be implemented. Here they mainly used the internet as a resource and referenced international examples of 'good practice'. From what could be determined the question of what constitutes 'good practice' was not explored in depth, with universal solutions of sustainable architectural components adopted (as opposed to adapted) where possible. Their 'green' definition made energy saving a

top priority and conserving (non-renewable) resources. In this stage of the project's development it seems that the initial targets were redefined when the solutions and their implementation was better understood.

The architectural practice involved in Case Study 2 (CS-2) is well-known for their conventional office developments. The architects noted that sustainability considerations are generally not included in the commercial development agenda. When discussing aspects surrounding research and implementation of sustainability objectives, they pointed out that in the interest of using their time most efficiently and cost-effectively, no resources are left to do additional (sustainability) research. In the design process of CS-2, the team largely took their sustainability direction from the mechanical engineers on the project who had some background on 'green' practices in their field of specialisation. The architects also pointed out that they did not feel that significant 'green' education was needed to prioritise the sustainability checklist items. But no further reference was made to additional sustainability research conducted to implement these sustainability priorities.

From project outset the architects in Case Study 3 (CS-3) were intent on designing a 'green' building, although they had not done one prior to this project. They had to start from scratch to source regionally relevant 'green'/sustainability material and commented on the extent of additional sustainability research that was required as well as the limited applicable resources available at the time. The architects took a rather pragmatic approach in implementing 'green' technologies by focusing on basic 'green' building principles e.g. in building's orientation, façade treatment and variety of ventilation systems. The architects also argued that the nature of the design approach is not scientific and that interpretation of scientific specifications is needed, which may inhibit the extent to which these can be realistically incorporated into the design if the knowledge is lacking.

In Case Study 4 (CS-4) all the team members understood the level of commitment to sustainability/resource-efficient targets and the architects confirmed that everyone undertook extensive research work in order to

meet project objectives. They also noted feeling overwhelmed by the immensity of the task of addressing aspects they had never before encountered. A wide variety of innovative design alternatives were investigated and extensive feasibility studies conducted to verify applicability. Sustainability targets were weighed up against cost (and vice versa); decisions were made accordingly with synergies/trade-offs agreed where needed and consequently many of these researched initiatives were not implemented.

Summary

There are again a wide range of approaches documented in responding to the decision-making team's education and expertise in the effort to develop more sustainably. Here the intent of the research is to determine whether additional sustainability research had been undertaken and all of the investigated case studies have. Some projects demonstrated a more dedicated approach to resolving sustainability issues, whilst others made a more intuitive reference to their understanding of 'green' aspects. Generally, it can be concluded that the depth to which sustainability research is pursued within each project, is largely dependent on the team's understanding of and their commitment to sustainability.

In one of the case studies, the targets were refined and to an extent redefined as the research and applicability investigation intensified. This illustrates an understanding of target achievability emerging through the research process which was not present in the initial target-setting stage. In another case study reference was made to the ability of setting targets without relevant sustainability knowledge. Here one would argue against making generalised/unfounded assumptions of what constitutes sustainable architecture as these lead to watered-down targets and reduced ability to implement sustainability measures that make a difference. As pointed out in one of the case studies: if no or only partial knowledge exists, then sustainability integration is more difficult.

Another enlightening outcome is again in reference to the issue of ownership. Generally, it seems that architects are more open to pursuing

sustainability objectives if these are client-driven. In these scenarios the architects take more of a reactive role in pursuing sustainability solutions. In being reactionary the critical sustainability learning that is required, cannot be facilitated and the repeated application of partial solutions and half-truths are only further perpetuated.

5.1.3 Team coordination

Outcomes of the hypothetical case studies

In the theoretical parameter of Case Study 0 (CS-0), the coordination process between decision-makers primarily serves the purpose of transferring information from one discipline to the other until all aspects of the building system are addressed. Typically consultants perform specific tasks which are confined to their particular discipline. The process is largely linear and sequential, with minimal interaction between disciplines.

Within the sphere of the sustainable design process, the coordination process between consultants in the theoretical parameter of Case Study 5 (CS-5) are markedly different. The coordination is founded in the integrated design process (IDP), which recognises the importance of equal and active participation between all decision-making stakeholders. The creation of synergies is welcomed in these scenarios as mechanism that facilitates innovative thinking. Furthermore, the inherent sustainability expertise which exists in the (sustainable) consultant team leads to further changes in the manner in which they think, interact and arrive at design solutions.

Outcomes of the actual case studies

In Case Study 1 (CS-1) the consultants were briefed about the sustainability/'green' objectives of the project. Each of the project consultants was encouraged to conduct their own research into the sustainability opportunities available within their respective disciplines and raised appropriate/feasible sustainability initiatives for consideration. An environmental consultant from the CSIR's Boutek team assisted in

providing some sustainability guidance early in the design decision-making process. According to the architects, some of the design shortcomings which were highlighted through the SBAT assessment had already been decided and could not be changed. The tenant was also invited to actively participate in the design decision-making process. In retrospect, the architects were of the opinion that the conventional coordination process is as integrated as the sustainability design process and that the success of coordination is dependent on the team leader and the nature of the communication within the team.

Different task responsibilities were allocated in the initial target-setting checklist of Case Study 2 (CS-2) and the project's sustainability goals were discussed in the early design and coordination meetings. When choices needed to be made between conventional and sustainable solutions, the quantity surveyor did cost comparisons exercises and within the (consequent) increase over (initial) costs for 'green' solutions, the team typically opted for the tried-and-tested and often more cost-effective, conventional solutions. Energy-efficiency initiatives were developed by the mechanical engineers to reduce the solar heat gain through the building's facade, thereby reducing energy costs. These examples suggest coordination process approaches similar to conventional, where disciplines largely work independent from one another, making decisions and transferring knowledge to the next team member once its has been resolved.

In Case Study 3 (CS-3) the architects were selected through an interview process and, once appointed, they recommended the project manager and other professional consultants to the client. Their selection was based on the identified core project needs, a commitment to 'green' building and demonstrated environmental awareness. From project outset, 'green' vs. 'low-tech' goals and objectives were discussed to determine what is practically achievable and economically feasible. As the decision-making process intensified, value-engineering workshops (VEWs) were introduced where synergies between disciplines could be recognised and all parties could contribute to realise the project's fundamentals.

The architects in Case Study 4 (CS-4) explained that they experienced the design and coordination process in this project distinctly different from previous (conventional) processes. In stead of the architect leading through prescriptions, the consultants were rather the ones advising what the different system design requirements were and the architects had to then in turn work around those. The mechanisms of the different building systems were discussed and debated at many coordination meetings, with every discipline's requirements contributing to the evolution of the design. The inclusive process approach of the meetings is demonstrated in some explicit examples in the eventual building outcome, e.g. the façade design, wind turbines, etc.

Summary

In three of the four investigated case studies the different coordination process approaches are all more integrated than is typical in conventional coordination processes. Of these three, in one it was argued that there are many similarities between conventional and sustainable coordination processes, claiming that an integrated approach is typical in both processes. Another case study noted a marked difference between conventional and sustainable coordination processes. In another, interactive coordination was encouraged and mechanisms (in the form of VEWs) were developed to assist in integrating sustainability in the design process.

It is commonly accepted that the IDP calls for significantly different coordination process approaches in comparison with conventional strategies. This is again underlined by the outcomes encountered in two of the described case studies. A possible explanation for noting similarities between conventional and sustainable coordination processes in the other case study could be that, even if a more integrated process was adopted, it was not perceived to be significantly different to previous process approaches and therefore not recognised as such.

Other aspects which also came to light are mostly related to the case study where the coordination process resembled conventional

approaches. In particular, it demonstrates that if the coordination process is not capable of supporting implementation of sustainability targets and know-how, the level of sustainability achievement is significantly constrained.

5.1.4 Modelling and simulation tools

Outcomes of the hypothetical case studies

In conventional Case Study 0 (CS-0) decision-makers use a variety of tools to develop and communicate their ideas. The typical tools in use by architects consist of presentation sketches, planning layouts, computer-generated drawings and details. In the engineering of building-specific services, a number of calculations are completed to design the building's systems. Generally, it is uncommon that an assessment of the design decisions is conducted to verify whether intentions meet targets, or whether predicted outcomes would actually be achievable.

In sustainability projects, such as is described in Case Study 5 (CS-5), the building's life-cycle impacts are of significant interest and here design teams use modelling software and simulation tools to guide decision-making, in addition to the conventional tools described in CS-0. The main purpose of modelling or simulating potential outcomes of decisions made, is to predict the potential building performance and make the necessary adjustments to meet the sustainability targets set.

Outcomes of the actual case studies

In Case Study 1 (CS-1), the architects described their design process approach as 'normal intuitive'. A particular line of decision-making (which was perceived as being appropriate) was back-tracked and tested against original principles to check that all/most aspects were addressed. In this type of back-and-forth exercise, they continuously verified decisions against initial targets. In some instances, basic calculations were conducted to size ventilation openings, but it appeared that many of the decisions were based on 'gut feeling' and not modelled. The architects also explained that many of the initially-envisaged 'green'

features were omitted due to feasibility and cost constraints as well as concerns relating to using untested products/technologies.

No other simulation/modelling tools (beyond the conventional) were applied in the second Case Study (CS-2). At this point in the design the architects largely depended on the mechanical engineers' analysis and calculations of determining the impact of heat gains on the façade and they provided input to the architects in sizing and specifying the appropriate glazing.

In the third Case Study (CS-3), no specific 'green' modelling tools were used. In Appendix B.3 the schematics illustrate details of the implemented 'green' technologies, which indicate the level of modelling that was considered to demonstrate air movement patterns, ventilation etc. through the building's interior spaces.

The architects in Case Study 4 (CS-4) elaborated a bit on their design method which evolved from an identification of design informants, followed by the development of a diagram which was used as tool to develop the specific building's design. They suggested that an architect's aesthetic skill should (amongst others) lie in integrating different system requirements. In this project, tools and calculations were used from initial concept to the detailed levels of implementation. The details of the simulation exercises were not made available for inclusion here, but countless references are made to the modelling exercises that were undertaken to demonstrate potential energy and water savings. Also, calculations and studies into sustainability initiatives were undertaken which were not implemented, e.g. rock storage (for heat), water cooling etc. Some schematic images of these are included in Appendix B.4

Summary

Overall all the case studies moved beyond the conventional in their approach to address sustainability objectives through calculations and modelling. In two of the case studies, reference is made to the calculations undertaken to, e.g. size window and ventilation openings. In

the other two case studies, the calculations had been taken a step further with schematic images indicating the intended sustainability initiatives. It was only in the latter case study where detailed calculations and modelling formed an integral part of the decision-making process, thereby demonstrating the rigorous attempts that were made to meet the initially set performance targets.

5.2 Comparison of assessment tool applications

5.2.1 Facilitating target setting

Outcomes of the hypothetical case studies

In Case Study 0 (CS-0), only conventional development targets were set and as such no assessment tools were used to consider sustainability aspects.

On the other hand, in Case Study 5 (CS-5) a specific type of assessment tool is applied to facilitate sustainability integration. Within the assessment tool is the wide range of outlined sustainability targets (economic, social and environmental). All the critical sustainability factors are listed, whereby project-appropriate sustainability priorities can be determined.

Outcomes of the actual case studies

In Case Study 1 (CS-1) the initial environmental targets were developed without the use of an assessment tool and only refined later when SBAT was introduced. These targets were largely focused on 'green' building aspects, which typically fall within the environmental category of sustainability. The SBAT tool covers all three categories of sustainability equally. In its application in CS-1, the assessment indicated low environmental performance in comparison to the social and economic assessment results. This could suggest that either the initial 'green' building targets were not carried through as had been intended, or that the assessment criteria are more extensive/rigorous than the design had originally allowed. The architects indicated that the graphic

representation of the SBAT outcome is easy to read, showing clearly where the design shortcomings lie and where the design focus should be if a more sustainable outcome is desired.

The green building checklist used in Case Study 2 (CS-2), is introduced as a form of assessment tool in the research context in that it facilitated setting sustainability targets and priorities in the project. The list is comprehensive in its sustainability scope, but lacks any quantitative/qualitative performance rating. Consequently, it is difficult to determine the extent of sustainability improvements, had all the targets been implemented. The manner in which the tool is adopted in this case study's design process is an example of the assumption that the assessment tool's checklist constitutes all the significant sustainability considerations and therefore the rating of criteria could be deemed irrelevant. The architects furthermore indicated that, although constraints in integrating sustainability objectives were encountered (beyond that of the tool), a few of the sustainability targets were eventually incorporated into the design.

In Case Study 3 (CS-3) the project goals and 'green' targets were derived from reference material sourced by the architect at the project's concept stage, without the use of an assessment tool. As such, no checklist was compiled or available to indicate what sustainability targets had been set. Rather than using a list of performance aspects to address, certain 'green' building concepts were pursued, which, in totality, would result in sustainability performance improvements. Only once that design process was underway were value-engineering workshops introduced as a way to evaluate the synergies and trade-offs between certain design decisions.

In Case Study 4 (CS-4), independent consultants developed a resource-efficient design (RED) brief, which was included in the original competition specifications. It is not clear to what extent SPeAR was used, but it is likely as this tool was referenced as it was developed by the independent consultants. Once appointed, the architects developed a target list of 49 items which facilitated decision-making throughout the

design process. This list was not made available for perusal in the study, but considering that it focused on resource-efficiency, it can be assumed that a heavier focus was placed on environmental performance. This target list was used as 'monitor' or tracking document throughout the design process, to assist in decision-making, thereby successfully facilitating sustainability integration.

Summary

It is not the purpose of the research to identify constraints within the specific tools used, but rather in their *application* in the design process. However, constraints within the tools themselves impact the manner and ability to which these successfully facilitate decision-making.

In three of the four case studies, the checklists within assessment tools were used to assist in sustainability target-setting. Of these, two of the checklists addressed the economic, social and environmental aspects of sustainability explicitly. It can therefore be concluded that in the majority of the investigated case studies, the assessment tools successfully facilitated sustainability target-setting.

Other aspects that came to light, beyond that of facilitated target-setting, relate to the requirements of tools to provide an assessment rating (whether prescriptive/performance based, or weighted score), to assist teams in identifying where the sustainability improvements would have the biggest impact.

Another aspect relates to the question as to whether delivering on a checklist actually constitutes sustainability, i.e. if checklist criteria are addressed, is the outcome then sustainable? With the abstract/subjective nature of design decision-making, the manner in which checklist criteria are understood and applied, varies significantly in its different application contexts. Therefore, the answer to the question is probably 'more or less', because a measure of knowledge and understanding is required to address checklist targets. This brings us then to the next critical attribute of decision-makers' education and expertise.

5.2.2 Integrated sustainability know-how

Outcomes of the hypothetical case studies

In Case Study 0 (CS-0), no assessment tool was used. By excluding sustainability objectives, no additional education and expertise (beyond the conventional) was conducted or required.

The successful application of an assessment tool in Case Study 5 (CS-5) suggests that the tool provides the mechanisms whereby the required practical sustainability know-how can be referenced and accessed. From target-setting, this aspect in the tool provides reference to sustainability databases, case studies as well as potential design strategies that can be employed to meet objectives. For the tool to successfully facilitate sustainability integration, the requirements here are that the generation of project-appropriate design alternatives are enabled. The value of using an assessment tool here lies in being able to assess the outcomes/impacts of different design alternatives to assist in the selection process.

Outcomes of the actual case studies

SBAT was used in Case Study 1 (CS-1). The tool provides some sustainability guidance through its criteria notes, but nothing more than general sustainability information as relevant to the respective categories. To use SBAT, the architects were introduced to the tool in an in-house workshop presentation and they also did the initial assessment. The architects pointed out that, although the tool successfully communicates where the environmental shortcomings lie, they were at a loss as to how to design more sustainably. The sustainability research process which followed, took place outside the realm of the assessment tool's application.

The assessment capabilities of the checklist tool used in Case Study 2 (CS-2), only went as far as allowing the team to prioritise sustainability objectives and even this process was largely informed by subjective project goals. As a checklist, the tool lacks the depth to convey any sustainability know-how beyond stating *what* range aspects would

constitute sustainability in the building. The '*how*' can therefore not be addressed with the use of the tool and no further reference is made to sustainability research undertaken.

No assessment tool was used in Case Study 3 (CS-3) and therefore there was no formal assessment/feedback process in place to guide the research exercise. With the introduction of value-engineering workshops (VEWs), a mechanism was provided whereby the merits of the sustainability solutions/overlaps within the different disciplines could be debated.

In Case Study 4 (CS-4), indicator categories were incorporated into the interpreted version of the RED brief, which indicates its priority level and the main party responsible for achieving indicator requirements. In this sense the target list serves as guideline, but it is not that sophisticated in its provision of pertinent sustainability knowledge. In order to source and develop appropriate design alternatives the architects and decision-making team had to find solutions without the use of an assessment tool.

Summary

The tendency to rely on assessment tools to provide sustainability guidance beyond target-setting, may be inappropriate. However, if the tools are to successfully facilitate sustainability integration, this is a critical requirement for any tool that is used in design. In the discussed case studies, the tools largely lack the mechanisms whereby design alternatives can be accessed. Consequently, the proposed solutions are not comprehensively assessed and therefore no awareness exists as to the extent that prioritised targets have been met. Furthermore, the understanding which could have emerged from the sustainability research, is also inhibited.

5.2.3 Coordination guidance

Outcomes of the hypothetical case studies

In the theoretical parameter of the conventional Case Study 0 (CS-0), the coordination process is linear, sequential and exclusive of sustainability

considerations beyond the economic. No assessment tool is used in this process, nor is there any assessment/feedback procedure in place to assist in coordination.

On the other hand, the comprehensive sustainability assessment tool, as it is applied in the design process of sustainability Case Study 5 (CS-5), would offer direction as to the nature and extent of the consultants' input that may be required during decision-making. The sustainability assessment tool provides guidance in the following ways: it indicates ...

- the different roles and expertise that may be required in the team
- where and when it is required in the decision-making stages
- potential synergies/trade-offs that may exist between disciplines

Here the assessment tool goes beyond its role of performance assessment by providing coordination/team interaction guidance, thereby further facilitating sustainability integration. The aspect of facilitating team effectiveness through enhanced expert input is, to some extent, further improved.

Outcomes of the actual case studies

In Case Study 1 (CS-1), where SBAT was applied, it was not used beyond its target-setting capabilities. The tool does not incorporate the mechanisms that are required to facilitate decision-making during project coordination. No reference is made to the range of different disciplines and stakeholders which may be required in the team, nor does it indicate which of the sustainability sub-categories are affected by the different disciplines.

The responsibility categories of the 'green' building checklist used in Case Study 2 (CS-2), are shown as single discipline action items.

Although it was established in the design process discussion that the team's interaction was limited in terms of facilitating multi-disciplinary discussions, it is still noteworthy that the checklist incorporated this aspect as a critical requirement when attempting to address sustainability objectives.

In Case Study 3 (CS-3), where no formal assessment tool was used, the mechanisms of the value-engineering workshops (VEWs) introduce interesting components into the possible requirements, which tools may need to incorporate should they be focused on facilitating the design process. The very purpose of VEWs was to facilitate coordination between the different team members. When specific design decisions were required, which involved a range of disciplines, all the decision-making factors were listed and each team member had an opportunity to rate their importance of the (opposing/synergistic) factors in respect to one another. The outcomes of these ratings were then debated in the VEWs until a decision could be made that was most beneficial for all parties. This process provided a mechanism whereby all persons' voices were heard equally and disciplines were valued equally in respect of one another.

In Case Study 4 (CS-4), the consultant team met continuously throughout the building's design process, to facilitate a truly integrated decision-making process. The architects pointed out that, throughout this process, the target list (wherein the team's responsibilities were listed) was used to track which indicators are achieved and when. Here the additional columns of % completion provided the assessment capability of the tool to further assist in facilitating coordination in the process of integrating sustainability.

Summary

One could argue that it may not be reasonable to expect that an assessment tool should provide coordination guidance, that that is not the purpose of an assessment tool. This argument is partly correct, but when assessment tools are being applied in the design process to assist in facilitating sustainability integration, the manner in which the tool assists decision-making within the team becomes relevant.

In conventional processes the architects are already overwhelmed with trying to achieve sustainability and, amongst the other constraints identified thus far, the lack of coordination guidance is another obstacle that they need to overcome.

At least three of the four case studies specifically identified the scope of the consultant input that was required and allocated responsibility roles accordingly. The latter two case studies went a step further by adding an assessment capability to the manner in which the consultant input was managed. In one of the case studies, this assessment capability was focused on the content of the sustainability aspect that was being investigated where decision-making priorities were rated within each of the disciplines. In the other case study the assessment capability was focused on tracking achievability of the target throughout the decision-making process.

5.2.4 Relating with modelling tools

Outcomes of the hypothetical case studies

With the lack of specific sustainability objectives, Case Study 0 (CS-0) did not apply any sustainability modelling/simulation tools, nor were any sustainability assessment tools introduced.

In hypothetical Case Study 5 (CS-5), the sustainability assessment tool correlated with the modelling/simulation tools that were used during the design process, so that the assessment outcomes provided feedback in respect of the design predictions.

Outcomes of the actual case studies

In Case Study 1 (CS-1), the design's assessment process was more intuitive with informal 'rule of thumb' applications. No sophisticated sustainability design or simulation tools were used. The assessment capability of SBAT is largely based on simple percentage calculations, where an increase of a specific strategy (whether in more reductions/savings) provides a higher rating. The relationship then between the calculated/simulated result and the assessment result is rather straight-forward, although it was not pursued to that extent in CS-1.

The scope of the checklist used in Case Study 2 (CS-2), is limited and not developed to accommodate simulated/modelled data. And with the

calculations undertaken in the design process by the mechanical engineers, no reference was made to the assessment procedures taken so as to verify whether designed systems would meet predicted targets.

The value-engineering workshops (VEWs) in Case Study 3 (CS-3), were introduced as assessment tool in the research context due to the manner in which their outcomes were evaluated in the VEWs (albeit intuitively) in relation to the original development targets that were set originally. But no reference is made to the manner in which the modelled designs were assessed, to determine whether they meet the initial sustainability objectives of the project.

In Case Study 4 (CS-4), the target list provided direction to some extent on what sustainability performance measures would be pursued. Detailed simulation and modelling calculations were done independently from the assessment process and the results were then checked against the initial targets in the decision-making/coordination meetings. An example of this is where the design targets, of e.g. energy use, show potential savings and the building systems were designed accordingly. This indicates that a mechanism (however rudimentary) was in place to provide the necessary assessment feedback to determine whether certain design strategies would be able to achieve the intended results. The architects also noted that, once completed, these aspects will be monitored and tested to verify that they were actually able to achieve the predicted savings.

Summary

In the investigation of the relationship between assessment tools and modelling/simulation tools, it became evident that, in addition to the required use of modelling tools to achieve sustainability, assessment capability is just as critical. The data generated through modelling or calculation exercises mean nothing to the design team if not evaluated. To be able to make appropriate sustainability decisions, the team needs to be able to determine how the design outcomes relate to the design intent. In at least two of the four case studies, this link between assessment and modelling tools was understated or non-existent.

Another aspect that became apparent is related to the connection between predicted and actual outcomes. In the design processes investigated here only predicted outcomes are evaluated. The modelling tools predict outcomes of different tested scenarios and the assessment tool would provide the reporting mechanism where the team could identify the most optimum predicted solutions. Feedback is still critical, in that the actual outcomes of the intended designs need to be gathered to verify how accurate the predictions were.

5.3 Conclusion

This discussion has highlighted how the design processes and assessment tool applications in actual case study outcomes compare to those of the hypothetical case studies. The final chapter will now conclude how these research outcomes relate to the research argument that had been proposed in the first chapter.



6 CONCLUSION

6.1 Research approach

6.1.1 Aim and intent

The problem and argument

In Chapter 1 the research context was introduced with, a brief discussion of the design process as it is positioned within the realm of the comprehensive construction cycle and the time aspects of sustainable construction. Four components of differences between conventional and sustainable design processes were identified: in setting targets, decision-makers' education/expertise, team coordination and the use of tools. Then the role of assessment tools was discussed within the realm of sustainability principles as it encompasses the scope aspects of sustainable construction. The theoretical framework illustrated that sustainable design practice takes place at the junction where design processes and assessment tools overlap.

Brief scenarios of assessment tool applications in the design process were discussed with problems identified in the attempts at facilitating sustainability integration. Furthermore, obstacles were noted in design processes, particularly in conventional process approaches that constrain sustainability integration. And, finally, constraints were identified in assessment tools, in their inherent characteristics when attempting to communicate and translate sustainability outcomes. These three components and the relationships between them, form the crux of the research problem, which states: **assessment tools fail to successfully facilitate sustainability integration when applied in the design process.**

In order to resolve this problem, a research argument was proposed to provide a mechanism that could be investigated through the research process. Within each of the identified sub-problems, sub-arguments were posed to substantiate as to why the problem exists. It is argued that assessment tools fail to successfully facilitate sustainability integration

when applied in the design process **because they are not adequately adapted to serve as sustainability design tools**. Here again three sub-arguments are provided to qualify why the problem(s) exists. In particular, the argument is that successful facilitation of sustainability integration is complicated, constraints exist in conventional design process approaches and current assessment tools lead to sub-optimal outcomes in their application in the design process.

The research context

From this proposition a literature review was undertaken in Chapter 2 to better understand the informants that impact the research context. The discussion started with a look at the first aspect of the research problem/argument, namely that of facilitating sustainability integration. Aspects surrounding building performance, intrinsic and extrinsic considerations and how these are addressed in design and assessment were discussed. The concept of a building as a system within systems and life-cycle approaches were reviewed. This process was undertaken to come to an understanding of the current 'conventional', business-as-usual approaches and how facilitated sustainability integration could transform these concepts into sustainable development.

Following this, the second component of the research problem was considered and the details of the design process were investigated. Here again the four components of target setting, decision-makers' education/expertise, team coordination and the use of tools were considered. Differences between conventional and sustainable development practices were discussed, as were aspects which inform decision-making, such as the nature of the development team, their coordination process and the role of the architect. Greater focus was placed on the building product or architecture being created with a look into what design is, tools that architects use and how sustainability is/can be integrated in this process. This aspect of the discussion concluded with two summary tables highlighting the critical attributes in both conventional and sustainable design processes.

Assessment tools were reviewed in the final component of the literature review. Firstly, their appropriate application environments were questioned, with a look into what assessment objectives are, which tools provide design advice, aspects surrounding forecasting/feedback for sustainability and how these outcomes are/should be communicated. A brief overview was given of some of the better-known assessment tools that are currently in use. Focus was placed on their application environments, availability, accessibility, basic frameworks and level of expertise that is required to use the tools. This discussion concluded with a summary table highlighting the critical attributes of a sustainability assessment tool as it relates to the four design process components.

6.1.2 Strategy

The research method

In order to resolve the research problem and test the argument, the case study method was selected as appropriate approach. It facilitated gathering data of current practices in a real-life context. As the design process is the aspect under investigation it was decided that interviews with decision-makers would form the critical component of the primary data. And in order to limit and manage the scope of the investigation, it was argued that architects represent the decision-making team and therefore only architects would be interviewed.

From this point, case study selection criteria were developed and appropriate case studies were identified. Private sector development and the office building type were selected as the construction industry example to be reviewed. The projects under consideration also needed to have considered aspects of sustainability in their initial project objectives and, if possible, have applied or referenced assessment tools to facilitate sustainability integration. Eventually, four case studies were selected, and these were reviewed in the research investigation.

An investigative framework

But, with the case study method, other research constraints arise such as dealing with the unique characteristics of each of the case studies and sources of information. An investigative model/framework was developed to assist in the research in a few ways. First, it enabled clarification of the research problem and the complicated relationships that exist between the sub-problem components. And secondly, theoretical parameters were developed in the form of hypothetical case studies (conventional and sustainable design processes) against which the case study outcomes could be measured. Thereby a 'pattern' was created and points where the pattern matched supported the research argument, whereas other outcomes either negated it or shed new light on the problem.

The framework was devised to illustrate the shift from conventional to sustainable practice and the role that sustainability assessment tools (can) play in facilitating this shift. The four design process components are mapped on the framework and show the stages from target-setting to (sustainability) education/expertise, team coordination and the use of modelling/simulation tools. In each of the case study reviews the different project characteristics are discussed as they pertain to these four design components. Two paths, or combinations of these two paths, are mapped: the 'shortcut' route illustrates where/how assessment tools facilitate sustainability integration and particularly in the extent to which they relate to the design process components. In the 'detour' route, where no assessment tools are applied, these design process components are dealt with as the process of moving toward more sustainable development practice unfolds. In some cases the assessment tools are only used for parts of the way and therefore the paths move between the 'shortcut' and 'detour' route. In other cases, evaluation methods, which facilitate sustainability integration, are introduced during the process. In these cases, these methods represent critical attributes which would further enhance the role of assessment tools in the design process.

6.2 Research analysis and interpretation

6.2.1 Data discussion

Theoretical parameters

In Chapter 3 the investigative framework is introduced. Two hypothetical case studies are discussed and their outcomes mapped on the framework, to illustrate where they are positioned in the shift toward more sustainable development practice.

Case Study 0 (CS-0) represents typical conventional design process approaches. The project characteristics are broadly generalised to arrive at a reference point at the one end of the research spectrum. Here the design process did not shift toward sustainable development practice, as no such objectives were proposed at project initiation. No assessment tools were used and the outcome indicates that the project did not move beyond the conventional development practice point on the framework.

The sustainable design process is introduced as Case Study 5 (CS-5) and is located on the opposite end of the spectrum, having successfully addressed all the critical attributes within the realm of the sustainable design process. In this case the (sustainability) assessment tool that was used successfully facilitated sustainability integration in the way that it related to the four identified design process components. Mechanisms within the assessment tool could provide design guidance at critical stages and levels of the design decision-making process.

The actual case studies

Chapter 4 follows with a similar approach in the discussion of each of the actual case studies and their outcomes. Here the different design process approaches, as they pertain to the four identified components, are discussed. The role of assessment tools, checklists and related evaluation methods are also reviewed in the discussion and their respective outcomes mapped on the research framework.

Case Study 1 (CS-1) most closely conformed to the established case study selection criteria. 'Green' building targets were set at project outset and an assessment tool was used to assist in integrating sustainability objectives. The team undertook additional sustainability-oriented research and embarked on a coordination process which was more or less integrated. No detailed modelling/simulation tools were used by the architects in their final analysis. SBAT was used to a certain extent, but its application was less successful as the decision-making process unfolded. The resulting outcome on the research framework at point no. 3 (team coordination) indicated that the project did not move beyond the coordination process in its shift toward more sustainable practices.

The approach in Case Study 2 (CS-2) followed a similar route, in that sustainability objectives were prioritised at project outset and a checklist assisted in the target setting process. In the discussion with the architect, insightful project characteristics were noted, which shed more light on the issues surrounding sustainability integration and these will be further discussed in the next section. The checklist was included as a type of 'assessment tool', in that it provided the team with some level of sustainability guidance in the design decision-making process. The team researched some 'green' building solutions, but, from what could be determined, there were no further shifts toward sustainable development practice in their coordination approach or in the use of (sustainability) modelling tools. This outcome is accordingly shown as coming to a close at point no. 2 (education and expertise) on the investigative framework.

Case Study 3 (CS-3) was introduced as a case study even though no formal assessment tools were used at the project outset to facilitate sustainability integration. In this case the project commenced with the 'detour' route taken in addressing the target-setting and education/expertise components. During the coordination process value-engineering workshops (VEWs) were introduced to assist in decision-making. The use of VEWs was included in the research framework as addressing an aspect of the (sustainability) assessment tool. Consideration is given to sustainable building system features, although

these were not modelled beyond concepts and therefore the project result is positioned at point no. 4.

The last case study, Case Study 4 (CS-4), is included in the research as an example of sustainable development practice. Although this project did not follow the straight-forward 'shortcut' route to get to that point (i.e. point no. 5 – sustainable development practice), it did take 'detours' in the way components of assessment tools were addressed and also in its approach to design process steps. A resource-efficient design brief was developed with sustainability targets set. Extensive sustainability research was undertaken by the decision-making team and the coordination process between disciplines was integrated, with much interaction taking place. Amongst others, modelling tools were used to assist in predicting possible performance outcomes.

6.2.2 Findings

Target setting

In the reviewed case studies, the process of setting sustainability targets seemed reasonably straight-forward with none of the teams indicating that significant difficulties were encountered. Different types of assessment tool checklists were used by the teams to assist in this process. Within the realm of sustainability, economic factors still play a prominent role, but focus is then also placed on 'green' or environmental aspects. Social aspects were also considered and applied (sometimes with more success than the environmental initiatives) although these may not have been pertinently addressed as a goal at project outset.

The foremost research interest here was to determine that, if sustainability objectives were considered at project outset, whether that was enough to motivate the project process to go beyond the realm of sustainability. The next level of this enquiry, which fell outside the scope of the current research, would be concerned with the extent and depth of sustainability targets set.

Furthermore, the issues of responsibility arose which posed the question: on whose shoulders does the responsibility of implementing

sustainability initiatives lies? The teams generally believed that the client's commitment to sustainability gave the project the necessary critical go-ahead to embark into the uncharted territory of sustainable design. But this leaves sustainability objectives in the hands of building owners. It was argued that architects and decision-makers, as the true creators of the buildings, have as important a responsibility in furthering the sustainability cause.

One also wonders whether realistic target-setting is possible if the sustainability understanding is lacking. As the designs were being realised, the teams rationalised many of the targets set, in a sense realigning the sustainability objectives with the direction the project was taking. In some cases sustainability goals were abandoned and in others they became more refined. This is a result of the reiterative nature of the design process. But what is revealing here is whether checklist-type target-setting is actually the appropriate approach when attempting to integrate sustainability. In a way the checklist merely points out where the sustainability 'holes' in the project are and that, by attempting to merely check those items off in isolation, the holes become blocked. This process inhibits identification of the connection that exists between the holes and more importantly, what caused the holes. It is only through an understanding of the holes that the intricate web of interdependence between all these sustainability concepts can be exposed to give rise to true synergistic sustainable solutions.

Education and expertise

As indicated, the aspects surrounding the decision-making team's extent of sustainability knowledge have profound impact on its ability to set realistic targets. In all of the case studies, the teams embarked on some level of research (some more intensive than others) in their attempts to achieve these targets. None of the assessment tools had inherent mechanisms whereby this research process could have been facilitated. In fact, the tools were more or less abandoned whilst the sustainability research was undertaken.

It was concluded that the extent to which sustainability was pursued, is largely a result of the team's sustainability knowledge. Simply put, 'one cannot do, if one does not know how to'. However, and in all fairness, it became evident that in many cases the architects lacked the necessary resources (such as time, money, skills) to responsibly address these issues even if they had wanted to. This aspect is another critical constraint that was identified in the outcome of the research.

Delving into the details as to what constitutes sustainability knowledge and know-how, fell beyond this enquiry. Further investigation should be focussed on some of these identified obstacles, e.g. how sustainability know-how is published, whether the information is accessible, useable and how the issue of resources can be suitably addressed in the design process.

Another aspect that has bearing here, but rose to beyond the scope of the research, relates to an individual architect's skills as designer and creator. Some architects are simply more innovative and inventive in developing sustainability solutions than others. This aspect also touches on the subjective nature of design enquiry which makes objective assessment problematic. It is difficult to measure sustainability and even more challenging to determine categorically whether sustainability integration was successfully facilitated.

Team coordination

Generally speaking, the building design coordination process requires participatory involvement by all decision-makers and looking at each process in isolation would generally lead one to think that all coordination processes are naturally integrated. However, it is only when coordination processes are compared with one another that the differences in levels of integration become evident.

The research interest here lay in determining whether the foregoing sustainability target-setting and search for sustainability education/expertise, changed the manner in which consultants related to one

another. In half of the case studies, the changes (from conventional approaches) were markedly different, whereas in the others it was less obvious.

In this category of the design process, the different assessment tools related to their team's coordination approach in different ways, each highlighting required critical features if an assessment tool was to successfully facilitate sustainability integration. One tool made no reference to what consultant expertise was required, or where, although their coordination process revealed integrated characteristics. Two of the tools highlighted team responsibilities as part of the target-setting process with one of the tools adding tracking and team-monitoring capabilities in coordination. Another tool introduced interactive workshops whereby the decision-making process between team members was documented in simple Q&A format. In a way one could argue that in most cases the different process approaches drew these requirements from the tools. Consequently, these characteristics are identified as critical assessment tool attributes for integration to be successfully facilitated.

Modelling and simulation tools

The use of sustainability modelling and simulation tools calls for a deeper understanding of sustainable concepts and it is in this aspect that the true achievability of initial targets is revealed. Some of the case studies made general reference to engineering calculations, some demonstrating more rigour than others in dealing with the sustainability considerations. In only one of the case studies detailed calculations and modelling exercises were undertaken to assist in the decision-making process. In this case study, the assessment tool was also used to assist in decision-making by comparing and continuously referencing the calculated performances with the initially set targets. In the other case studies, if the assessment tools referenced specific performance targets, no relationship became evident between the modelling tool data and their potential assessed outcomes.

Another aspect that also requires further consideration relates to the team's involvement in the project beyond the building's contractual completion. Although the installation of building monitoring systems is common, the generated data is rarely (if ever) used by the design team to verify whether initial design intentions and predicted outcomes have actually been realised in the building's operation. The aspects surrounding feedback is another critical component that has been identified in furthering sustainability success.

6.2.3 Summary

To this end it has been clearly demonstrated that the research argument is supported by the case study outcomes. Assessment tools fail to successfully facilitate sustainability integration when applied in the design process because they are not adequately adapted to serve as a sustainability design tools. The main purpose of the research was to determine how assessment tools could be transformed into design tools to ensure that they succeed in facilitating sustainability integration in the design process. The manner in which the case studies worked around the flaws in the assessment tools demonstrated that critical attributes were dysfunctional or absent. But the case study investigations also demonstrated that constraints exist in the design process approach, especially for decision-makers whose expertise is founded in conventional development patterns. The argument here is again that in these types of scenarios the transformed assessment tools would be better suited to successfully facilitate sustainability integration in (conventional) design processes.

6.3 Final thoughts

6.3.1 Constraints in the investigative framework

It has to be clearly understood that the results mapped in the investigative framework demonstrate the actual case study outcomes in relation to the hypothetical case studies, as defined within the boundaries of the theoretical parameters. Therefore, if a case study satisfied all the

criteria then this means that it has met all the requirements to qualify it as 'sustainable development practice'. Therefore all the outcomes are relative to that with which they are being compared – all case studies shifted beyond the conventional and are in the process of shifting towards more sustainable development.

The components of target setting, education/expertise, team coordination and modelling/simulation tools were furthermore identified as the features which most broadly covered the characteristics of the design process. These aspects also formed the building blocks of the investigative framework which created the lens through which the case studies were viewed. These views, in effect the case study 'results', are therefore a product of the inquiry definition which may have excluded particular project merits (such as aesthetic or architectural achievements) of the different case studies reviewed. But again, the factors informing e.g. aesthetics or architectural quality were not the focus of the research. Further investigative processes may identify other components in the design process (such as sustainability responsibility, level of commitment, access to required resources, aesthetics, site characteristics, etc.) which also have a significant impact on the success of sustainability integration.

Finally, the investigative framework is rather simplistic in its current definition and does not take cognisance of the depth to which each of the design process components were addressed. By introducing a mechanism whereby this aspect could be accounted for, a more accurate result of a case study's design process could be determined. The framework components are also evaluated in sequence, with the one coming before the other in a linear fashion, thereby assuming that with each category a different level of depth is entered as the design evolves. But, as was noted previously, the very nature of the design process is iterative and therefore this aspect is also not currently demonstrated within the mechanisms of the framework.

6.3.2 Comparing case studies

Just a final word on some of the research outcomes which were not covered by the research argument, such as resources, responsibility, comprehensive coordination guidance and the provision of feedback. These aspects were noted in the respective case study discussions and outcomes, although not specifically emphasised in the context of the research problem.

As the case study method dictated, diligence was required to consistently reference the case study outcomes *to the established theory*, rather than opting to compare the different case studies with one another. Each case study is unique and conclusions, which are drawn from subjective interpretations, may not be accurate. However, the similarities/overlaps in some of the outcomes, which arose to extend beyond the research argument pointed to interesting aspects (such as the client's agenda, managing budget costs, etc.) which also contribute to the complexity of the research problem.

6.3.3 Moving forward

If sustainability pursuits are to become more successful, the following aspects would need to be addressed (or resolutions need to be developed):

- conventional development objectives need to align with sustainable development objectives so that synergies, rather than trade-offs, are dealt with;
- sustainable development objectives need to be uniformly adapted as a development priority within the decision-making team;
- conventional applications are tried, tested and more economically feasible and here reliable, cost-effective sustainability alternatives need to be developed to replace wasteful conventional practices;
- where the tenant benefits in the long-term from sustainability performance improvements paid for in the short term by the developer, simpler 'cost transference' mechanisms need to be implemented where the developer can be compensated by the tenant for these improvements;

- this also raises the point of enhancing measurement capabilities of soft issues (often social benefits) to also demonstrate these performance enhancements.

The outcomes that are highlighted in the research and above, point to interesting avenues for further investigation. Inter alia,

- in dealing with the depth of issues and applying tools in appropriate contexts, Lollini et al. (2005:4077 – 4084) has proposed a procedural methodology for using simulation tools in the different stages of the design process and suggestions by Robert et al. (2001:197 – 214) may be useful as well;
- in the context of adapting existing assessment tools to address process requirements, Kaatz et al. (2005:1776 and 2004:8) calls for building enhancement tools;
- for further insights into operational feedback, BRE's post-occupancy evaluation (POE) and Post-occupancy Review Of Buildings and their Engineering (Probe) studies (various authors, Building Research & Information, vol. 29 (2), March-April 2001) would be invaluable.



APPENDICES

A Interview Guide

MArch Synopsis	M Jani Loots
MARCH RESEARCH PROJECT: BACKGROUND	
Prepared by:	M Jani Loots
Student no.:	0112682K
Supervisor:	Dr. Daniel K. Irurah
	School of Architecture and Planning, WITS
Date:	June 2005
PROPOSED RESEARCH TITLE	
<u>Integrating sustainability in architecture: informing design decision-making processes through consideration of building performance assessment outcomes</u>	
SYNOPSIS	
The research project is concerned with the relationship between building performance assessment tools ('outputs') and design decision-making processes ('inputs') for the integration of sustainability in architecture. Historically, assessment tools were developed to determine and report on the environmental impacts of buildings with specific aims at understanding wasteful operational practices (e.g. in waste management, energy and water use). Over time these environmental assessment tools have developed to include the related social and economical aspects that are relevant to the more inclusive issues of sustainable development. Assessment tools consist of all the building blocks that constitute the relevant consideration aspects of sustainable architecture and as such they are further applied to facilitate design decision-making processes. The research project is concerned with the nature of the problems/solutions that arise out of this type of 'cut-and-paste' method where outputs from one scenario are applied as inputs in another (though similar) scenario. For various reasons sustainability goals are rarely incorporated into conventional development processes and thus destructive construction practices persist. Considering the sustainability knowledge that exists through assessment procedures and the possibly more beneficial outcome that can be achieved at early sustainability integration, the relationship between assessment tools and design processes become important. In order to fully understand all the related issues surrounding this relationship and the specific focus of this research project, the respective roles and purpose of assessment tools and design processes in conventional development practices need to be considered.	
KEYWORDS AND RELATED RESEARCH ASPECTS	
Sustainability, architecture, design decision-making processes, building performance assessment tools, project life-cycle, forecasting and back-casting strategies, feed-forward and feedback procedures, construction industry, South Africa	
June 2005	

Figure A.1.01 Interview Guide (p.1)

MArch Synopsis	M Jani Loots
PROPOSED RESEARCH PROBLEM AND ARGUMENT From the foregoing discussion the <u>main problem of the study</u> can be identified as follows – <i>constraints exist in the transference of sustainability knowledge gained through the application of building performance assessment tools into conventional design decision-making processes</i> The <u>main argument of the research</u> is that, as a consequence – <i>these constraints hinder the successful integration of sustainability goals into conventional design decision-making processes, further perpetuating unsustainable development practices</i>	
RESEARCH STRATEGY Qualitative research methodology using case studies scenarios for comparison: conventional, in transition and sustainable	
Identifying sustainability obstacles: assessment models applied <u>International examples:</u> - assessment tool applied as design tool - using tool: facilitatory, benefits, strengths? - new learning: IDP, time, knowledge, other? - bridging the gap - e.g. White Rock Operations Building (LEED) ... (BREEAM) – specialist constraints? - Arkitektur-og-miljø (BEAT interpreted) <u>South African examples:</u> - assessment tools (SBAT/SPeAR) applied as design tools - using tool: facilitatory, benefits, strengths? - new learning: IDP, time, knowledge, other? And bridging the gap - e.g. ... (SBAT – SB04 winners – CSIR?) - Spier (SBAT?) - BP Headquarters (SPeAR) – specialist constraint - Design for sustainability (SBAT interpreted)	
Identifying sustainability obstacles: design process - clients and developers: is there a business case for sustainability in construction? - practising architects: conventional approach, pro-active and expert - general aspects for interview questions: - sustainability agenda → what drives brief? - integrating new knowledge: process(es) adopted → on-going learning? (conventional) design tools in use → repetitive or exploratory?	
June 2005	

Figure A.1.02 Interview Guide (p.2)

MArch Synopsis M Jani Loots assessment tools consulted → are they of any use? typical project process → linear, integrated consultation, changing? personal role in team → principal decision-maker, design ownership? In terms of <u>conventional design and project processes</u>, the following research questions arise, with regard to – • <i>project scope</i> - What intrinsic/extrinsic performance aspects are typically considered? • <i>professional team dynamics</i> - Do the respective disciplines work in isolation? What is the nature of the co-ordination processes? Are they sequential? - Is there knowledge transfer between disciplines and do these processes typically support the creation of synergies? - How is new knowledge integrated into existing processes? Are 'proven' solutions repeated or tested and improved? • <i>forecasting and feedback procedures</i> - What design methods/tools are typically used by the professional teams to facilitate decision-making? - What kind of forecasting strategies used to predict possible outcomes of design decisions? - Are feedback procedures in place that communicate decision outcomes and are professional teams generally aware of the actual outcomes of decisions made at design stages? In terms of <u>building performance assessment tools</u>, the following research questions arise, with regard to – • <i>assessment tools currently in use</i> - What assessment tools are commonly used? - What is the nature of the assessment tools: are they easily accessible and easy to use or is specialist input required? • <i>assessment procedures</i> - Actual buildings: why are assessments carried out? How are the outcomes of the assessments handled – in what type of forum are the results published or communicated and to whom? - Predicted buildings: why are assessments carried out? Do the assessment tools facilitate design decision-making? If so, how? • <i>assessment reports</i> - Are the reports in summary format, graphic and/or descriptive? - Are the reports easy to understand or is a certain level of interpretation required? Do the reports consist of the technical substantiation needed to provide credibility to design solutions? - Do the assessment reports communicate the connection between design decisions and their related assessed outcomes? - Are the reports different for the different stages of the development? June 2005

Figure A.1.03 Interview Guide (p.3)

B Case study data

B.1 Case Study 1: DST office building

Checklist

Description	Data avail.	Comments
Project background <u>Consultant team:</u> client (owner/tenant), developer professionals other (specialists, users etc.) Development objectives Brief, grade, size, location, value?	 √ ? √ ½ s x	 Client tenant + developer Not available For SBAT Toward sustainable Not available
Summary of interview <u>Design and project process:</u> project scope professional team dynamics forecasting, feedback procedures <u>Assessment tools:</u> assessment tools in use assessment procedures assessment reports	 √ √ √ √ √ √	 SBAT in early design stage
Drawings, photos etc.	√	Primary
Data from Assessment tools SBAT done for SB04	√ x	

Interview Notes, Abbreviations etc.:

Built 2005

The following documentation of the interview is not a word-for-word transcription, but rather a summary of the discussion between interviewee and researcher, organised in bulleted form under appropriate headings as relevant to the research topic.

<i>'in italics'</i>	words written in italics with quotation marks, were the actual words of the Architect
[in brackets]	words written in square brackets are notes which have been added by the researcher for clarification purposes

Abbreviations:

DST	Department of Science and Technology
SBAT	Sustainable Buildings Assessment Tool
CSIR	Council for Scientific and Industrial Research

Summary of Interviews:

20050318 – BILD & Terra Ether Architects:

Project background:

- trade-off in marrying commercial objectives and incorporating sustainability objectives
- initial project brief included the promotion of sustainability objectives
- thereafter architects compiled the 'High Performance 'green' Building' list of targets to determine what they'd like to achieve (i.e. lower-tech issues)
- tools used to set targets: background reading through internet browsing, viewed general input aspects (some American and Australian examples); based target-setting on 'good practice'
- use of SBAT tool was introduced via the CSIR (the DST building is located on the CSIR campus)
- SBAT tool presented and explained to Architects at workshop (morning session in Architect's offices) by CSIR Boutek specialists
- architects did preliminary assessment of building using SBAT
- thereafter a coordination meeting was setup with the CSIR Boutek specialist to *'fill in the gaps'*
- CSIR Boutek specialist conducted own assessment of design using SBAT to look for innovation opportunities
- use of SBAT: definitely helpful in highlighting sustainability consideration points although problematic that it has merely a reporting function

Building and design characteristics:

- building site is a disturbed 'green'/brownfield site: rock dumped
 - intention to retain natural/indigenous vegetation wherever possible
 - powerlines overhead across portion of site – steer clear in terms of building's position
- parking basement: on grade and cut at back with natural ventilation provided
- aesthetic requirements:
 - express a sense of science and technology (reflect occupation of intended tenants of building)
 - architectural language to tie into that of existing architectural language of surrounding buildings
 - North/South orientation of office wings with 10,2m spans between column allow for open plan office space, less cellular spaces as per tenant requirements
 - corporate street acts as communal space that tie wings of offices together, opportunity for interactivity between staff members where meeting rooms draw people from offices into communal spaces
 - strong wall element on west façade gives building identity toward highway, i.e. the face of the building towards the city of Pretoria
- corporate street houses all the public functions (e.g. exhibitions) with the common space that provides the vertical break between security zones
- Department of science and technology houses natural and bio sciences as well, not only pure sciences – interactive west wall draws 'pure' science (i.e. man-made) into natural surroundings of landscape
- office wings: all floor levels between the blocks are on the same levels
- end-user participation: briefed and closely involved, making presentations to tenant staff members to facilitate their involvement with new building

'Green' design aspects:

- features: light scoops (or light shelves) and punched windows on North façade at cellular offices

- background research aspects: 3 months period available to design, develop and incorporate 'green' features
- fast track programme: internet useful resource, although not comprehensive
- life-cycle costs discussed with client where appropriate in decision-making process
- west façade: aluminium frame with 'solarvue' glass
- central heating points in building
- adjustable lights and lightfittings
- rainwater re-used in toilets and stormwater attenuation pond to collect rainwater to irrigate landscape
- water supply routed in single pipe system with (shuttle) valves to drive to Fire/Water as required
- where possible, local materials were sourced with preference for non-toxic products in finishes specified
- considerations at the construction stages:
 - specifications and documentation encourage participation in waste management, training etc. with a 40% black economic empowerment component across the board
 - invited tender with pre-qualification process: 5 contractors selected to tender in order to qualify for sustainable aspects that need to be integrated in the design
- considerations at the operational stages:
 - for Internal Services ('developer'): recycling waste possible
- landscaping:
 - formal/urban toward side of building and entrance facing CSIR buildings
 - natural landscape (incl. enhancement of existing) toward SW views and highway traffic

Consultants' recommendations:

- electrical: energy-efficient lighting
- structural: investigate fly-ash alternatives to Portland cement

- mechanical: possibilities to switch between ‘passive’ and mechanical ventilation systems; natural ventilation extract fresh air from outside when no cooling is needed
- investigate evaporative cooling: drawbacks of dust and humidity to overcome

Facilitating future learning:

- architects now more aware of aspects to look out for when designing next building
- incentives: kickbacks provided from Eskom for operational savings

20050728 – BILD & Terra Ether Architects:

[follow-up interview to discuss in what way assessment tools facilitated the design process, obstacles encountered and how these can be overcome]

Implementing design decisions:

- decisions have been made, now in process of implementing them
- one aspect succeeded in getting into building: energy saving light fittings – very expensive, persuade client by demonstrating long-term benefit (mostly from electrical engineer’s directive) – large amount of power savings in long term: ESKOM kickbacks/incentive to save + rebate on bill
 - 26 different types of lightfittings: electronically controlled and most are energy-saving
 - movement sensors in room – lights switch off automatically
 - light sensors measure level of natural light in room – through seamless dimming mechanisms lux levels remain constant throughout day
 - light shelves incorporated which brings natural light further into building’s deeper spaces – aid in reduced requirement for artificial light

Role of SBAT:

- concept of building designed by BILD, design requirement from CSIR and DST that ‘green’ building – show ‘modern’ techniques, called in CSIR Boutek

- SBAT used upfront to set targets, never used thereafter
- closer to completion of building, architects may go back tool to see how targets have been met
- tool more facilitating with different aspects [i.e. sustainability design considerations] in the beginning

Discussion of aspects related to research objectives:

- research argument: assessment tools don't succeed as design tools – they tell one *what* to do, not *how* to do it
 - architects agree – normal and 'good' practice to incorporate 'green' aspects
 - objective not to find completely new and innovative technologies: rather use products and technologies that are in the market and have been tested to know that architects are specifying things that will work and that will benefit the tenant and client in energy savings
 - technology application in this way not necessarily client-driven, but perceived as 'good' design practice

'green' technologies:

- water use: collecting rainwater – reuse in toilets and urinals, tank in basement and pumped through building
- fire and water mains joined – cost-saving in single pipe system
- materials used: avoid toxic where possible; fly ash (not aware if implemented)

Integrating sustainability:

More robust integration of sustainability technologies: if architects had another brief, how would they implement 'green' technologies or how can they (as architects) facilitate the process better to see more integrated outcomes?

- depends largely on client – in this building because DST (tenant) wanted 'green' whereas CSIR (developer) were driven by cost, which created obstacles for integration of 'green' aspects
- budget limitation: from developer's side they could see the possibility of spending '*a fortune*' to get the 'green' side right, but would not

have paybacks initially that they wanted, so 'green' technologies were not incorporated

- where architects argued long-term benefits: could convince client [developer] on lighting whereas other areas more conservative, *'going back to what they knew'*
- think that [sustainability integration] depends very much on client – if client more open-minded then much more easy to convince them to achieve higher levels of 'green' or sustainability

Building design aspects:

- majority of building 'traditional office wings' (60 – 70% of building) whereas 'corporate street' is different/special in this building that gets natural ventilation: here are 'green' things – went extra mile to ventilate, light, temperature controls in this portion of building with a give and take where to use the money
- 10,2m clear span between columns allows flexible floor plan which can be laid out in any way with 'saturated wired' in ceiling void allowing for distribution of points in any location on floor

Treatment of west façade along corporate street:

- designed automatically adjustable blades to screen façade as sun angle changes
- design principle: did not want to use small window openings on west façade, rather remove office wings away from west façade and use communal space of corporate street to shelter the work spaces from west sun with a naturally ventilated void and screened façade whilst retaining views
- west façade becomes important and strong design feature which provides identifiable character to the building
- design of passive ventilation system with water feature at bottom of wall:
 - draw air across from outside to create cooling effect, passive ventilation system within atrium
 - 'not really calculated' – they knew how much air they needed to provide and calculated in a way that they knew what size of openings were needed to get air movement through there; but no

exact measurement of the way the air would be cooled or to what degree – the systems works in principle and any cooling effect in that atrium space would only aid in its ventilation

- o air movement principles not based on wind direction, but natural ventilation, i.e. 'passive' ventilation
- o sprays introduced at bottom to further cool air – same principle, know air will cool, it will work, bit not to what degree or to what extent
- certain amount of spillage of mechanical ventilation from office wings into corporate street – these features all aid in ventilating corporate street without needing to install additional mechanical ventilation

Ventilation system:

- centrally ventilated mechanical system: normal supply/return air that pumps air through space with chillers located on roof
- windows openable for cleaning, but not for natural ventilation purposes; it was considered, but consultants advised against: not appropriate in climate (high temperatures and high humidity in summer) – works better in low humidity scenarios (same consultants cited other examples/ experiences where windows open and indoor temperatures are very uncomfortable – not adequate cross ventilation)
- according to architects cross ventilation also problematic in high humidity areas where cross ventilation works with evaporation
- in the end client [i.e. developer] selected mechanical ventilation in office wings: compromise from passive ventilation point of view
- consideration of seasonal changes to mechanically ventilate when temperatures are most severe: 'monitor' built into air-conditioning ventilation system where e.g. cool air pumped from outside without chilling air where possible (energy saving advantages)

Interaction between consultants:

Research argues that conventional process where consultants work in isolation + sequential fashion of coordination process: architects comment that it is a theoretical argument that the sustainable process is different

- coordination process relies wholly on team leader – consultants' gave participation in full with '*incredible spirit*' in group: if communication works well, then project goes well
- where consultants work in isolation, they talk to one another by passing info back and forth and a problem can arise: team dynamics depend on team leader and has nothing to do with the sustainability process
- the theory is that in the sustainability process one now has to get everybody involved, but it is the architect's experience that in every normal project (no matter what it is) one has to do that anyway
- also technology supports closer interaction – email greatly facilitates ease of coordination and distribution of information
- meetings: more formalised coordination process, meeting once a week with structural engineer and every 2nd week with mechanical + electrical engineers
- ad hoc meetings as and when required with landscaping and plumbing consultants (e.g. greywater principles were set out by a consultant in beginning of project and architects followed them through)
- at beginning: meeting to brief all consultants of project objective to 'go 'green', go sustainable' and each consultant in his/her professional capacity did what they could in their discipline
- architects received positive feedback from all consultants in attempts to incorporate 'green': mechanical and electrical were all proactive to look at ways to implement 'green' technologies
- overall opinion: worked out well, has been a compromise between corporate street passively ventilated and office wings mechanically ventilated

Environmental consultant's role:

How was team advised on sustainability aspects?

- research argues that a obstacle in integrating sustainability is that environmental consultant is not part of 'core' consultant group: architects agree – in this project environmental consultant was not intricately involved

- however, core team still pursued sustainability objectives and assessment tool highlighted aspects decided on already, non-negotiable aspects (from concept stage) that needed to be considered as well
- in a sense many of the concept stage 'green' targets were rationalised back into SBAT to demonstrate compliance at detailed design stages when SBAT was brought into the process
- normal intuitive design process: architects have a sense that they are doing the right thing, then go back and test against principles – as in any design process: one thinks *'this is going to be a good idea'*; it is not a straightforward step-by-step process, one makes decisions then go back to principles to check that the answer is correct – a bit more of one, less of the other, each building has components of this and is different in its own way
- architect's toolbox/kit of parts: SBAT helps with target setting and shows that development objectives were on the right track, but design solutions were given 'intuitively', *'from own knowledge'*

Moving from conventional to sustainable:

- how to overcome obstacles of 'difficult to go 'green'': more of a challenge than an obstacle – it has to do with a mindset
- working through 'green' thing – people are more open/into 'green' with much publications of 'green', wanting to get into 'the 'green' thing', *'more of a prestige thing'*, *'responsible thing to do'* – architect feels that this is also where the normal, 'good practice' aspect comes in
- most difficult thing to convince client and quantity surveyor of life-cycle benefits, i.e. *'by spending more money now, they're actually going to benefit in the long-term'* that is very difficult – they look at initial returns in feasibility studies to decide where to give go-ahead

Developer-client-tenant relationship:

- architect agrees with research comment that the developer is the client to consultant team but that the tenant puts down building specifications which lead to disjuncture in achieving project objectives

- architects want to satisfy tenant requirements whilst addressing cost constraints and brief parameter of their own client (i.e. the developer)
- architect adds that it is also an issue that the tenant is only paying rent (which should not be too much) and wants nice-to-have's, without being concerned with building returns
- leverage aspect lies in negotiations between tenant and developer where increase in building cost results in additional nice-to-haves
- in this building also separate budget where 'tenant' budget refers to project add-ons requested by tenant, over and above that of initial cost of building – mostly with respect to finishes, electronic equipment

Project scope:

- social aspects
 - CSIR's campus location easily accessible with public transit
 - provision of canteens etc. with emphasis on good staff interaction between all levels (from minister to cleaner) which dictated design
 - didn't want workers cooped up in office wings – through introduction of corporate street with communal services (pause areas, meeting rooms, toilets) in semi-public area coming from office into big open space, could promote intended interaction
- contractor's bills of quantities – black economic empowerment component in CSIR's development agenda for this project
- recycling component, waste management, high embodied energy materials etc. (specifically under construction) – attempted incorporation, not really carried through

Feedback and forecasting aspects:

- SBAT assessment will be conducted of building – architects '*a bit nervous*' about outcomes though, but think that they've '*done pretty well*'
- also performance of building will be continuously monitored – performance is displayed to the users on plasma screens throughout building and picks up with electronic, lighting (dimming, on/off etc.) and building management system (which controls the air-conditioning system) to monitor 'living' aspects of building

- architects expect that tenant will educate users in terms of what building can do – from building functioning to individual use (e.g. furniture etc.)
- architects reasonably comfortable that technologies will perform as expected, although these performances are more on the respective consultants' side (and they are confident)

Design tools:

- using the internet for design advice, i.e. what are others doing to implement sustainability: mostly sourced from America, some from Australia
- some building features drawn directly from that search: e.g. light shelves
- all very well to say that building needs to be 'green', but architects had to find out what a 'green' building is to start off with and then 'how' to implement those things
- what did 'green' mean in this building, for DST? No.1 is energy saving (through light fittings, mechanical ventilation, water) and all aspects relate back to energy saving (e.g. light shelves assist in reduction of artificial light) objectives in order to save resources

Implementing sustainability in the next building?

- having gone through process already, it is now a lot easier; although architects are always a bit nervous about these things, i.e. not knowing
- even if not asked to go 'green', architects may advise clients because it's the responsible thing to do – one has to start looking at [the availability of] global resources: sustainability implies that once sustainability has been 'set up', one will limit the use of outside resources

Using SBAT:

- architects will refer to SBAT in next project as it is a good checklist and very useful to set targets, because one can see graphically where you are – it is always easier to see if shown graphically, otherwise one doesn't really know if you're getting there (i.e. meeting targets)

- SBAT is easy to read and easy to see on the graphic where shortcomings are and where focus needs to go to make improvements
- difficulty lies in implementation however – it is easy to set targets, but to implement them in line with the client's expectations (brief and cost) is another thing [obstacle]
- difficult also to police sustainability incorporation – architects have to rely on other people with different values (e.g. contractor doesn't have same appreciation for natural landscape, it is seen as 'a piece of veld' that can be used for temporary site offices, rather than preservation)
- responsibility of others not closely under architect's (as principal agent) control – architects try to get through with reasoning and think that others understand, but if the need increases, then the [sustainability/'green'] argument is ignored and they do whatever they want

DST Offices – Green Building Checklist

<u>PROPOSED NEW DST PROJECT – CSIR CAMPUS</u>	
HIGH-PERFORMANCE GREEN BUILDINGS	
1.	"Reducing the impact of development on the natural environment".
2.	"Sustainable design and development is good design".
3.	"A successful high-performance Green Building is achieved through a Team approach by setting Project goals". Step 1: Develop a vision statement. Step 2: Develop goals that reflect the vision. Step 3: Develop the goal(s) into defined, achievable design criteria. Step 4: Prioritize the design criteria.
4.	"Sustainable design recognizes the Building's relationship to and impact on the larger context of Community and Region" by: ▪ Site selection and Site systems. ▪ Enclosure systems - Thermal comfort - Visual comfort ▪ Mechanical systems- Thermal comfort - Indoor air quality ▪ Interior systems - Functional and spatial criteria - Acoustic quality - Lighting systems ▪ Selection of building materials.

Figure B.1.01 *DST Offices – green building checklist (BILD Architects, 2005b:1)*

Design drawings and photographs



Figure B.1.02 DST Offices – aerial photograph of site and proposed building overlay (BILD Architects, 2005a:3)

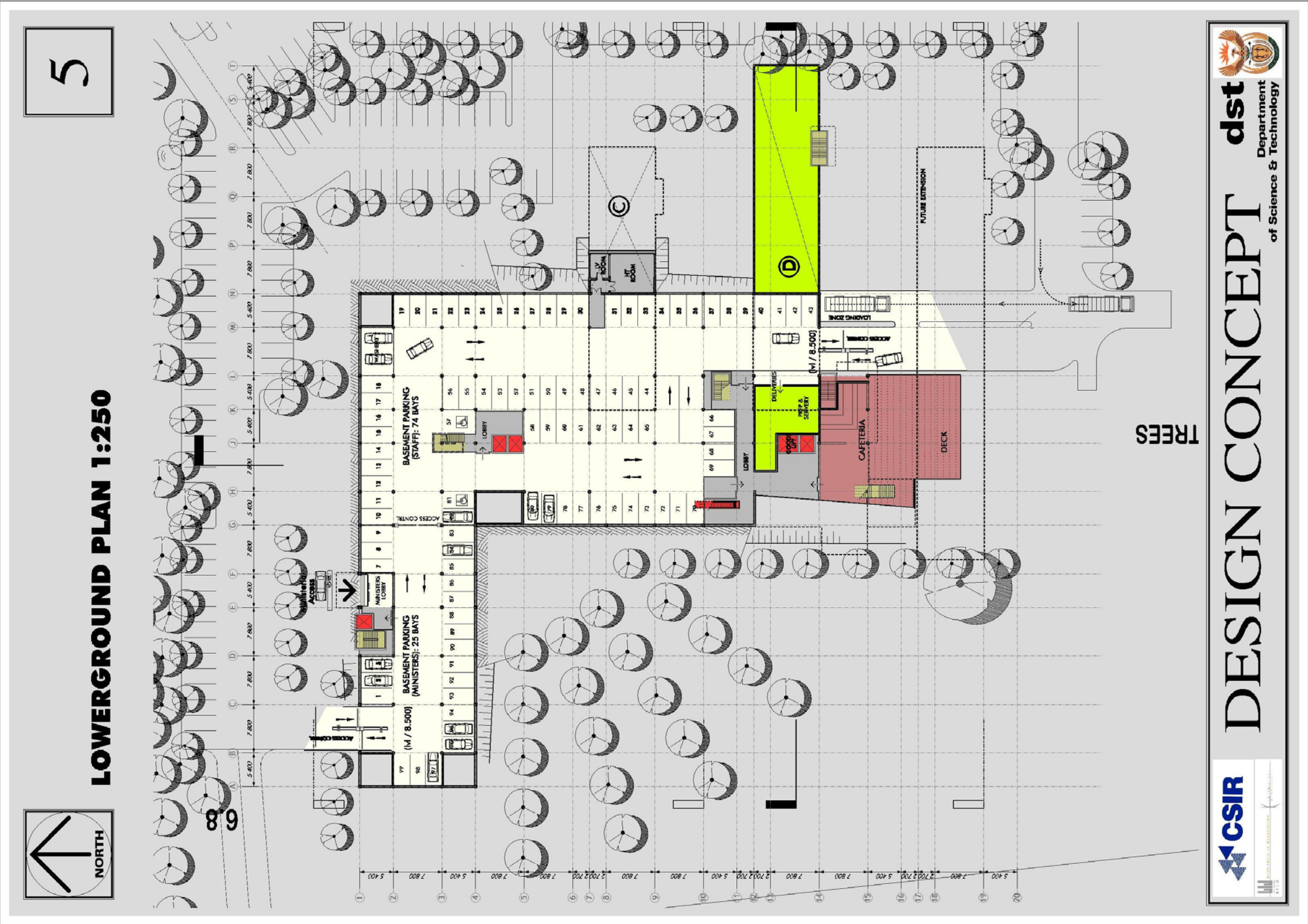


Figure B.1.03 DST Offices – layout plan of lower ground floor level (BILD Architects, 2005a:5)

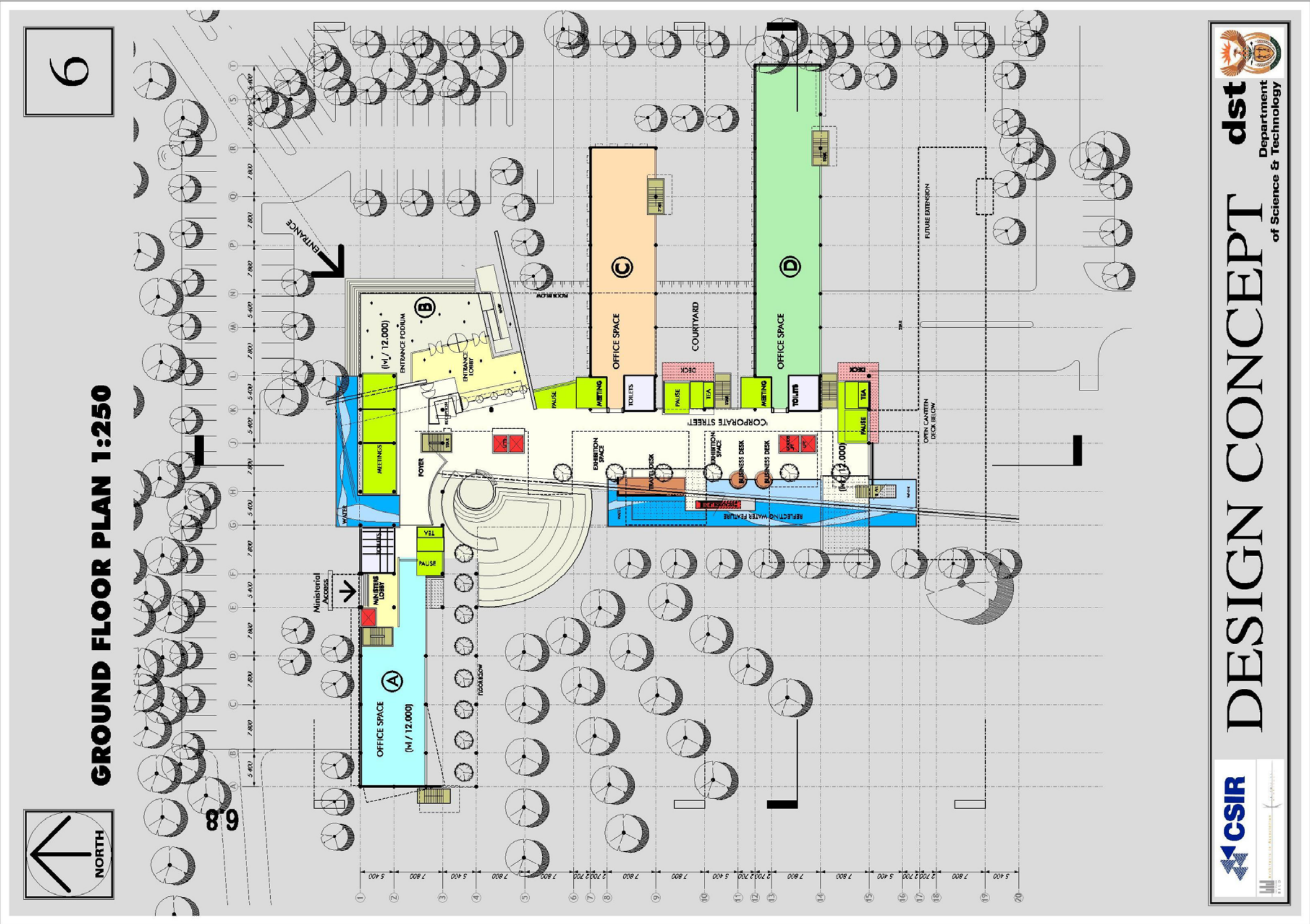
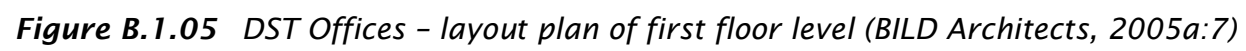


Figure B.1.04 DST Offices – layout plan of ground floor level (BILD Architects, 2005a:6)



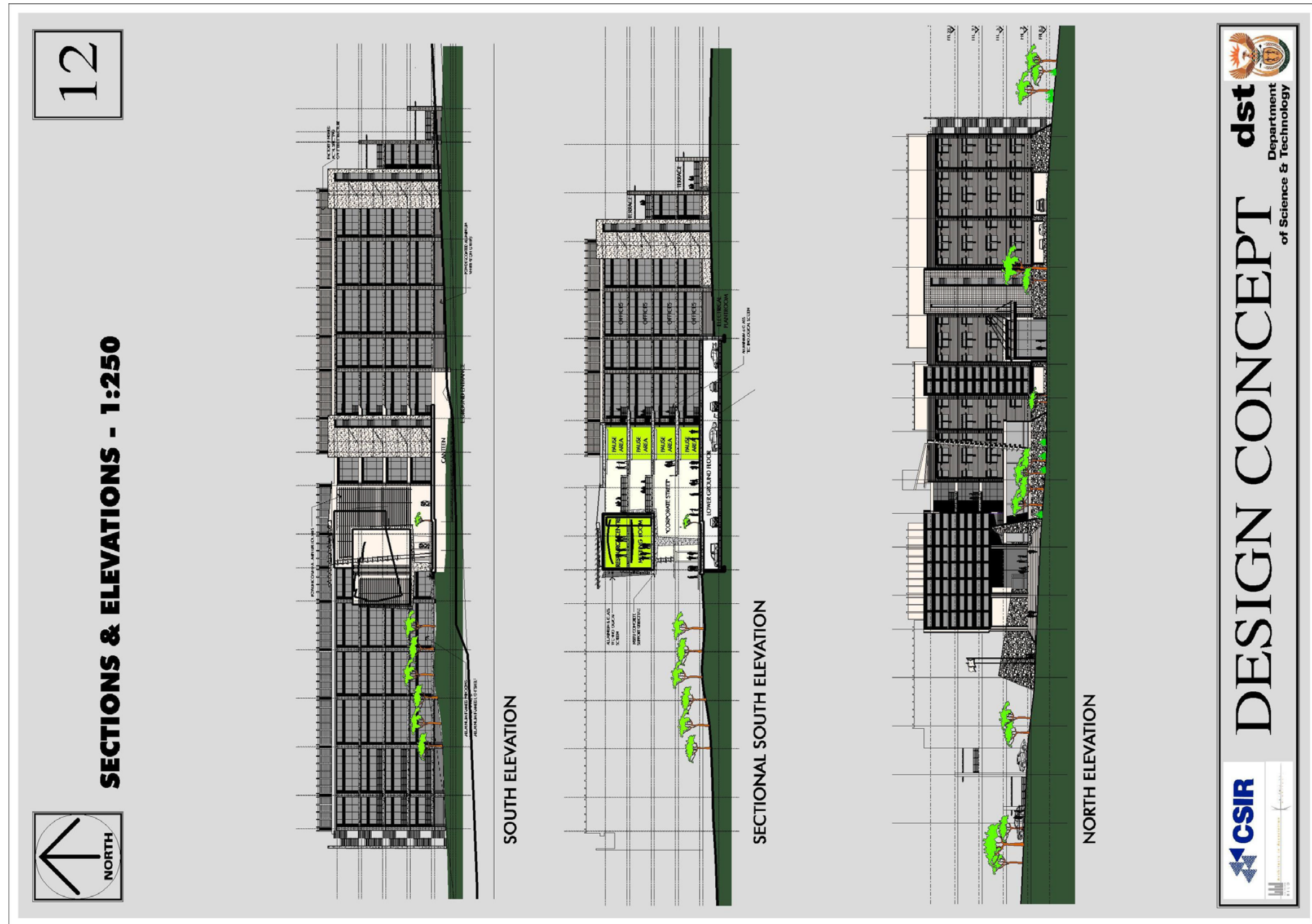


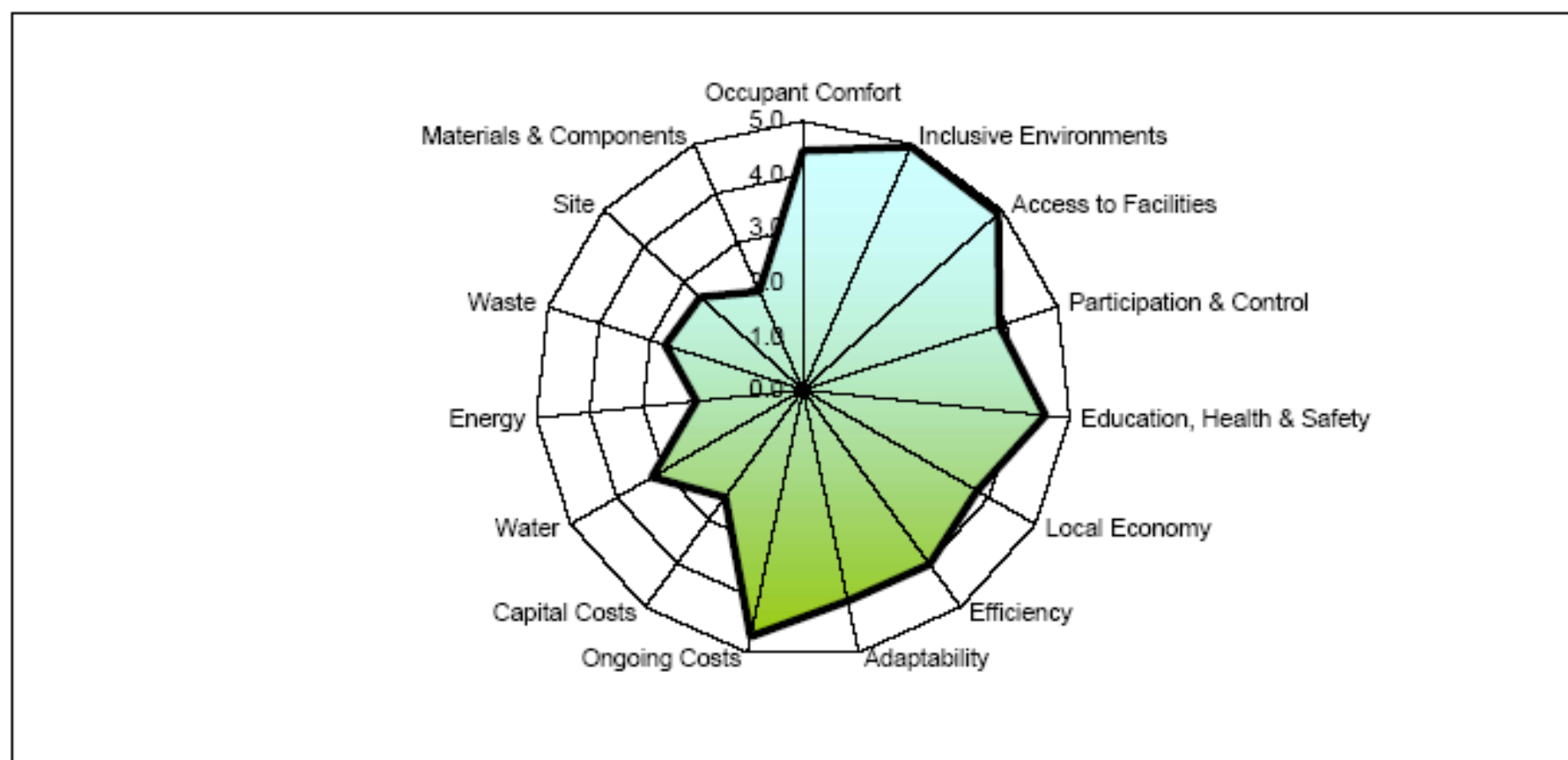
Figure B.1.06 *DST Offices – typical sections and elevations of building (BILD Architects, 2005a:12)*

SBAT**Table B.1.02** *DST Offices – SBAT Report (BILD Architects, 2005c:1)*

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

SUSTAINABLE BUILDING ASSESSMENT TOOL

PROJECT	ASSESSMENT
Project title: CSIR-DST Head Office Project	Date: 9/22/2004
Location: CSIR Campus Pretoria	Undertaken by: The Team
Building type (specify): Commercial/Public	Company / organisation BILD+Terra Ether Architects
Internal area (m2): 10000	Telephone: 012 346-1295
Number of users: 400	Fax: 012-346-1249
Completion date: Dec-05	Email:



Social 4.5

Economic 3.8

Environmental 2.5

Overall 3.6

Sustainable Building Assessment Tool

© CSIR

Table B.1.03 DST Offices – SBAT Instructions (BILD Architects, 2005c:6)

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

Instructions

Objective

The objective of the tool is to provide an indication of the performance of a building or the design of a building in terms of sustainability principles.

Scope

The tool should ideally be used on a building that has just been completed.
It can be used at other stages of a building's lifecycle but some criteria may not be relevant.
The tool can be used on most building types such as schools, housing and offices, used by people to live and work in.

Instructions

- Step One Setting the project up**
Complete the *project* and *assessment* sections of Section A. *Report*
Refer to *definitions* below
- Step Two Entering measurements**
Complete each of the sections *B. Social*, *C. Economic* and *D. Environmental*
Should you require a description of the broad criteria used, refer to *Criteria Notes*.
Under the column *Measured*, indicate the percentage compliance from 0 to 100 % for each of the relevant criteria.
If you do not have the information required for the criteria, enter 0%
Should you have detailed modelled or measured quantified performance data relevant to the criteria, enter this under *Quantified modelled or measured performance data*. Where possible, ensure that this data aligns with protocols provided in the green building assessment methodology (see <http://greenbuildings.ca>).
Detailed technical performance information on your building should also be entered directly into the powerpoint presentation accompanying this document.
- Step Three Reading the report**
On completion, return to *Section A. Report*. The spidergraph should now have filled and values should have appeared in all boxes.
- Social** provides an indication of the social performance of the building in terms of sustainability principles.
Economic provides an indication of the economic performance of the building in terms of sustainability principles.
Environmental provides an indication of the environmental performance of the building in terms of sustainability principles.
Overall provides an indication of the overall building performance in terms of sustainability principles.

Definitions

Occupied Space: Space that is normally used by people for living or working in
User: People who regularly use the building
Construction worker: People involved in constructing the building including subcontractors

Contact

Should you wish to comment on this tool, please contact:
Jeremy Gibberd
CSIR, Division of Building and Construction Technology
Tel: 012 841 2839 Fax: 012 841 3504
Email: jgibberd@csir.co.za

Table B.1.04 DST Offices – SBAT Instructions (BILD Architects, 2005c:5)

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

Criteria Notes

Reference	Criteria	Description	Modelled or measured performance data / notes
SO1	Occupant Comfort	The quality of environments in and around buildings has been shown to have a direct impact on the health, happiness and productivity of people. Healthier, happier, more effective people contribute to sustainability by being more efficient and therefore reducing resource consumption and waste.	Under the heading you may enter specific performance information that may have been gathered for the building.
SO2	Inclusion	Buildings should be designed to accommodate and be accessible to everyone. Ensuring that buildings and construction are inclusive supports sustainability by addressing inequity and reducing resource consumption (as facility replication is reduced and change of use supported).	As far as possible, ensure data is normalised so that it can be used for comparison purposes. For instance rather than list water consumption in litres only, describe this as litres per user per day.
SO3	Access to Facilities	Conventional living and working patterns require regular access to a range of services. Ensuring that these services can be accessed easily and in environmentally friendly ways supports sustainability by increasing efficiency and reducing environmental impact.	Guidance, indicators, units and measurement protocols can be found at http://greenbuilding.ca . Where possible these should be used.
SO4	Participation & Control	Enabling users to participate in decisions about their environment helps ensure that they care for and manage this properly. Control over aspects of their local environment provides for personal satisfaction and comfort. Both of these support sustainability by promoting proper management of buildings and increasing productivity.	This column can also be used for notes by you that qualify / expand / explain particular aspects related to the issue being assessed.
SO5	Education Health and Safety	Buildings need to cater for the rights, development, health and safety of the people that construct and use them. Learning and access to information are increasingly seen as requirements of a competitive work force. All of these factors contribute to sustainability by helping ensure that people remain healthy and economically active, thus reducing the 'costs' (to society, the environment and the economy) of unemployment and ill health.	
EC1	Local Economy	The construction and management of buildings can have a major impact on the economy of an area. The economy of an area can be stimulated and sustained by buildings that make use of, and develop, local skills and resources.	
EC2	Efficiency	Buildings cost money and make use of resources, whether they are used or not. Effective and efficient use of buildings and materials support sustainability by reducing waste and the need for additional buildings.	
EC3	Adaptability and Flexibility	Most buildings can have a life span of at least 50 years. It is likely that within this time the use of the building will change, or that the feasibility of this will be investigated. Buildings that can accommodate change easily, support sustainability by reducing the requirement for new buildings and the need for physical adaptation and associated disruption, energy consumption and cost.	
EC4	Ongoing Costs	Buildings cost money to operate. These costs include cleaning, maintenance, security and energy. These costs are often indicative of consumption and waste in the building. It is therefore important to monitor them. In addition, operational budgets can be used to support the development of local economies.	
EC5	Capital Costs	Buildings are generally one of the most valuable assets that people, and often organisations and governments, own. Money spent on buildings is not available for other uses such as health, education and business development. In addition, expensive buildings may mean that the services (such as health and education) they contain or the accommodation (for work and living) they provide is beyond the means of most users.	
EN1	Water	The large-scale provision of conventional water supply has many environmental implications. Water needs to be stored (sometimes taking up large areas of valuable land and disturbing natural drainage patterns with associated problems from erosion etc); it also needs to be pumped (using energy) through a large network of pipes (requiring maintenance and repairs). Having delivered the water, parallel efforts are then required to dispose of it. Reducing water consumption supports sustainability by reducing the environmental impact required to deliver water and dispose of it after use. Maintaining natural ground water systems also supports sustainability by maintaining existing ecosystems and avoiding the environmental impact associated with disposal of storm water and runoff.	
EN2	Energy	Buildings consume a large proportion of all energy produced. Conventional energy production contributes significantly to environmental damage and non-renewable resource depletion. Using less energy or using renewable energy in buildings therefore can make a substantial contribution to sustainability.	
EN3	Waste	Raw materials and new components used in buildings consume resources and energy in their manufacture and processes. Buildings accommodate activities that consume resources and produce waste. Reducing the use of new materials and components in buildings, and in the activities accommodated in buildings, and reducing waste by recycling, and reuse, support sustainability by reducing energy consumption, resource consumption and environmental damage.	
EN4	Site	Buildings have a footprint and a size that take up space that could otherwise be occupied by natural ecosystems which contribute to sustainability by helping create and maintain an environment that supports life (by, for instance, controlling the carbon dioxide and oxygen balance and maintaining temperatures within a limited range). Buildings can support sustainability by limiting development to sites that have already been disturbed, and working with nature by including aspects of natural ecosystems within the development.	
EN5	Materials and Components	The construction of buildings usually requires large quantities of materials and components. These may in turn require large amounts of energy to produce. Their manufacture may also require processes that are harmful to the environment and consume non-renewable resources. It is therefore important to carefully select materials, components and construction methods.	

Table B.1.05 DST Offices – SBAT Social building performance indicators (BILD Architects, 2005c:2)

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

Building Performance - Social

Criteria	Indicative performance measure	Measured(%)	Points	Modelled or measured performance data / notes
SO 1 Occupant Comfort			4.5	Explanatory notes
SO 1.1 Daylighting	% of occupied spaces that are within distance 2H from window, where H is the height of the window or where there is good daylight from skylights	85	0.9	ie daylight factor (%)
SO 1.2 Ventilation	% of occupied spaces that have equivalent of opening window area, equivalent to 10% of floor area or adequate mechanical system, with unpolluted air source	100	1.0	
SO 1.3 Noise	% of occupied spaces where external/internal/reverberation noise does not impinge on normal conversation (50dbA)	100	1.0	
SO 1.5 Thermal comfort	Temperature of occupied space does not exceed 28° or go below 19°C for more than 5 days per year (100%)	100	1.0	
SO 1.5 Views	% of occupied space that is 6m from an external window (not a skylight) with a view	60	0.6	
SO 2 Inclusive Environments			5.0	
SO 2.1 Wayfinding	Comprehensive, high-contrast, clear print signage in appropriate locations and language(s) / use of understandable symbols / manned reception at all entrances (75%), use of tactile and other indicators (25%)	100	1.0	
SO 2.2 Space	% of occupied spaces that are accessible to ambulant disabled people / wheelchair users	100	1.0	
SO 2.3 Toilets	% of occupied space with fully disabled-accessible toilets within 50m along easily accessible route	100	1.0	
SO 2.4 Fittings & furniture	% of commonly used furniture and fittings (reception desk, kitchenette, auditorium) fully disabled-accessible	100	1.0	
SO 2.5 Representative	Inclusive construction team, 10+% youth (age 18-28), 2+% disabled people, 20+% women (100%)	95	1.0	
SO 3 Access			4.9	
SO 3.1 Public transport	Building is within 400m from disabled-accessible (20%) and affordable (80%) public transport	100	1.0	
SO 3.2 Banking	All users can walk/use the internet (100%) / use public transport (50%) to get to banking facilities	100	1.0	
SO 3.3 Retail	All users can walk (100%) / use public transport (50%) to get to food retail	100	1.0	
SO 3.4 Children	All users can walk (100%) / use public transport (50%) to get to their childrens' schools and creches	100	1.0	
SO 3.5 Cycling / walking	Safe access routes (clearly distinguished from vehicular routes) to the building (50%), provision of shower/changing facility and secure cycle storage (50%)	90	0.9	
SO 4 Participation & Control			3.9	
SO 4.1 Environmental control	% of occupied space able to control their thermal environment (adjacent to openable windows/thermal controls)	60	0.6	
SO 4.2 Lighting control	% of occupied space able to control their light (adjacent to controllable blinds etc/local lighting control)	75	0.8	
SO 4.3 Social spaces	Social informal meeting spaces (parks / staff canteens / cafes) provided locally (within 400m) (100%)	100	1.0	
SO 4.4 Sharing facilities	Five per cent or more of building/site facilities (ie training venue/recreation/equipment) designed to be shared with (community groups) who do not have access to these (50%), sharing activities occurring on a weekly basis (50%)	100	1.0	
SO 4.5 User group	Users actively involved in the design process (50%) / active and representative management user group (50%)	50	0.5	
SO 5 Education, Health & Safety			4.6	
SO 5.1 Education	Training provided to construction workers (50%), facilities provided to support education (training venue / library / free access to learning material) in or near building (50%)	60	0.6	
SO 5.2 Accidents	Process in place for recording all occupational accidents and diseases and addressing these, during construction (50%) and in the building (50%)	100	1.0	
SO 5.3 Awareness	Highly visible information on key health and safety issues (including HIV/AIDs) in appropriate locations, during construction (50%), in completed building (50%)	100	1.0	
SO 5.4 Materials	All materials/components used do not have any negative effects on contractors and indoor air quality (100%)	95	1.0	
SO 5.5 Safety	Construction workers provided with protective clothing, equipment and relevant training (50%), site activities in line with good site health and safety practice (50%)	100	1.0	

Table B.1.06 DST Offices – SBAT Environmental building performance indicators (BILD Architects, 2005c:3)

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

Building Performance - Environmental

	Criteria	Indicative performance measure	Measured(%)	Points	Modelled or measured performance data / notes
EN 1	Water			3.3	Explanatory notes
EN 1.1	Rainwater	% of water consumed sourced from rainwater harvested on site	95	1.0	ie litres per person per day consumed
EN 1.2	Water use	% of equipment (taps, washing machines, urinals, showerheads etc) that are water efficient	100	1.0	
EN 1.3	Runoff	% of carparking, paths and roads that have absorbant/permeable surfaces (grassed/looselaid paving/absorbant materials)	50	0.5	
EN 1.4	Greywater	% of water from washing/relatively clean processes recycled and reused	0	0.0	
EN 1.5	Planting	% of planting (other than food gardens) on site with low / appropriate water requirements	80	0.8	
EN 2	Energy			2.0	
EN 2.1	Location	% of users who walk / cycle / use public transport to commute to the building	10	0.1	
EN 2.2	Ventilation	% of occupied space ventilation requirements met through natural / passive ventilation	10	0.1	
EN 2.3	Heating & cooling	% of occupied space which relies solely on passive environmental control (no or minimal energy consumption)	10	0.1	
EN 2.4	Appliances & fittings	% of appliances / lighting fixtures that are classed as highly energy efficient (ie energy star rating)	95	1.0	
EN 2.5	Renewable energy	Ten per cent or more of building energy requirements met from renewable sources (100%)	75	0.8	
EN 3	Waste			2.7	
EN 3.1	Minimisation	Waste minisation through procurement (ie no / easily recycled packaging specified) and safe storage of materials, on site (50%), in building (50%)	80	0.8	
EN 3.2	Organic waste	% of organic waste recycled	60	0.6	
EN 3.3	Inorganic waste	% of inorganic waste recycled	70	0.7	
EN 3.4	Sewerage	% of sewerage recycled / disposed of safely on site	0	0.0	
EN 3.5	Construction waste	% of damaged building materials / waste developed in construction recycled on site / used by others	60	0.6	
EN 4	Site			2.6	
EN 4.1	Brownfield site	% of proposed site already disturbed / brownfield (previously developed)	50	0.5	
EN 4.2	Neighbouring buildings	No neighbouring buildings negatively affected (by reduced access to sunlight, daylight and ventilation) (100%)	100	1.0	
EN 4.3	Vegetation	% of area covered in vegetation (include green roofs, internal planting) relative to whole site	47.5	0.5	
EN 4.4	Food gardens	% of soft landscaping that produces food	0	0.0	
EN 4.5	Construction process	Volume/area of site disturbed during construction less than 2x volume/area of new building (100%)	60	0.6	
EN 5	Materials & Components			2.0	
EN 5.1	Embodied energy	% of the building envelope (by area) that uses low embodied energy materials and components	45	0.5	
EN 5.2	Sources	% of materials and components by volume from sustainable grown sources (animal/plant)	15	0.2	
EN 5.3	Ozone depletion	No materials and components used requiring ozone-depleting processes (100%)	100	1.0	
EN 5.4	Recycled / reuse	% of materials and components (by weight) reused / from recycled sources	20	0.2	
EN 5.5	Landscape inputs	% of soft landscape that does not require mechanical equipment (ie lawn cutting) and/or artificial inputs such as weed killers and pesticides	20	0.2	

Table B.1.07 DST Offices – SBAT Economic building performance indicators (BILD Architects, 2005c:4)

Note: SBAT developed by the CSIR, project-specific data added by BILD + Terra Ether Architects

Building Performance - Economic

Criteria	Indicative performance measure	Measured(%)	Points	Modelled or measured performance data / notes
EC 1 Local Economy			3.8	Explanatory notes
EC 1.1 Local contractors	% value of the building constructed by local (within 50km) contractors	50	0.5	ie person years of employment created per unit currency
EC 1.2 Local materials	% of materials (sand, bricks, blocks, roofing material) sourced from within 50km	50	0.5	
EC 1.3 Local components	% of components (windows, doors) and furniture and fittings made locally (in the country)	85	0.9	
EC 1.4 Worker rights	Construction workers have employment contracts and are paid at least relevant minimum wage on a regular basis (100%)	100	1.0	
EC 1.5 Maintenance	% of maintenance and repairs by value that can be, and are, undertaken by local contractors (within 50km)	90	0.9	
EC 2 Efficiency			4.0	
EC 2.1 Capacity	% capacity of building used on a daily basis (actual number of users / number of users at full capacity*100)	99	1.0	
EC 2.2 Occupancy	% of time building is occupied and used (actual average number of hours used / all potential hours building could be used (24) *100)	34	0.3	
EC 2.3 Space per occupant	Space provision per user not more than 10% above national average for building type (100%)	76	0.8	
EC 2.4 Communication	Site/building has access to internet (25%), telephone (25%), local (within 3km) postal (25%) and courier facilities (25%)	100	1.0	
EC 2.5 Material & Components	Building design coordinated with material / component sizes in order to minimise wastage. Walls (50%), roof and floors (50%)	92.5	0.9	
EC 3 Adaptability			4.2	
EC 3.1 Vertical heights	% of spaces that have a floor-to-ceiling height (structural elements) of 2800mm or more	100	1.0	
EC 3.2 External space	% of external space (as a proportion of ground floor area) that is designed to extend functionality of building	30	0.3	
EC 3.3 Internal partition	% of internal partitioning that is non-loadbearing and can be easily adapted (freestanding partitions / studwall)	95	1.0	
EC 3.4 Modular planning	Building with modular structure, envelope (fenestration) & services allowing easy internal adaptation (100%)	95	1.0	
EC 3.5 Furniture	Modular, limited variety furniture - can be easily configured for different uses (100%)	95	1.0	
EC 4 Ongoing Costs			4.7	
EC 4.1 Users	All new users receive induction training on building systems (50%), detailed building user manual (50%)	80	0.8	
EC 4.2 Consumption & waste	Mechanisms (notice boards, meters, intranet) to ensure users are exposed on a monthly basis to building performance figures (water (33%), energy (33%), waste (33%))	100	1.0	
EC 4.3 Security	Main routes in and around building well lit (25%) and visually supervised (25%), secure perimeter and access control (50%)	100	1.0	
EC 4.4 Maintenance & Cleaning	% of building that can be cleaned and maintained easily and safely, using simple equipment and local non-hazardous materials	95	1.0	
EC 4.5 Procurement	% of value of all materials/equipment used in the building on a daily basis supplied by local (within the country) manufacturers	95	1.0	
EC 5 Capital Costs			2.5	
EC 5.1 Sharing	Reduction in capital costs through sharing facilities with other buildings/organisations (ie parking, reception, meeting, equipment/plant, maintenance, recreation, catering) (100%)	30	0.3	
EC 5.2 Procurement	Design/construction packaged to ensure involvement of small local contractors/manufacturers (100%)	40	0.4	
EC 5.3 Building costs	Capital cost below national average building costs for the building type (100%)	77	0.8	
EC 5.4 Technology	Five per cent of capital costs allocated for supporting/developing small enterprises / the use of sustainable or indigenous technologies (100%)	100	1.0	
EC 5.5 Existing Buildings	% of building reused (not newly built)	0	0.0	



B.2 Case Study 2: MTN office building

Checklist

Description	Data avail.	Comments
Project background <u>Consultant team:</u> client (owner/tenant), developer professionals other (specialists, users etc.) Development objectives Brief, grade, size, location, value?	 √ x √ ½ s x	 Client tenant + developer Not available None specific Toward sustainable Not available
Summary of interview <u>Design and project process:</u> project scope professional team dynamics forecasting, feedback procedures <u>Assessment tools:</u> assessment tools in use assessment procedures assessment reports	 √ √ √ √ √ √	 GB Tool (?) in prelim. stage
Drawings, photos etc.	x	Not available
Data from Assessment tools SBAT done for SB04?	√ x	 (Optional)

Interview Notes, Abbreviations etc.:

Phase 1 built 2000, Phase 2 built 2004

The following documentation of the interview is not a word-for-word transcription, but rather a summary of the discussion between interviewee and researcher, organised in bulleted form under appropriate headings as relevant to the research topic.

<i>'in italics'</i>	words written in italics with quotation marks, were the actual words of the Architect
[in brackets]	words written in square brackets are notes which have been added by the researcher for clarification purposes

Abbreviations:

GBTool Green Building Tool

Summary of Interview

20050808 – Boogertman + Partners Architects:

Development characteristics:

- commercial developer provided structured finance with MTN as tenant
- building environment: high density office space with many computer stations
- hardest thing to get building user as participant – feedback complaints
- architects often work at risk, requiring efficient use of time, no resources left to do research (e.g. in alternative technologies)

Design process in Ph. 1:

- building management system monitors performance – reading into systems is submitted for evaluation (e.g. greywater)
- water in cooling towers used for flushing in toilets and irrigation
- economy cycle on air-conditioning: part of good practice
- all design principles derived in Ph. 1 applied in Ph. 2

Sustainability/environmental considerations:

- biggest impact of 'green' technologies in use of double glazing on all façades: potential savings in air-conditioning costs motivated to client, thus installed
- 'green' awareness with developer although not generally accepted, may lose business in situation where additional costs cannot be justified
- quantity surveyor compares 'green' to standard with added benefit requirements, resulting in costs over standard: architects often argue that these increased initial costs can be salvaged in operational phase,

but there is no argument with the developer if one can go back to the standard [at no extra cost]

- useful to transfer benefits from developer to client [i.e. tenant] where operational benefits are translated into cost, although some things cannot be argued in terms of pure numbers, e.g. 'soft' issues of how business works, efficiencies etc. requires a new way of working

Design aspects:

- office layout phase 1 – core with open plan offices surrounding
- office layout phase 2
 - core to sides with open plan throughout office floor which increases efficiencies (less sqm/person) and densities
 - in turn saved space given back through better + increased atrium space, canteen etc. – activities joined in collective space
 - work space also better
 - reduced building size, users happier through shared breakaway spaces
- mechanical engineer calculated ratio of floor area to façade to reduce as far as possible: result – square most ideal for façade length

Use of assessment tool in design process:

- Phase 1 of development: registered building with the 'green' Building Council – never assessed however because the data was not submitted
 - mechanical engineers suggested registration of project with the 'green' Building Council; 'green' aspects also part of client's [tenant] intentions
- Green Building Council and GBTool was discussed in design meetings, presented to client/developer and consultants to work toward implementation
- GBTool gave items for consideration, listing the different aspects of sustainability, e.g. some social aspects informed design – masterplan 106 000 sqm, thus convenience facilities needed
- GBTool did not change the conventional process, but provided additional consideration points, e.g. use of greywater from cooling towers, dual flushing system
- GBTool dictated maximum distance from desk to natural light

20050815 – Boogertman + Partners Architects:Notes from site visit:

- phase 1: 20 000sqm, GLA 27 000sqm (in addition to 20 000sqm), total 35 000sqm incl. in basement construction
- design aspects:
 - office wings in courtyard – orientation allows for northern sun
 - glass on west façade: low E (reduce radiation) with shading devices
 - hot air from atrium moves upward
 - insulation and fire: double/triple volume of atrium
 - internal street creates vertical and horizontal circulation
 - meeting clusters conceived as ‘bird’s nests’ that punch through west façade
 - concepts of ‘transparency and accessibility’ improve efficiency
 - red colours used for service towers which house toilet cores
 - water from air-conditioning ‘bleeder’ used to flush toilets
- council charges quantity of water that is being used by tenant and they are later reimbursed for what is put back or used on site
- lux levels in offices range between 350 – 500 lux
- noise from water fountain at entrance shelters outside cafeteria against street noise

MTN Offices – Green Building Checklist

Table B.2.01 *MTN Offices – green building checklist: social aspects (reformatted from Boogertman + Partners Architects, 2005a)*

Description	Sector	Criteria	Sub criteria	Priority	Responsibility	
Ease of access and use	Social	Inclusive Environments	Workplace furniture	Essential	Arch	Yes
Access in building for disabled	Social	Inclusive Environments	Routes, changes in level	Essential	Arch	Is achieved thru out.
Changes in level have ramps	Social	Inclusive Environments	Routes, changes in level	Essential	Arch	Yes except to top level of street terraces
100m from disabled accessible public transport	Social	Inclusive Environments	Public Transport	Essential	Transp	
Contrasting colour on edges	Social	Inclusive Environments	Edges	Essential	Arch	Will be taken care of in choice of materials
Signage	Social	Inclusive Environments	Edges	Essential	Arch	Still to be resolved
Appropriate location, number, layout and equipment	Social	Inclusive Environments	Amenities and toilets	Essential	Beads	Part of space planning still to be resolved
6m or less from a window	Social	Occupant Comfort	Views	Essential	Arch	8.5m from centre of office wing to façade or atrium
Unimpeded view of window	Social	Occupant Comfort	Views	Essential	Arch	Is achievable due to open plan offices
Quantity of fresh air	Social	Occupant Comfort	Ventilation	Essential	Mech	
Quality of fresh air	Social	Occupant Comfort	Ventilation	Essential	Mech	
Background noise	Social	Occupant Comfort	Noise	Essential	Acoustic	Acoustic treatment to u/s of roof and double glazing
Peak noise	Social	Occupant Comfort	Noise	Essential	Acoustic	Acoustic treatment to u/s of roof and double glazing
Quality of daylight	Social	Occupant Comfort	Lighting	Essential	Elec	
Variability of daylight	Social	Occupant Comfort	Lighting	Essential	Elec	
Location from access points	Social	Occupant Comfort	Access to Green Outside	Essential	Arch	Easy access from internal street

Building shape, footprint and site coverage	Social	Occupant Comfort	Access to Green Outside	Essential	Arch	Building shape almost square i.e.: economical. Footprint large due to enclosed atriums
Local access to facilities	Social	Well-being	Sport, recreation	Essential	Arch	Shopping and gym precinct opposite highway
Smoking areas	Social	Well-being	Smoking	Essential	Arch	2no dedicated enclosed smoking areas per floor provided and balconies
Safety on route to building	Social	Well-being	Security	Essential	Elec	Highway traffic!
Safety in building	Social	Well-being	Security	Essential	Elec	All aspects of safety eg hadrails, stairs taken into account
Visual links	Social	Well-being	Security	Essential	Elec	Yes, from inside to other parts of builing and to outside
Lighting	Social	Well-being	Security	Essential	Elec	Good natural light
Technological security	Social	Well-being	Security	Essential	Elec	
Physical security	Social	Well-being	Security	Essential	Elec	
Materials, components and finishes screened for health hazards	Social	Well-being	Health	Essential	Arch	We are considering alternatives to 201rèches201ss insulation, no fibre cement
Access to internet	Social	Well-being	Education	Essential	Arch	Yes, at work stations and at canteen, coffee shop and pause areas
Space for structured courses	Social	Well-being	Education	Essential	MTN	To be confirmed by MTN
Spaces with books	Social	Well-being	Education	Essential	Arch	Part of space planning still to be reolved
Retail within 3 km	Social	Access to Facilities	Retail	High	Arch	Yes ,across highway in shopping precinct
Distance and time commuting	Social	Access to Facilities	Residential	High	ARUP Traffic	

Post Office within 3 km	Social	Access to Facilities	Communi-cation	High	Arch	Yes, across highway in shopping precinct
Postal, telecom, email in building	Social	Access to Facilities	Communi-cation	High	Arch	Yes
Schools, 202rèches within 3 km	Social	Access to Facilities	Childcare	High	Arch	Still to be determined
ATM within 3 km	Social	Access to Facilities	Banking	High	Arch	Yes ,across highway in shopping precinct
Training for facilities managers	Social	Participa-tion and control	User manual and training	High	RMBP	
Induction of new occupants	Social	Participa-tion and control	User manual and training	High	Client	
Design and location of space for formal and informal social interaction	Social	Participa-tion and control	Social spaces	High	Arch	Yes. Meeting rooms, atriums, canteen, coffee shop pause areas.
Open-able windows	Social	Participa-tion and control	Environmen-tal control	High	Arch	Yes. One window /door per 3900 bay
Blinds	Social	Participa-tion and control	Environmen-tal control	High	Arch	Yes.
Control of light	Social	Participa-tion and control	Environmen-tal control	High	Elec	
Control of temperature	Social	Participa-tion and control	Environmen-tal control	High	Mech	Yes
Space available to or shared with local community	Social	Participa-tion and control	Community involvement	High	Arch	Not planned for in phase one
Design and location of amenities	Social	Participa-tion and control	Amenities	High	Arch	?

Table B.2.02 *MTN Offices – green building checklist: environmental aspects (reformatted from Boogertman + Partners Architects, 2005a)*

Description	Sector	Criteria	Sub criteria	Priority	Responsibility	
Passive ventilation	Environmental	Energy	Ventilation system	High	Mech	
10 % of energy required from renewable sources	Environmental	Energy	Renewable energy	High	Mech	
Within 400 m of public transport	Environmental	Energy	Location	High	Transp	
Passive environmental control design	Environmental	Energy	Heating and cooling	High	Mech	
Specification of energy efficient fittings, appliances, plant and lighting	Environmental	Energy	Appliances and fittings	High	Mech	
Design and management for safe disposal and recycling of harmful waste	Environmental	Recycling and re-use	Toxic waste	High	Arch	Part of waste management proposal to RMBP and MTN
Biolytic and other local systems	Environmental	Recycling and re-use	Sewerage	High	Civil	
100% of organic waste re-used on site	Environmental	Recycling and re-use	Organic waste	High	Arch	Part of waste management proposal to RMBP and MTN
Minimum 30% inorganic waste recycled	Environmental	Recycling and re-use	Inorganic waste	High	Arch	Part of waste management proposal to RMBP and MTN
Arrangements for sorting, storing and transporting inorganic waste	Environmental	Recycling and re-use	Inorganic waste	High	Arch	Part of waste management proposal to RMBP and MTN
Design to limit construction waste	Environmental	Recycling and re-use	Construction waste	High	Arch	Yes. Grinaker to monitor construction waste
Detail requirement for construction waste minimization in tender	Environmental	Recycling and re-use	Construction waste	High	QS	
Area of landscape created = footprint area of building and hard surfaces	Environmental	Site and Landscaping	Vegetation	High	Land-scape	
No impact on neighbouring buildings' access to sunlight and natural ventilation	Environmental	Site and Landscaping	Neighbouring buildings	High	Arch	No adjoining buildings and future will not be affected due to backset from boundary lines

No or minimum artificial inputs required to landscaping (fertilizer or pesticides)	Environmental	Site and Landscaping	Landscape inputs	High	Land-scape	Yes
Building supports diversity of plant and animal life - number and range of species supported	Environmental	Site and Landscaping	Habitat	High	Land-scape	Yes
Building occupies already disturbed site	Environmental	Site and Landscaping	Brownfield site	High	Dev	NO
10% of building materials are from re-used/recycled sources	Environmental	Materials and components	Recycle/re-use of material	Medium	Arch	NO
1 of 5 main materials by volume and 3 main components are from renewable sources	Environmental	Materials and components	Material/component sources	Medium	Arch	NO
No materials used of which production involves large scale direct pollution/greenhouse gasses	Environmental	Materials and components	Manufacturing processes	Medium	Arch	?
Low embodied energy in 5 main materials (by weight) and 3 main components	Environmental	Materials and components	Embodied energy	Medium	Arch	?
Large scale vegetation clearing and earth moving is minimized	Environmental	Materials and components	Construction processes	Medium	Arch	No vegetation on site except veld. Earthworks relocated on site for re-uses in landscaping
Water efficient delivery devices	Environmental	Water	Water use	Medium	Civil	Yes
Design and management of runoff	Environmental	Water	Runoff	Medium	Civil	Yes to be part of civil and landscaping design still to be resolved
Systems for capturing, storing and using rainwater	Environmental	Water	Rainwater	Medium	Civil	Yes to be part of civil and landscaping design still to be resolved
Low water requirement landscaping	Environmental	Water	Planting	Medium	Land-scape	Yes
Use of grey water systems	Environmental	Water	Grey water	Medium	Civil	Yes

Table B.2.03 MTN Offices – green building checklist: economic aspects
(reformatted from Boogertman + Partners Architects, 2005a)

Description	Sector	Criteria	Sub criteria	Priority	Responsibility	
Dimension of floor slab to u/s of roof slab	Economic	Adaptability and flexibility	Vertical dimension	Essential	Arch	3750
Location and size of vertical service cores	Economic	Adaptability and flexibility	Vertical circulation and service cores	Essential	Arch	Easily located at each end of office wing in vertical cores. Refer to plans for size.
Location and size of structural elements	Economic	Adaptability and flexibility	Structure	Essential	Struct	
Location and access to services	Economic	Adaptability and flexibility	Services	Essential	Arch	Easily located at each end of office wing in vertical cores
Ease of reconfiguring spaces	Economic	Adaptability and flexibility	Internal partitions	Essential	Arch	Open plan space planning policy. High density structured electrical and data grid in access floor for easy churn
Construction of partitions	Economic	Adaptability and flexibility	Internal partitions	Essential	Arch	Traditional drywall to minimal enclosed areas only 7.5m linear metres per 100sqm of office space
Space use indices (useable/rentable)	Economic	Efficiency of use	Useable space	Essential	Arch	RU Factor GLA/Offices 1.32(excluding courtyards) / 1.23 (including courtyards)
Use technology to reduce travel and space	Economic	Efficiency of use	Use of technology	Essential	MTN	Internet and e-mail, Hot-desking, working on the road or home MTN to confirm
Cost centres for space and equipment	Economic	Efficiency of use	Space/services use monitoring	Essential	Elec	
Occupancy linked switching of lights and AC	Economic	Efficiency of use	Space/services use monitoring	Essential	Mech	Yes

m ² per user	Economic	Efficiency of use	Space management	Essential	Arch	GBA/1525 = 22.89, GLA/1525 = 16.63, Usable/1525 = 12.59
Occupancy rates (% occupied)	Economic	Efficiency of use	Occupancy	Essential	Arch	Usable/GLA 19200/25354 = 76%
New space minimized through maximising use of existing	Economic	Capital costs	Shared costs	High	Dev	NO
Cost savings through agreement between users and developers	Economic	Capital costs	Initial cost	High	Dev	
Incentives to reduce capital and ongoing costs (performance related fees)	Economic	Capital costs	Consultant fees	High	Dev	
Building designed to grow over time	Economic	Capital costs	Build-ability	High	Arch	No but it is designed to be flexible.
Simple form/repetition/module sizes/minimize waste	Economic	Capital costs	Build-ability	High	QS	
Ongoing monitoring and improvement of cost of Water	Economic	Ongoing costs	Water	High	Civil	
Ongoing monitoring and improvement of cost of Sewerage	Economic	Ongoing costs	Sewerage	High	Civil	
Spatial layout and visual supervision by neighbouring buildings	Economic	Ongoing costs	Security/care taking	High	Arch	No buildings on adjoining site as yet. Campus development taken into account for proximity to adjoining buildings
Cost of maintenance limited through design	Economic	Ongoing costs	Maintenance	High	Arch	External facade maintenance free except for cleaning of windows.
Consideration of access	Economic	Ongoing costs	Maintenance	High	Arch	?
Life cycle cost considered in specification and procurement	Economic	Ongoing costs	Maintenance	High	Mech	Yes
Ongoing monitoring and improvement of cost of insurance	Economic	Ongoing costs	Insurance	High	RMBP	
Ongoing monitoring and improvement of cost of Energy	Economic	Ongoing costs	Energy	High	Mech	

Access and location, service without disruption of electrical and communication services	Economic	Ongoing costs	Disruption and downtime	High	Elec	
Access and location, service without disruption of HVAC services and plant	Economic	Ongoing costs	Disruption and downtime	High	Mech	Access onto roof via external stairs to plant rooms
Building kept clean easily and safely	Economic	Ongoing costs	Cleaning	High	Arch	Yes. Facade cleaning apparatus still to be resolved
Local maintenance contractors	Economic	Local Economy	Repairs and maintenance	Medium	Arch	Yes. RMBP to report on facilities management
Space for outsourced contractors	Economic	Local Economy	Outsource opportunities	Medium	Arch	Yes.
Management plan for emerging business	Economic	Local Economy	Outsource opportunities	Medium	Arch	Yes. Grinaker to report on local percentages
Materials sourced locally	Economic	Local Economy	Local material	Medium	Arch	Main façade elements are imported, percentage to be calculated
Use of local contractors	Economic	Local Economy	Local Contractors	Medium	Arch	Yes. Grinaker to report on local percentages
Building components sourced locally	Economic	Local Economy	Local component, fittings and furniture manufacture	Medium	Arch	Main façade elements are imported, percentage to be calculated

Design drawings

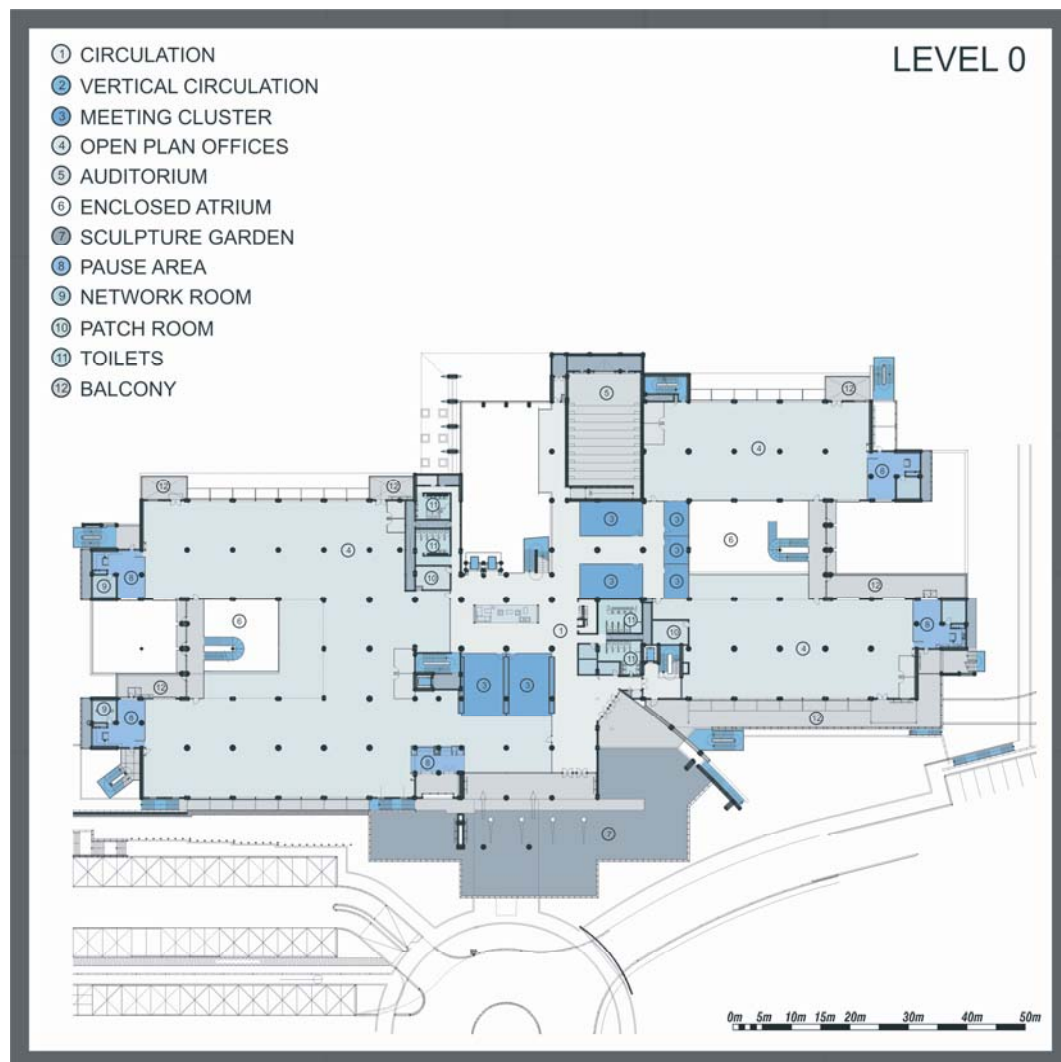


Figure B.2.01 MTN Offices – layout plan of ground floor level
(Boogertman + Partners Architects, 2005b)

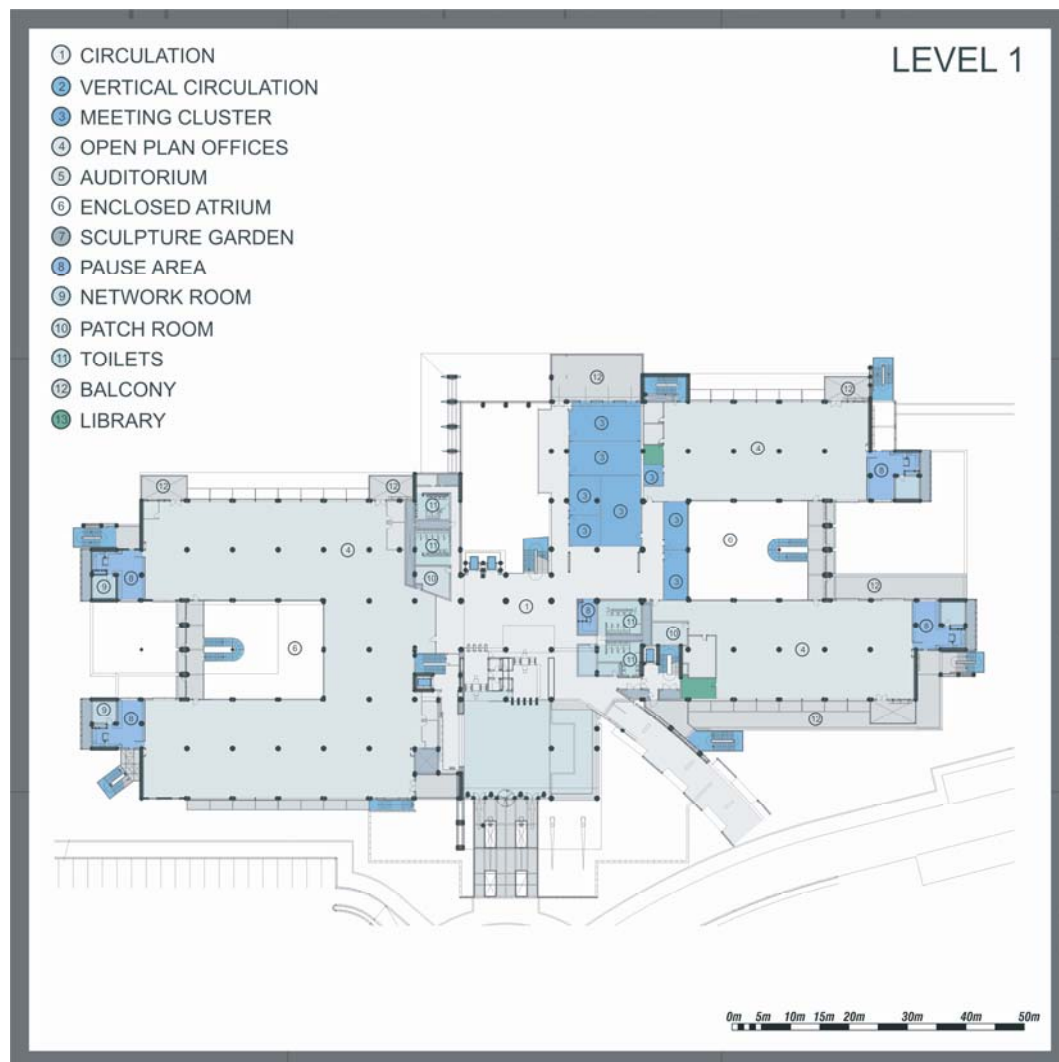


Figure B.2.02 MTN Offices – layout plan of first floor level (Boogertman + Partners Architects, 2005b)

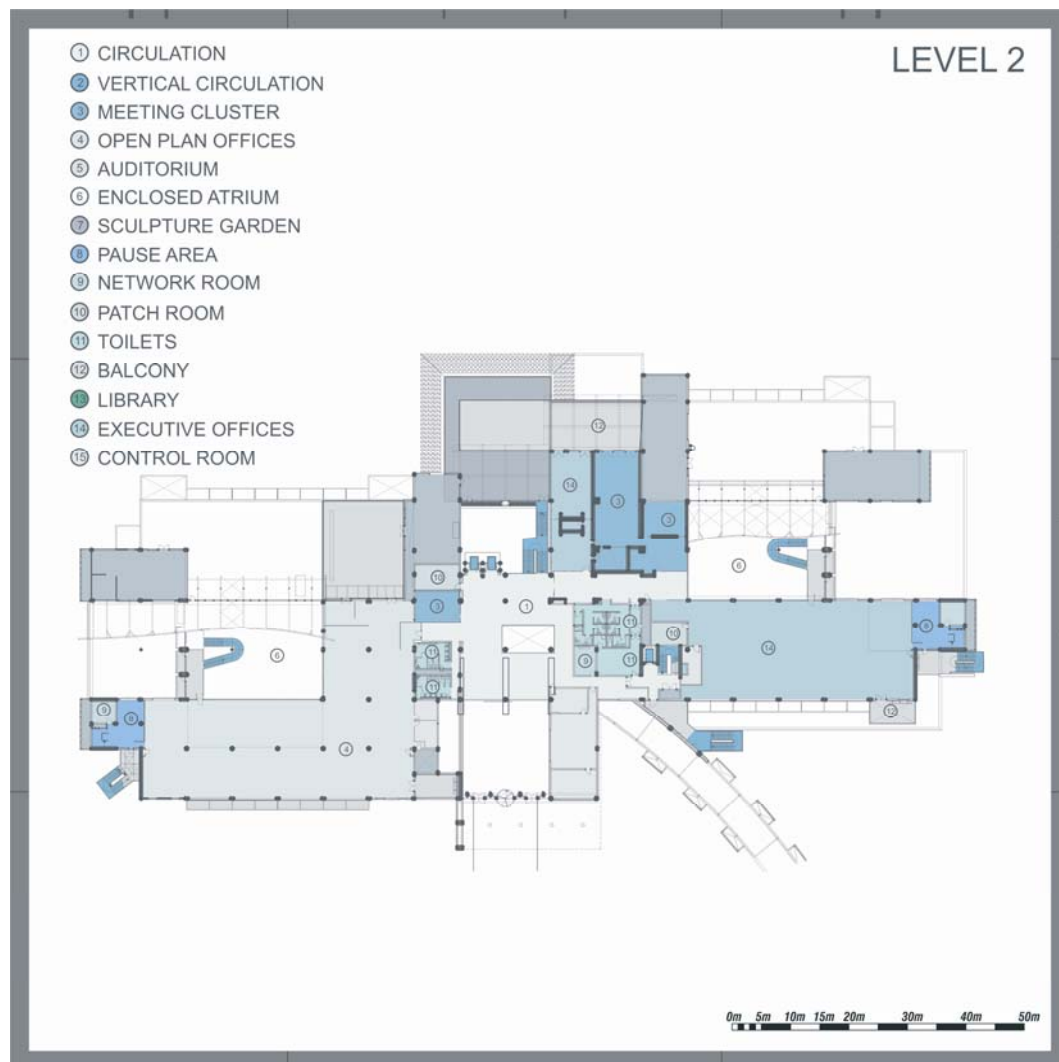


Figure B.2.03 MTN Offices – layout plan of second floor level
(Boogertman + Partners Architects, 2005b)

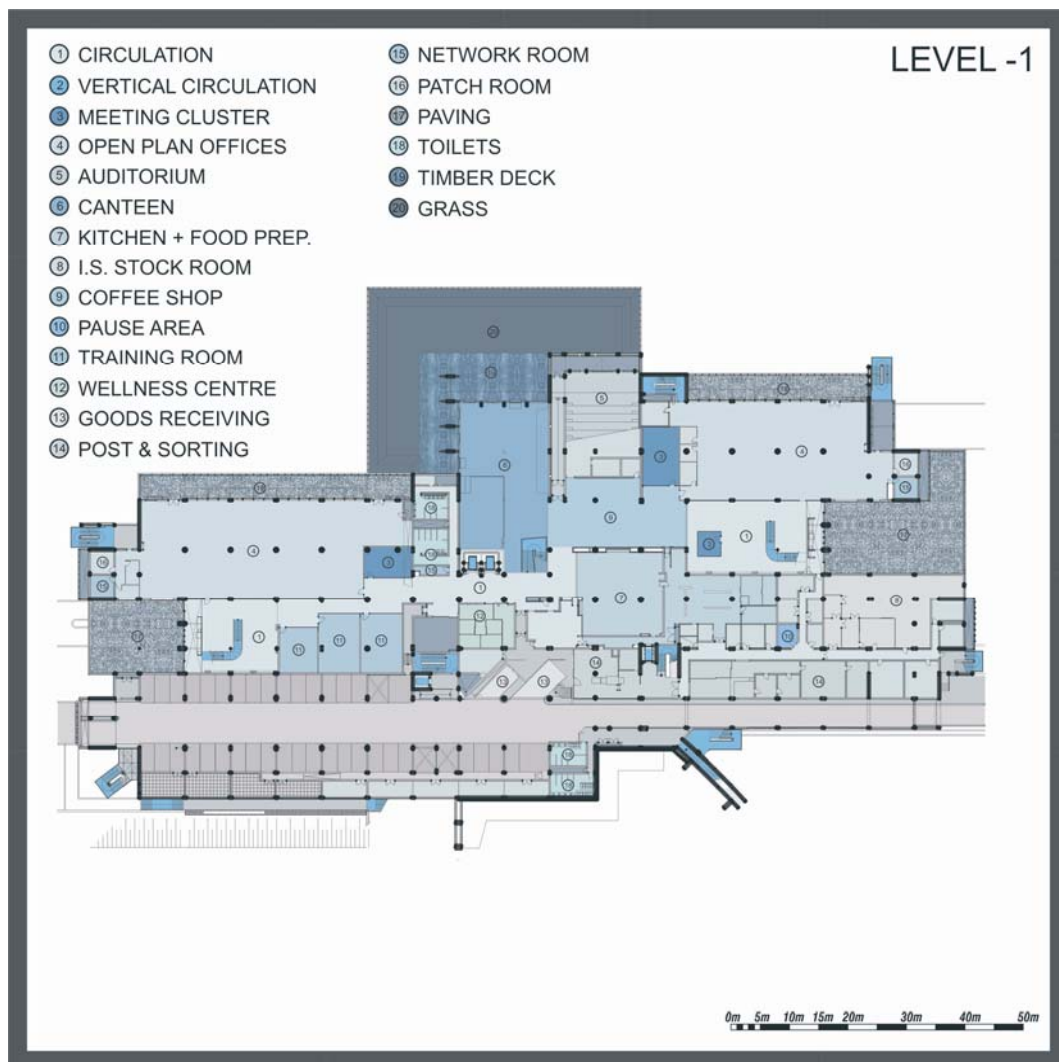


Figure B.2.04 MTN Offices – plan of underground parking level 1
(Boogertman + Partners Architects, 2005b)

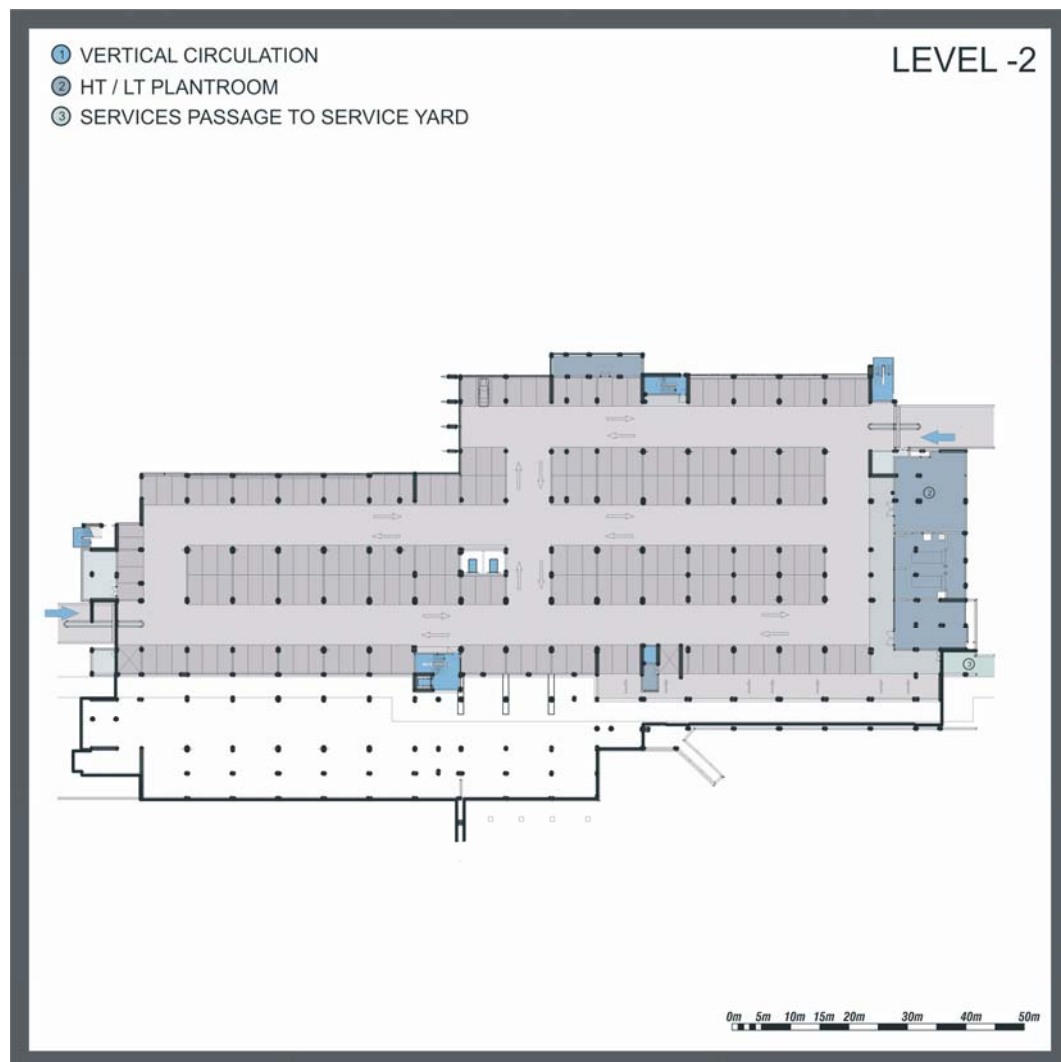


Figure B.2.05 MTN Offices – layout plan of underground parking level 2 (Boogertman + Partners Architects, 2005b)

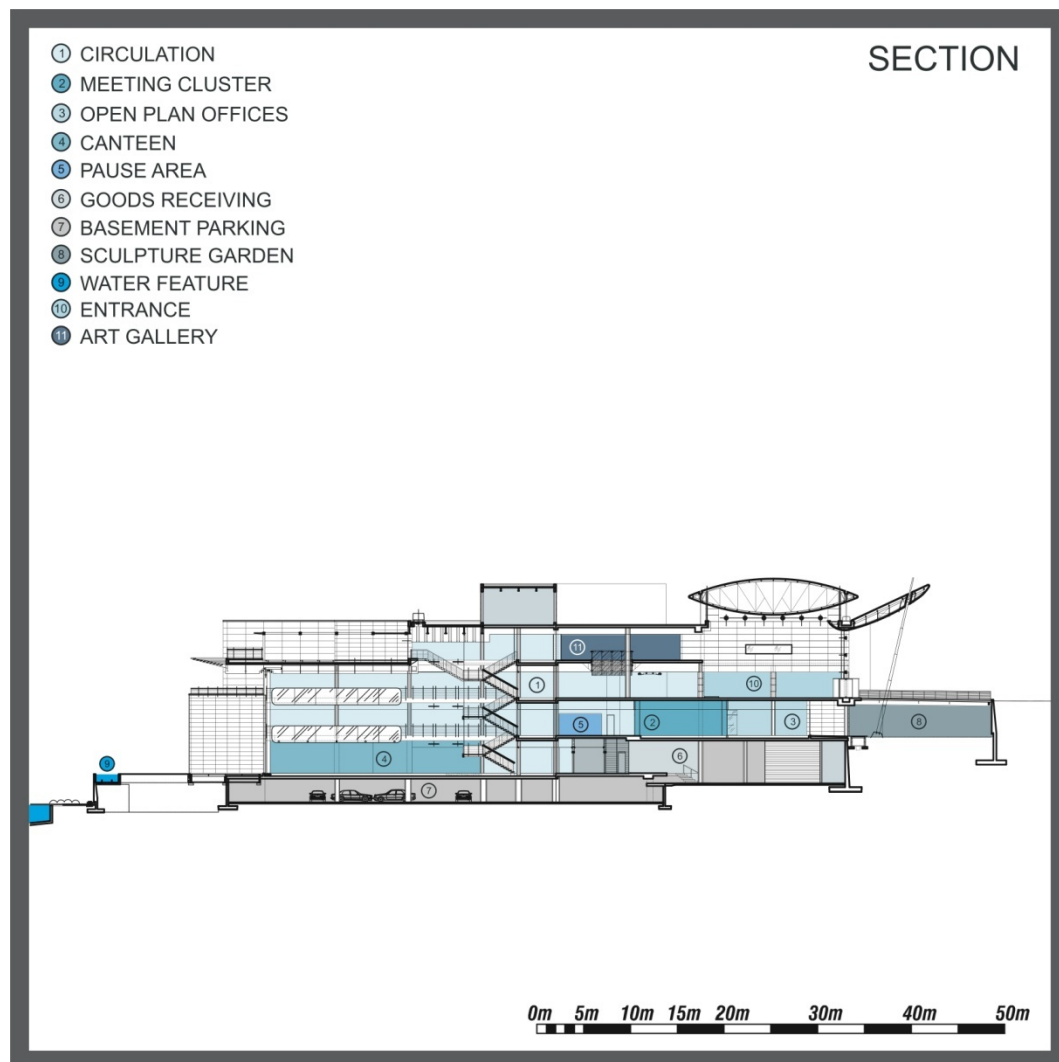


Figure B.2.06 MTN Offices – typical north-south cross section through building (Boogertman + Partners Architects, 2005b)

Photographs

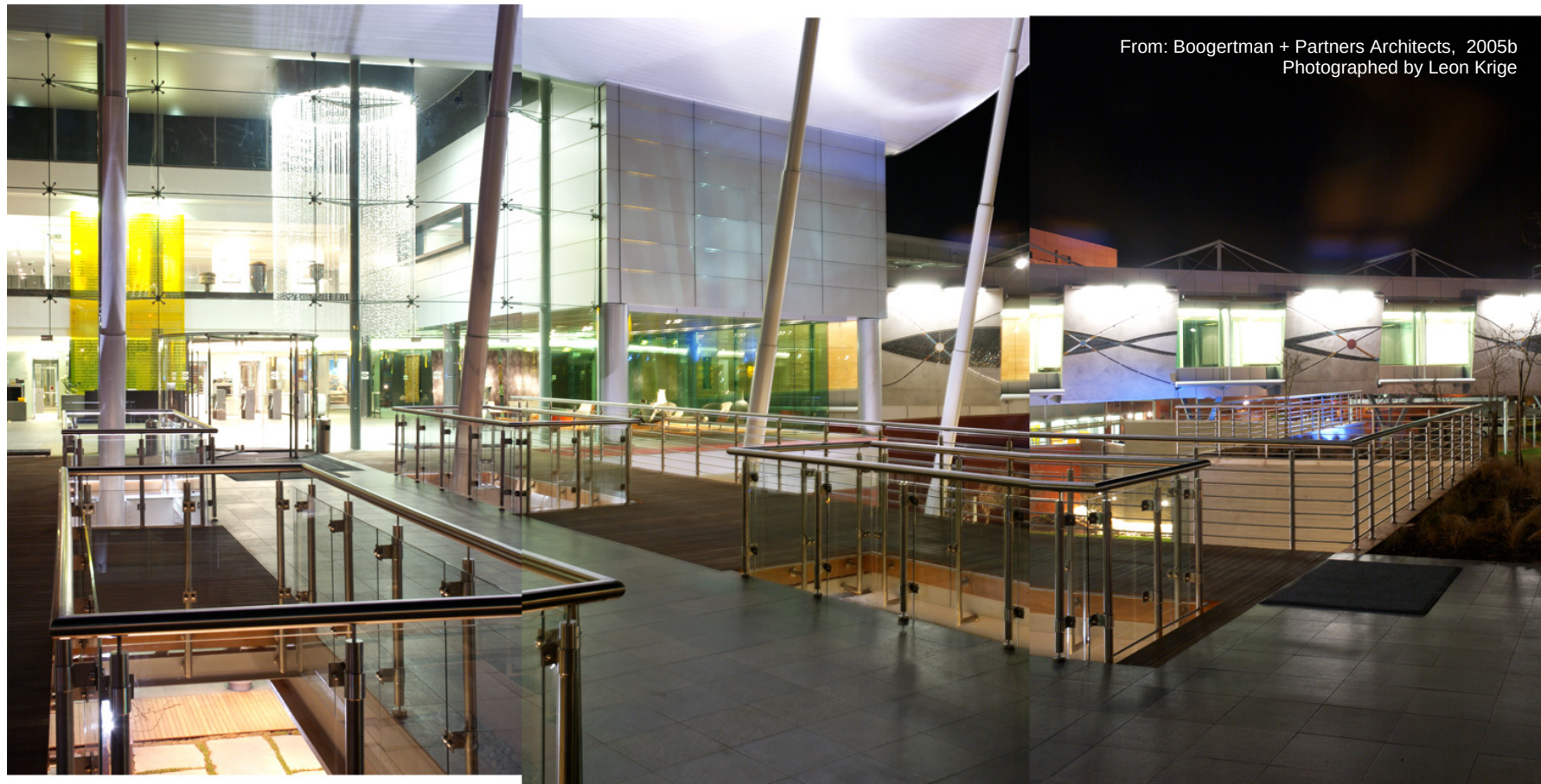
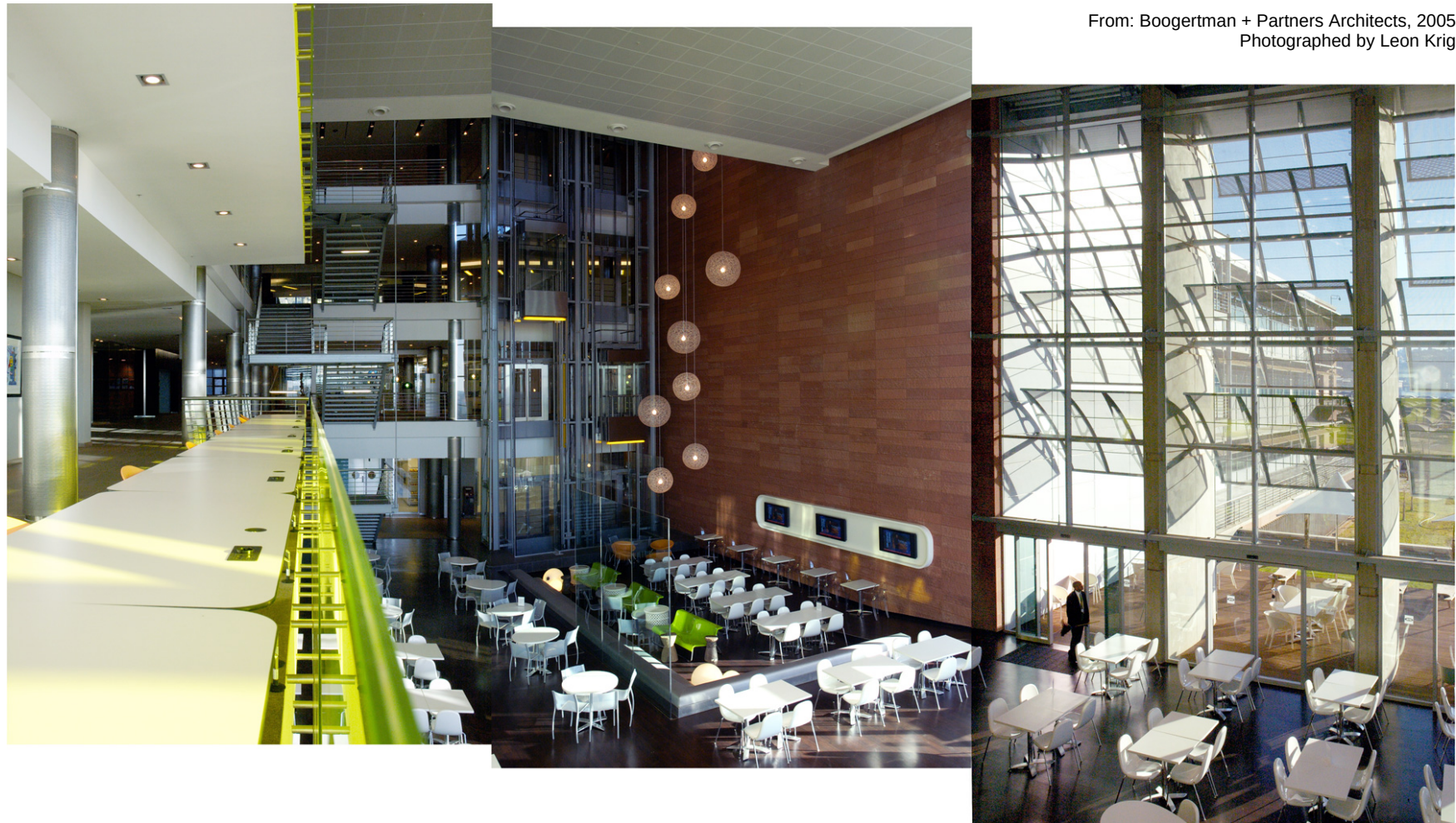


Figure B.2.07 MTN Offices – panoramic view of main entrance to MTN Offices (Boogertman + Partners Architects, 2005b)

From: Boogertman + Partners Architects, 2005b
Photographed by Leon Krige



Figure B.2.08 MTN Offices – panoramic view of north and west façades (Boogertman + Partners Architects, 2005b)



From: Boogertman + Partners Architects, 2005b
 Photographed by Leon Krige

Figure B.2.09 MTN Offices – panoramic view of food court interior (Boogertman + Partners Architects, 2005b)



Figure B.2.10 MTN Offices – view of main entrance (Boogertman + Partners Architects, 2005b)



Figure B.2.11 MTN Offices – view of north façade with shading devices (Boogertman + Partners Architects, 2005b)



Figure B.2.12 MTN Offices – view of north façade (Boogertman + Partners Architects, 2005b)



Figure B.2.13 MTN Offices – view of south façade (Boogertman + Partners Architects, 2005b)



Figure B.2.14 MTN Offices – view of office interiors (Boogertman + Partners Architects, 2005b)



Figure B.2.15 MTN Offices – view of shading devices on west facade (Boogertman + Partners Architects, 2005b)



Figure B.2.16 MTN Offices – view of food court interiors showing shading devices on west facade (Boogertman + Partners Architects, 2005b)



B.3 Case Study 3: MRe office building

Checklist

Description	Data avail.	Comments
Project background <u>Consultant team:</u> client (owner/tenant), developer professionals other (specialists, users etc.) Development objectives Brief, grade, size, location, value?	 √ x √ ½ s x	 Client owner/developer Not available None specific Toward sustainable Not available
Summary of interview <u>Design and project process:</u> project scope professional team dynamics forecasting, feedback procedures <u>Assessment tools:</u> assessment tools in use assessment procedures assessment reports	 √ √ √ n/a n/a n/a	 No assessment tool used
Drawings, photos etc.	√	Primary and secondary
Data from Assessment tools SBAT done for SB04	n/a x	 (Optional)

Interview Notes, Abbreviations etc.:

Built 1998

The following documentation of the interview is not a word-for-word transcription, but rather a summary of the discussion between interviewee and researcher, organised in bulleted form under appropriate headings as relevant to the research topic.

<i>'in italics'</i>	words written in italics with quotation marks, were the actual words of the Architect
[in brackets]	words written in square brackets are notes which have been added by the researcher for clarification purposes

Awards

Received the South African Institute of Architects' (SAIA) Award of Merit, 1999.

Summary of Interview

Carlyn Winch Architects (formerly from Stauch Vorster MOM Architects):

General design approach:

- water feature on southern side placed at entrance to mask traffic noise along busy road
- site enormous with undevelopable northern ridge, so bulk of site positioned on side of site south of culvert (which runs along the south edge of the ridge)
- 3 storey building, 2 floors similar with top 3rd floor set back to reduce the overall massing of the building
- 'green' principles: north/south orientation maximised, minimal east/west exposure – use those areas for pause areas, morning sun and areas where one is not working (*'I love the sun to come into the building in those areas'*)
- building size: approx. 5500sqm of offices over 3 storeys
- very tight site had to optimise office layout
- discreet parking:
 - o all parking underground with minimal visitors parking (+-12 bays) on grade
 - o from an aesthetic point of view did not want to see loads and loads of open parking

- o also as a reinsurance company, insure all employees' cars and required underground parking to protect against possible hail damage
- client came from corporate 'hierarchical' office [system] in CBD – in 1998 they realised that they needed to have new accommodation, open plan, much more transparency in operations
- fantastic client – provide Re-Insurance services to large insurance companies in the world, although not that well-known to the public

Introduction of 'green' philosophy:

- architect approached client to consider 'green' building principles (such as waste etc.) and questioned how they'd feel about it
- client went into discussions with board in Germany and very open to 'green' ideas, but as an architect *'I knew nothing about it'*
- at the time not many text books, research papers or anything commonly available on the subject
- it was a case of looking at [any] available material, especially southern hemisphere, Australian – a lot of it was sourced from Australia – not just examples, but basic philosophies on how to approach 'green' building design *'and its very simple'*
- look at building's mass, orientation, JHB client heavy-duty mass due to extreme temperature swings – architect approached it very pragmatically, very roughly, *'swotted up'* principles which needed to be embodied in the building (and they were very basic)
- tackled 'green' design aspects from its onset, *'crammed a little bit as the design architect'*

Appointment of professional team:

- when selected as architect, 'green' building issues did not come into it – SVA selected out of a group of approx. 5 architects through interview process
- building designed through full analysis of core needs of client which was then translated into the built fabric
- project manager appointed first on project, then architect
- from there the other team members were selected in a similar way: some suggestions put forward by architects, 4/5 CV's each from

electrical, mechanical and structural engineers – all assessed by client and in turn by architect

- consultants selected based on merit and in terms of what they could bring to the client from core needs identified: at that time ‘green’ building principles were very strong [as part of project brief]
- contractor:
 - put contract out to tender – required good quality, good management of sub-contractors (e.g. 28 selected sub-contractors involved in project – much of that due to sophisticated BMS, security etc. systems installed)
 - clerk of works on board in addition to architects to ensure quality of workmanship that would lessen maintenance requirements later on
 - quality of workmanship reflected in how well building has aged in the seven years since construction

Architect’s approach:

- architects felt building was a great opportunity to incorporate ‘green’ principles with a client responding so well to the technologies and then selecting a team *‘that would be with it all the way’*
- architect feels that through sufficient assessment of client [and their needs] it was appropriate to introduce them to ‘green’ philosophies and that client recognised marketing benefits, welcoming people into the building
- architect promised client that ‘green’ technologies did not have to cost more and believes that as an architect (if client does not wholeheartedly embrace the ‘green’ philosophies) you can introduce them: *‘it is how you design’*
- many buildings are orientated the wrong way and ignore the simple truths of the climate in which you are working – as an architect you have a choice how you work, who you work with and how you approach design: in terms of longevity these types of buildings are not sustainable
- seven years after MR building was built, the building still looks good, the client still takes pride in it and still has many students interested in it as it was in the first year the building was constructed

- in this building, architect's approach is [in a sense] to work with the client and professional team: argue that this is the specification we are looking for and through analysis and discussion explain necessary considerations to client that leads to the appropriate selection
- this presentation method provides integrated harmony where not only function, but also aesthetics are considered on equal par [with other influencing factors]

Professional team dynamics and coordination process:

- 'green' vs. 'low-tech': early in process professional team discussed what can be achieved practically, reasonably and especially what is commercially viable should building be sold in the future
- professional consultants were team players who were '*open-minded to do something different*' and demonstrated environmental awareness
- architect had overall principles in mind, and later in more detailed planning stages, 'value-added engineering workshops' were introduced
- approx. eight value-added engineering workshops were conducted:
 - main features were discussed, aspects such as double glazing, structural slab solution, access flooring
 - e.g. 'want to assess realistically what double-glazing would do for us', same workshops conducted for slabs, ceilings, access flooring: weigh up pros and cons to make decisions
 - all consultants, client and any other interested parties could contribute to the building [the decision-making process]
 - no computer tools/software used but 'old-fashioned' multiple choice questions and answers with 1 to 10 rating
 - unusual for commercial building to get both access flooring and suspended ceilings
 - the team realised all the fundamentals ...

'green' technologies:

- insulation:
 - knowledgeable mechanical engineer advised on importance of insulation
 - architect knew about general requirements to insulate roof and ground floor slab above basement

- o with client's openness to 'green' technologies, professional team was free to investigate insulation of facades from [more than] a costing point of view
- o outcome: double glazing to windows (provides sound insulation as well); mechanical engineers advised insulating the southern façade first (where insulation is a cold issue, thus address coldest façade first) and ultimately all facades were insulated; cavity walls on east + west with insulation material placed in cavity
- lighting:
 - o very little low-voltage lighting installed
 - o mainly low-compact fluorescents with some low-voltage lights installed 'for sparkle'
 - o uplighters installed for general lighting – as an architect one can be clever and pro-active without client needing to spend a lot of money
 - o emergency lighting in ceilings
 - o used a computer model for lighting, not too scientific though and used guideline of 500 lux
- passive ventilation:
 - o needed access floor to purge air at night and also needed return air through ceilings – at one of the value-added engineering workshops, the team discussed the issue of a combined access floor with suspended ceilings:
 - quantity surveyor argues the constraints in costs to install both systems
 - architect argues that suspended ceiling is needed for aesthetic, and acoustic reasons as well as fire protection (sprinklers)
 - mechanical engineer then says that if both are installed, the return air can be installed 'very cheaply'
 - after multiple choice evaluation was completed to reach the appropriate conclusion, the simple answer [in favour of access flooring and suspended ceilings] addressed the combined concerns of all interested parties

Budget aspects:

- approx. less than R1000/sq more expensive than conventional at that time
- brief called for triple A grade offices, which dictated above average costs, also excavations for 3 floors of basement parking were expensive
- sandstone R200/sqm more expensive than facebrick – architect argued that there would be a payback in use of materials (e.g. sandstone, double glazing) offset with maintenance and operational cost savings

Other building features:

- multi-purpose facilities in canteen with cooking facilities, dining, training and entertaining
- eucalyptus trees removed and 60 new indigenous trees planted
- ‘golden dawn’ sandstone cladding material on facades: architect wanted as little embodied energy as possible – difficult to prove however what embodied energy of sandstone material is because no data available; sourced from quarry north of Pretoria
- natural materials used externally as far as possible – maintenance aspects an important criteria in selection
- 15 years life-cycle of building
- sunscreens on north façade:
 - shade windows from direct sunlight
 - also as architectural feature to *‘create a bit of dynamic’*
 - some dappled light enters building on ground floor along northern façade where sunscreen is louvered (not solid as at top floor) – architect is looking into possible solutions, prefers not to use blinds in these areas which lead to closing off building from outside views
- sun screens on south façade:
 - with due north sun orientation, sun penetrates work spaces in summer afternoons, thus sun control is needed
 - also high glare off south façade of building due to open space of parking area adjacent building

- o fin wall feature at entrance has dual function: strong element announces entrance and also protects windows for sun along eastern side of south façade
- imported materials: only American carpets and chillers (?) from Belgium
- ventilation system:
 - o 2 windows in every bay with openable window per office: open at user's discretion – not often necessary
 - o during daytime AC system pushes conditioned air through access floor into office space and extracted in ceilings
 - o at night-time fresh air pushed through building – purged through floor, to flush the building
- noise control seen as part of environmental impact of building that needs to be managed – do that through installation of dampers in ducting that muffle noise where it enters/exits the building
- visual pollution was also an environmental consideration: minimise views of equipment, outlets etc. by using enclosures

Discussion of aspects related to research objectives:

- research argument: assessment tools don't succeed as design tools – they tell one *what* to do, not *how* to do it
 - o interviewee agrees: nobody tells you (apart from looking at basic issues) how to achieve e.g. specific energy values
 - o but unless one starts with these essential elements, one is not going to achieve them and yet that is not a scientific route
 - o the question remains: if it is so easy to go 'green', why isn't everything 'green'?
- observation: where owner of building is also occupier, with no developer involved, architect could communicate value to client directly [e.g. where initial expenses translate to greater operational savings later]

Related experience of the architect:

- architect has more than 7 years' experience in corporate offices: became specialist and worked in 'niche' market
- scenario in another project where architect worked with both developer and tenant:

- o developer responsible for financing: concerned with budget allowances and not in added benefits to a tenant who is only occupying the building for 10 – 15 years – ‘classic case’ where workplace enhancements can be included without allowing commercial, viability issues of developer to be jeopardised
- o in this scenario architect still considered basic design aspects: orientation, mass, shading (sun screens architect had to fight for those)
- feels confident that an architect can sell ‘green’ ideas to a client who is both owner and occupier

Feedback:

- process where everyone participated in the decision-making and kept them informed, so feedback was provided during the design process
- feedback does not stop at handover: compiled a comprehensive manual of taking care of the building which includes an overall ‘architect’s maintenance manual’ providing an easy user-guide for the client
- architect continuously involved with building since construction, aware of clients’ needs – also participated in post-occupancy changes and extensions

Building management systems and operational monitoring:

- Building management systems (BMS) installed and client was trained to manage and operate
- water consumption conventionally metered through main water pipes (i.e. municipal supply)
- dual flushing system installed, although the use of grey water is not acceptable in triple A grade specifications
- mechanical engineer needs to follow-up monitoring systems and compare it to the cost output
- architect not aware if the building is more energy efficient than a conventional building of the same kind, but feels that the BMS should be able to reveal that
- overall BMS specialists are the mechanical and electrical engineers, but architects are mostly ignorant [of the use of these systems]

Design drawings and photographs



Figure B.3.01 *MRe Offices – view of main entrance to building (Stauch Vorster MOM, 1998:1)*

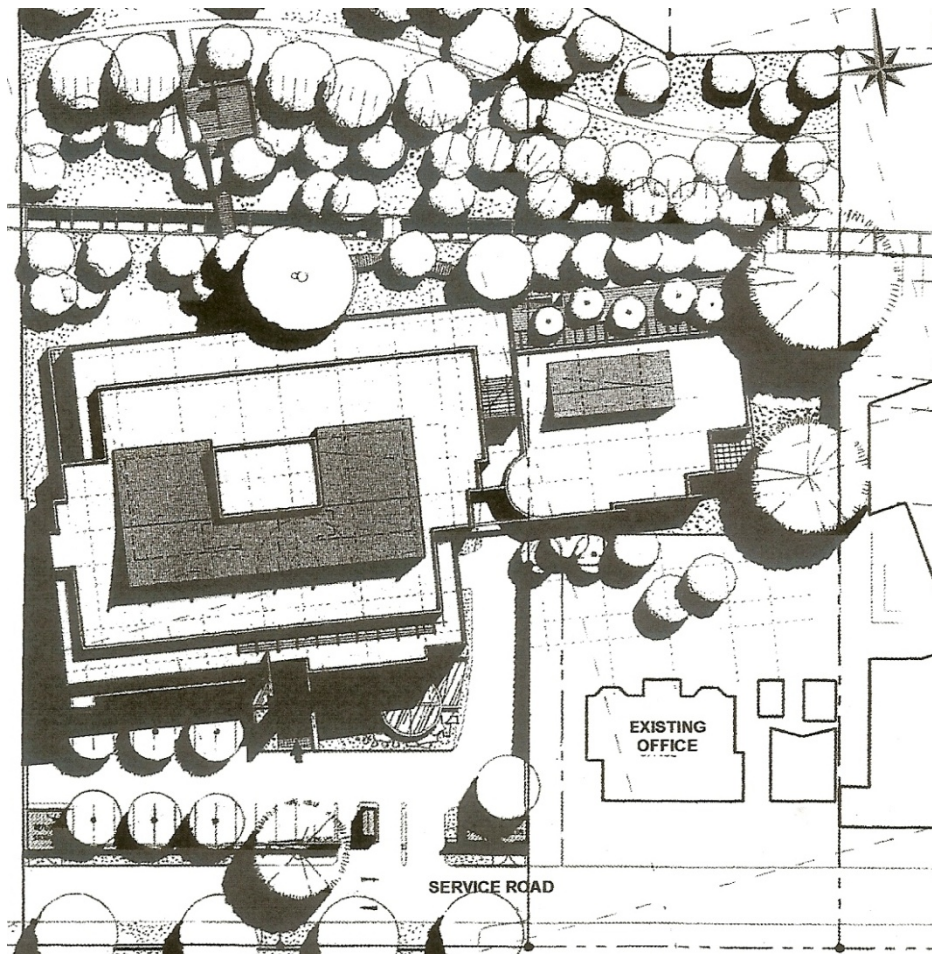


Figure B.3.02 *MRe Offices – site plan (Stauch Vorster MOM, 1998:6)*

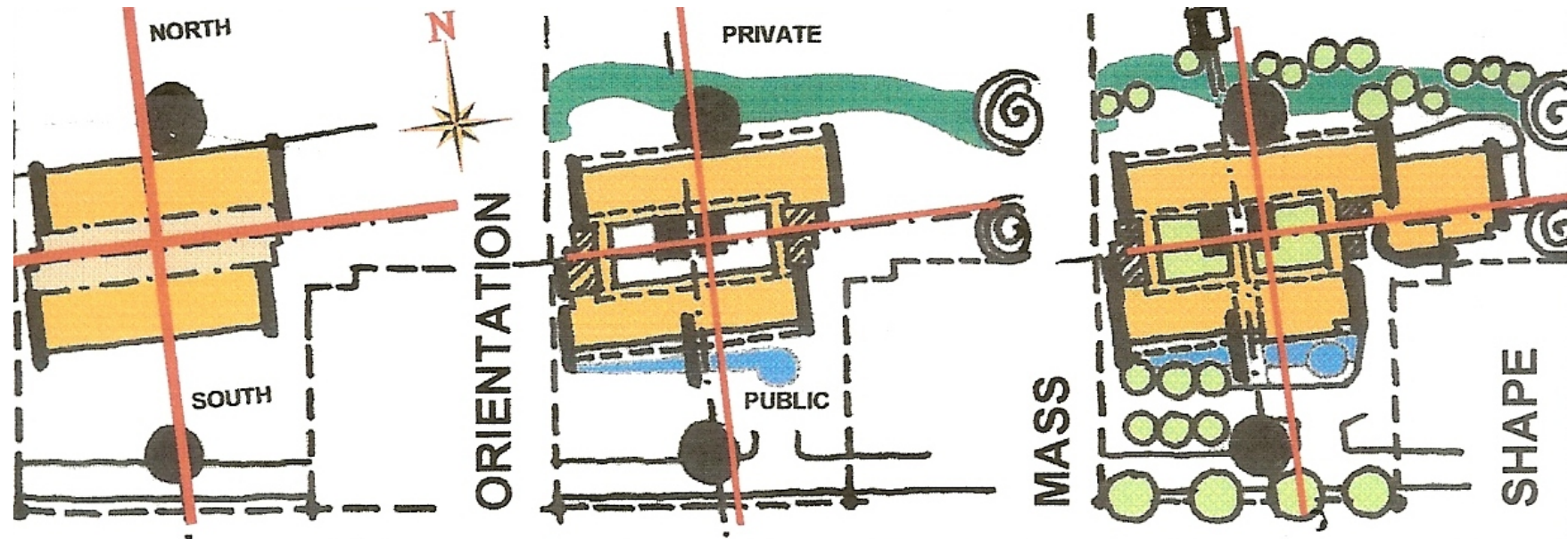
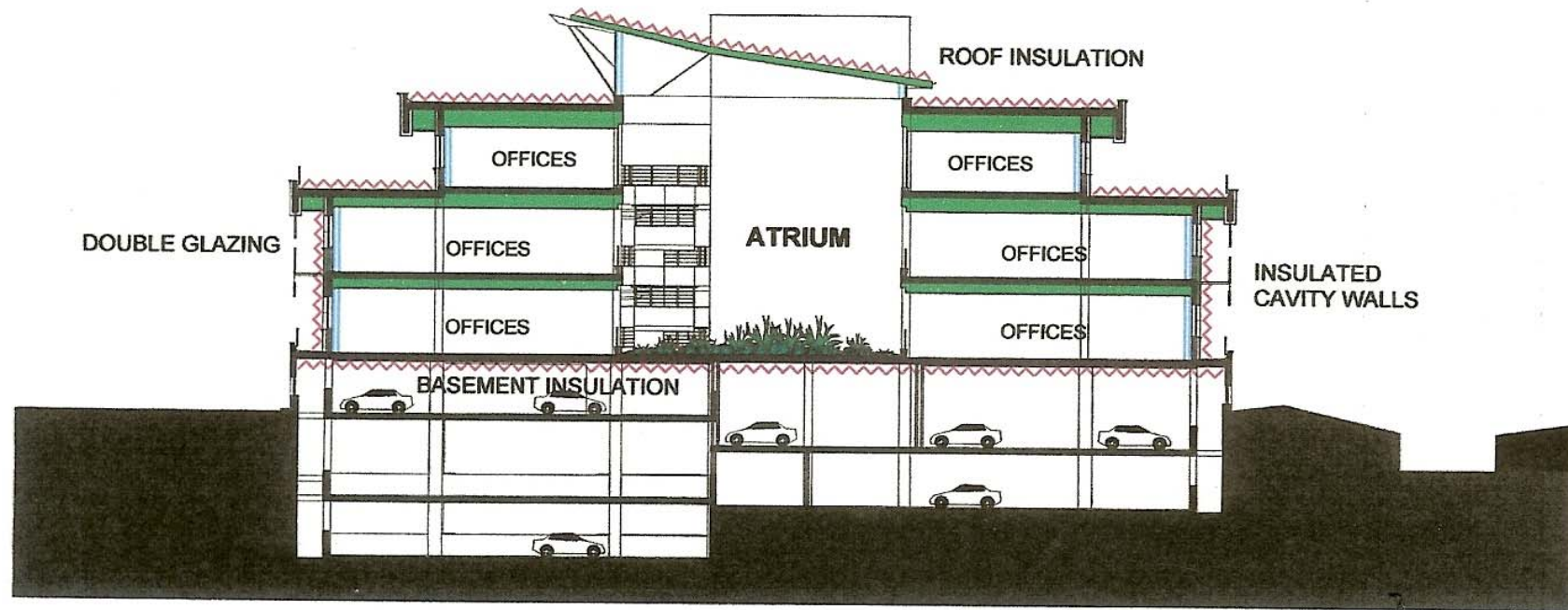


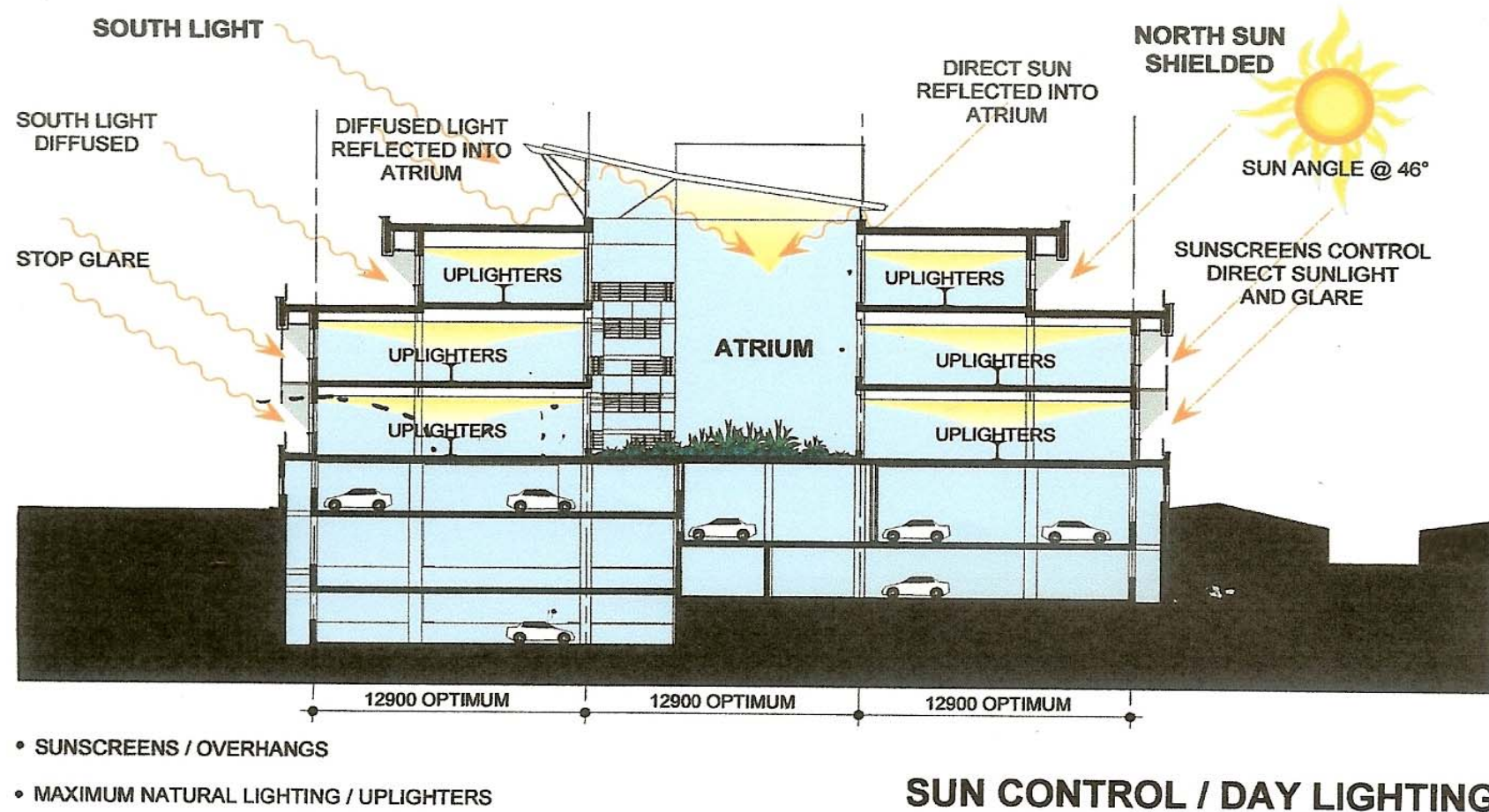
Figure B.3.03 MRe Offices – sketch studies of building orientation, mass and shape on site (Stauch Vorster MOM, 1998:6)

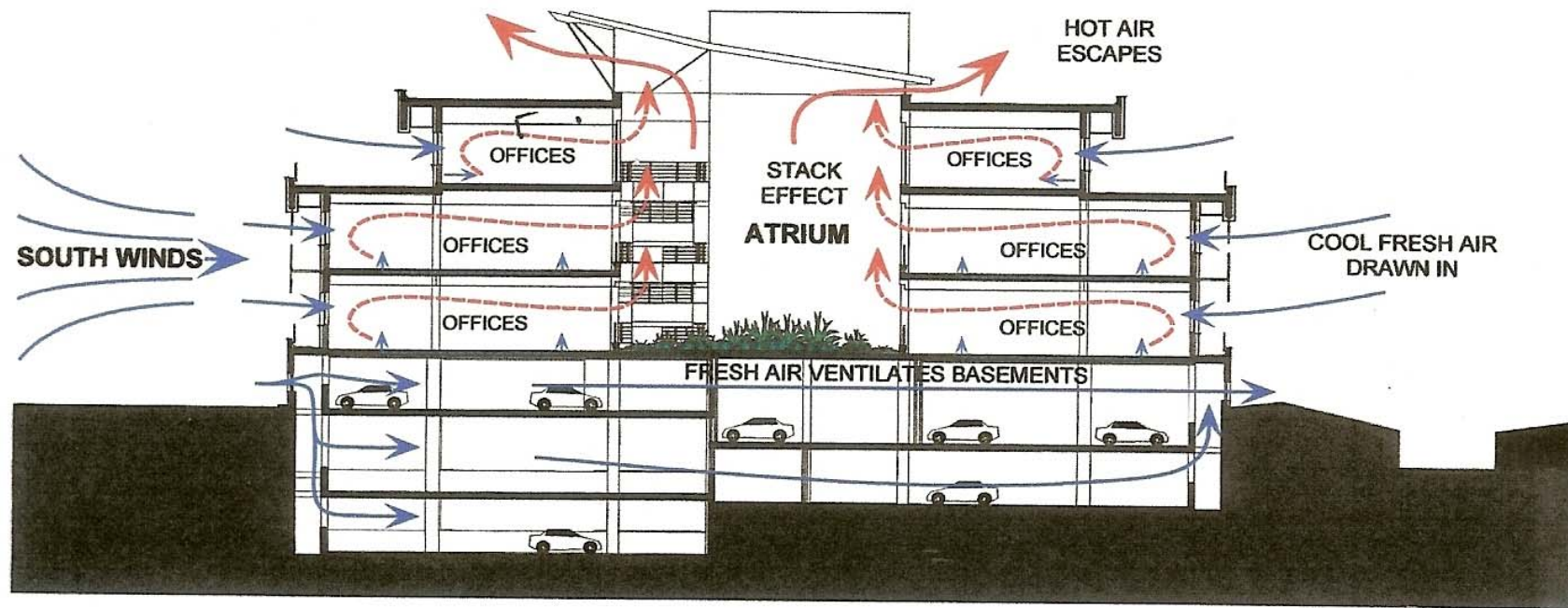


- BUILDING 'SKIN' LAYERED -STRUCTURE, INSULATION, CAVITY AND CLADDING
- HEAVY CONSTRUCTION - MASS

INSULATION / GLAZING

Figure B.3.04 MRe Offices – sketch studies of insulation and glazing through cross-section of building (Stauch Vorster MOM, 1998:7)





- 'PURGE' BUILDING AT NIGHT
- ATRIUM EXHAUSTS HOT AIR

VENTILATION / COOLING

Figure B.3.06 MRe Offices – sketch studies of ventilation and cooling through cross-section of building (Stauch Vorster MOM, 1998:6)

Photographed by Carol Knoll

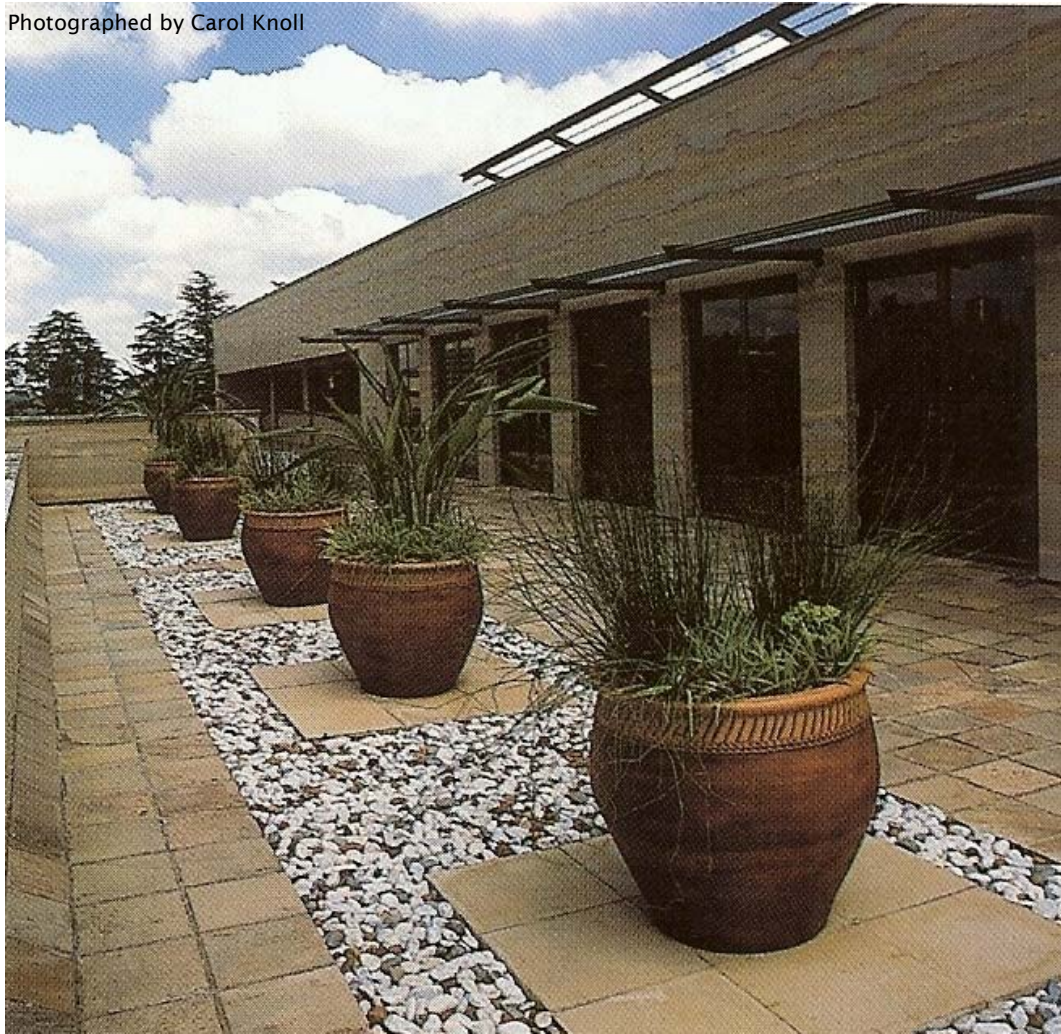
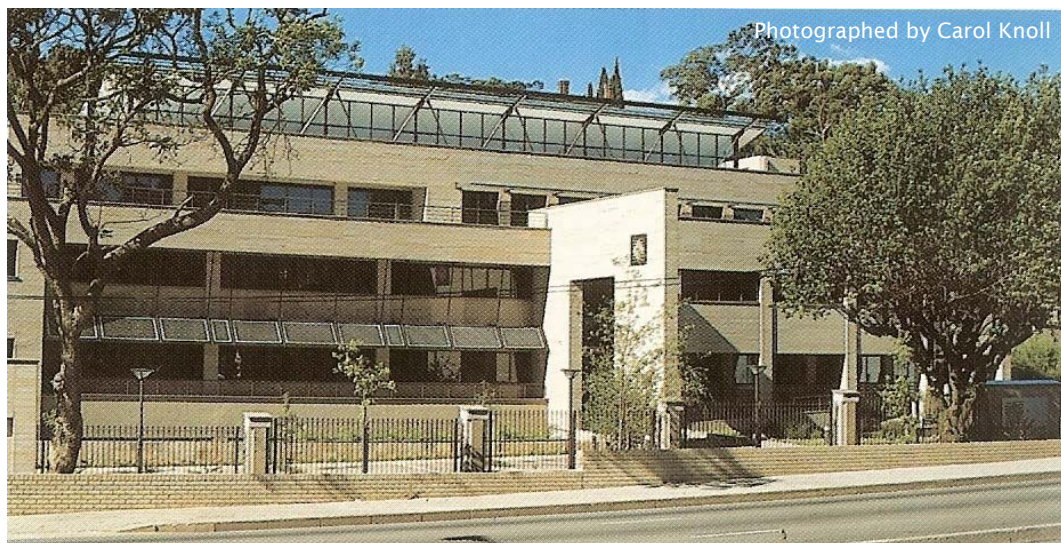
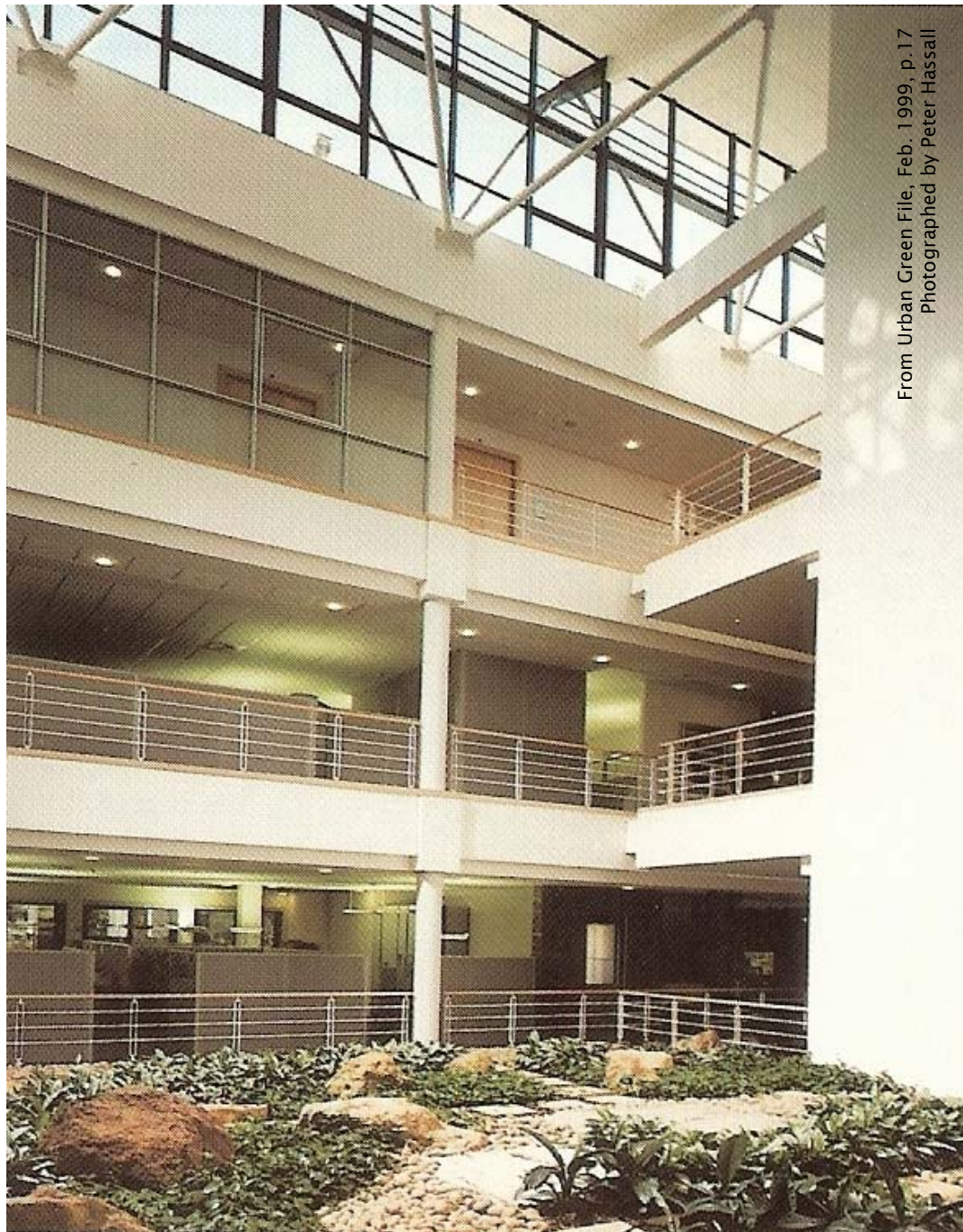


Figure B.3.07 *MRe Offices – view of interior atrium (Knoll, 1999:21)*



Photographed by Carol Knoll

Figure B.3.08 *MRe Offices – view of main entrance with shading devices over windows (Knoll, 1999:19)*



From Urban Green File, Feb. 1999, p.17
Photographed by Peter Hassall

Figure B.3.09 *MRe Offices – view of interior atrium (Knoll, 1999:17)*



B.4 Case Study 4: BP office building

Checklist

Description	Data avail.	Comments
Project background <u>Consultant team:</u> client (owner/tenant), developer professionals other (specialists, users etc.) Development objectives Brief, grade, size, location, value?	 √ x √ s x	 Client tenant + developer Not available Environmental consultant Sustainable Not available
Summary of interview <u>Design and project process:</u> project scope professional team dynamics forecasting, feedback procedures <u>Assessment tools</u> assessment tools in use assessment procedures assessment reports	 √ √ √ √ x x	 SPeAR? Team's target list Not available Not available
Drawings, photos etc.	x	Secondary
Data from Assessment tools SBAT done for SB04	x √	Not available (Optional)

Interview notes, abbreviations etc.:

Built 2004

The following documentation of the interview is not a word-for-word transcription, but rather a summary of the discussion between interviewee and researcher, organised in bulleted form under appropriate headings as relevant to the research topic.

<i>'in italics'</i>	words written in italics with quotation marks, were the actual words of the Architect
[in brackets]	words written in square brackets are notes which have been added by the researcher for clarification purposes

Awards

SA Property Owners' Association (SAPOA) voted it the "most innovative office development" in Southern Africa, 2005.

Received a commendation at the Sustainable Building Best Practice Awards, 2004.

Summary of Interview

20050615 – KrugerRoos Architects:

Project brief:

- project started as a design competition with a 'resource-efficient design' brief (commonly referred to as the RED brief) compiled by ARUP
 - included socio-economic aspects of sustainability
 - influenced selection of consultants
 - passive energy aspects of building were also considered
 - required a building management plan/environmental management plan for contractors which was included in tender conditions, e.g.
 - recycling of waste
 - reduction of dust, noise emission etc.
 - safety and health aspects
- brief influenced materials selection
 - architects had to research and investigate recycling aspects
 - e.g. wood used had to be certified that it was sourced from a sustainable source
- once architects were appointed they discussed the RED brief with ARUP in detail
- architects also appointed the environmental consultant as specialist advisor to them and the consultant team

Resource efficiency target issues:

- architects in conjunction with the environmental consultants summarised the RED brief into a document of the building's efficiency requirements
 - this document was used as a 'monitor' to the team throughout the process to show that all the aspects [i.e. target issues] required in the original ARUP brief were addressed
 - some of the total 49 target issues consisted of e.g.:
 - energy
 - resource
 - materials use
 - water
 - disruption in construction
 - staff well-being
 - support of local industry
 - the document shows what the indicator is, what its priority is (because the aspects were given different priorities), who is responsible for achieving it and who reviews it
- throughout the year [during the design/construction stages] the consultant team met and tracked what was achieved (in % ratings) in pre-contract, during contract and post contract periods

Question to the architect:

Who reviews the achievement of targets? [This question is linked to the research question re expertise (or knowledge capacity) of consultant team]

- [interviewer comment] document of target issues enables consultants to know where to apply their focus in relation to the client's more conceptual brief

Development costs and budget constraints:

- another argument came from the developer re cost and who should bear the costs of the [resource efficiency] premium to the building over and above the original development intentions of building an A-grade office

- architects' approach and contract then was to revisit the budget and '*manipulate*' it in such a way that it would not cost much more than a conventional A-grade office building
 - in conjunction with the quantity surveyors architects made savings on finishes and rather spent the money on the passive energy measures
 - [interviewer comment] did not need to compromise however on client's requirement for an A-grade standard due to reduction in funds for finishes: through good design architects were able to achieve both (passive energy installations as well as sophisticated finishes)
 - eventual development outcome – BP building is approx. 5% more expensive than a conventional building [in terms of capital costs]
- targets also show savings
 - e.g. target for overall energy-use limited to 115kWh/sqm per year – will now [that building is complete] be tested, but it seems like they are able to achieve these anticipated savings

Appointment of consultants:

- black economic empowerment (BEE) requirement that addresses economic aspects of sustainability: all consultants were in joint ventures with BEE firms
- once consultants were on board they launched an extensive research investigation to address the brief requirements

Focus on finishes:

- had to determine what came from a sustainable source
 - e.g. windows frames:
 - can use recycled aluminium, but much more costly – this in turn impacts economic sustainability, so one goes back to conventional solutions in some instances
 - team considered use of timber frames as an alternative, but it requires too high maintenance
 - eventually they chose aluminium because it is the only material that can withstand the harsh sea-side environment

- o in terms of the targets set, they were weighed up against cost – these are the realities of development practice
- o however, all the carpets in the building are recycled, but they were expensive

Building systems investigated:

- cooling:
 - o e.g. rock storage investigated but found that in Cape region the temperature swings between day and night are too small to use a rock store effectively
 - o also investigated water cooling using sea water from the harbour sea basin, but found that it may cause ecological disturbance because the harbour area is an 'entity' [like a closed system]
 - o looked into using water from the open sea with sea life in culverts growing their own insulation, but found that this option was cost prohibitive and too expensive
 - o in the end settled on the 'VAV' (variable air valve) air-conditioning system which only works when it is necessary and also, the building circulates air through its façade
- water:
 - o greywater is harvested in the building: all the rainwater is collected on a flat roof through a 'pluvia' system [it is a stormwater collection system] directed into a big water tank where it is stored in winter and in summer it is used for irrigation and to flush toilets [throughout the year]

Question to architect:

Storage tank is very big: approximately 1,450sqm. Was it difficult to convince the client to construct such a big storage tank? How was it justified or the benefit demonstrated to the client?

- consultant team (specifically environmental and plumbing consultants) did an extensive study to prove that ... [it was economically feasible]
- bottom-line was that only 20-25% of water used in building would be from municipal supply (where a conventional building uses 100% municipal supply) which convinced the client (i.e. the tenant) to install the storage tank

- there was however a resistance to the idea due to large cost implications, but the BP tenant felt very strongly that it was needed, so it was installed

Facades and energy efficient measures:

- ‘kit-of-parts’ developed for the façades:
 - ‘parts’ consist of
 - a light shelf to bounce sunlight deeper into the office space and to provide shade
 - balcony to provide access for cleaning
 - terracotta [coloured] brick panel which keeps heat out where façade is in direct sunlight
 - where the sun hits the façade, the glass panel of window is positioned in the shade
- roof
 - photovoltaic cells installed on steel supporting structure which also put the entire roof in shade which significantly reduces heat gain
 - energy generated with photovoltaic cells are put back into the municipal grid, which is in turn reimbursed to the tenant, further reducing the tenant’s operational costs
- lighting
 - internal lights set on dimmers, so when it gets lighter outside, lights dim automatically although it is imperceptible
 - dimming also allows for constant lux levels throughout the day

Question to architect:

Architect mentioned extensive research work that was undertaken to incorporate efficiency measures in the building, e.g. materials, energy use etc. Did it seem like it was the first time that the ‘supporting’ industry (i.e. the manufacturers and suppliers) worked with these ‘efficiency’ aspects?

- most people knew about it and were very helpful, especially with respect to the carpet and floor finishes
- for some it was their first time and this process made them more aware of these aspects

Design process:

- as an architect experienced the process as distinctly different from previous [conventional] processes
- architects still led the process as the principal agent, but in other projects they are more prescriptive where in this one it was more a case of *'they were prescribed to'* by the consultants and the consultants played a leadership role
- many meetings were held where all the consultants were present and each would put their system on the table
- instead of architects being prescriptive, they were inclusive: rather than saying this is what the building is going to look like, *'you have to fit in'*, they said *'you want this, you want this and you want this'* and then *'let's put it all together to create an aesthetic'*
- e.g. the depth of the façade, the sizes of windows, the kit-of-parts and 'lantern' skylights on roof were all a direct consequence of these interactive meetings
- normally architects are on one side with consultants giving their input, but in this process the architects were at the same level, another one of the consultants
- architects kept the leadership of the process however and was still responsible for the coordination

Question/comment to the architect:

The architect is the only consultant on the team that has the capacity to integrate all the different requirements of the various consultants, to bring it together aesthetically. Argue that sustainability is not a style, but in a good design these features are so integrated in the building that the 'style' (or sustainability features) are not visible.

- in this building it was an interesting situation too: there was a historic identity to the building's urban context and the architects had to conform to the [surrounding] style 'family' in this building, e.g. in terms of its form, colour etc.
- on the other hand, the tenant required that the efficiency features are demonstrated in the building

- the architects thus had to balance the aesthetic so that it fit in on a historical level (in terms of window sizes, massing etc.) with the subtle presence of the efficiency installations
- comment: building does not look 'new', thus it very successfully blends in surrounding context
 - architect confirms that this was one of the brief requirements

Design tools:

What tools were used by the architects specifically? Or were the tools mostly used by the consultants who communicate outcomes to the architects?

- architects went through the learning curve with the consultants
- architects as principal agents needed to understand each of the systems in the building, so that they were able to '*make a call*' on certain issues
- if the architects were aware of an alternative in one discipline that could be used to solve an issue in another discipline that would allow that system to be installed, then the architects were able to make that call
 - o e.g. with the light shelves:
 - architects needed shade on the glass windows and they knew that they needed to reduce the heat gain from extensive artificial lighting inside
 - they found the solution of the light-shelf with the help of the consultants which provides shade and also bounces external light deeper into the office spaces, thereby reducing the need for extensive artificial lighting
 - o also example of photovoltaic cells used for shading on the roof:
 - one discipline requires insulation or shading to the roof to reduce the heat gain
 - another discipline requires location for photovoltaic cells
 - architect can bring two requirements together and provide one solution
- it was a learning curve for all and the consultants had a palette of aspects which they worked with – the architects understood each of

these palettes and put it together: in a sense the architects '*plugged into*' the consultants' information

Question/comment to the architect:

In conventional projects a sustainability consultant is appointed (as in this case) who works in a specialist field. How does an architect facilitate the creation of synergies? Architect does that through an understanding of each of the respective consultants' systems and has the ability to remain objective by not getting involved with the details of the sciences, but focus on using their creativity of how to solve problems and determine what can be manipulated

- architects were given a shopping list and they understood what the priorities were, e.g. lighting was low on the priorities list, others were high
- there were also some confrontations in the meetings because disciplines started to overlap [and interests clashed]
- another contributing factor could also be the short duration of the construction programme: people were forced to make decisions, which caused conflict, but alternatively, by making decisions the project's momentum could be maintained
- sometimes architect also felt overwhelmed by the task in terms of addressing aspects they've never before come across

Competition project:

- the winning design for the building was significantly different from it's eventual outcome
- architect feels that the key to winning lay in their approach that the competition scheme was seen as '*a framework and we now have to design a building with you*'
- the building massing was revised to optimise floor to façade area ratio, but wanted to retain '*fine grain*' [i.e. they did not want a heavy footprint]
- the eventual outcome of the design was based on passive energy principles

Question to the architect:

What about the building's orientation [which is not due north]?

- some of the earlier designs considered a north orientation for the building, but after consultation the architects and façade engineers convinced the client that it is not the building, but rather it's facades that is oriented
- if the facades are removed from the building and through the use of the kit-of-parts the facades can be designed and oriented in such a way that only the required sun enters the building
- approach was then to design each of the facades differently and [thus] each façade looks different from the other

Question to the architect:

What about future projects? How will the experience gained through this project inform future projects? What do you think lies within your capability as an architect to be proactive in terms of integrating sustainability aspects?

- in another project where developer indicated interest in sustainability, these aspects were integrated into their proposal and it was fantastic how it all fell into place and interesting to the architect to see how differently one thinks about design and buildings
- now when looking at buildings, in design architect immediately considers what are the possibilities of incorporating sustainability aspects, promoting natural ventilation etc.: *'it let's you think differently about buildings, their layout and how facades are treated'*
- interesting also how willing clients are to get involved

Question to the architect:

What are the tools that architects use? What is in their toolbox?

- for directors in this firm they are:
 - typically, design informants are:
 - client's needs: accommodation list
 - site: topography, environment etc.
 - money: cost, budget etc.
 - from above the architects develop a diagram
 - this diagram is then used as a tool to develop the design

- other architects work completely different, have another approach: each process is subjective

Question to the architect:

Forecasting and feedback: is a process underway to set up [performance] monitoring of building? Has a decision been made about the format that will be used or to whom the results will be communicated?

- the results will be communicated to the client [the developer] and the tenant
- it will also be used for the tenant's publication purposes
- architect needs to meet with environmental consultant to review the design process and determine:
 - the monitoring format
 - refer to the original target issues and determine whether they achieved the goal
 - the building's performance needs to be measured over time: a process stills needs to be put in place for that
- further idea of architect also to do a cost and life-cycle comparison by
 - creating a conventional building whereby BP's sustainability features are removed and the expensive [albeit conventional] finishes are included to compare it with the actual BP building
 - e.g. ARUP's original brief includes a framework of costs and how they are distributed throughout a building: e.g. the roof in a sustainable/energy efficient building is more expensive than in a conventional etc.
 - based on this premise it would be possible to compare the conventional and BP buildings and also to compare upfront cost vs. life-cycle costs thereby determining the viability of installing certain sustainability features
 - problematic however because a developer is concerned with the capital costs and not the life-cycle costs, which is passed onto somebody else

Design drawings and photographs

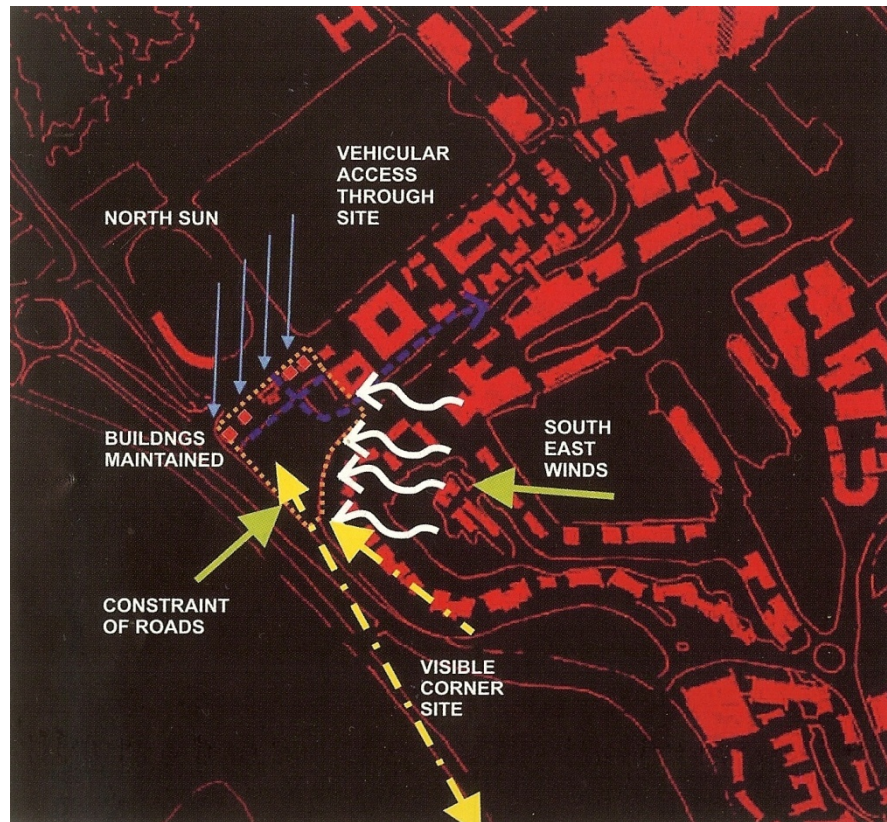


Figure B.4.01 *BP Offices – site design context (Darroll, 2003:30)*



Figure B.4.02 *BP Offices – view of building seen approaching from Dock Road (Kruger Roos Architects, 2004:90)*



Figure B.4.03 *BP Offices – view of north-east façade of building (Noir and Roos, 2005:40)*



Figure B.4.04 *BP Offices – main entrance (Digest of South African Architecture, 2006:137)*



Figure B.4.05 *BP Offices – view of green building design features (Digest of South African Architecture, 2006:137)*



Figure B.4.06 *BP Offices – view of north-east façade of building (Noir and Roos, 2005:41)*



Figure B.4.07 *BP Offices – detail view of light shelves, façade shading devices and passive-ventilation turbines (Kruger Roos Architects, 2004:89)*

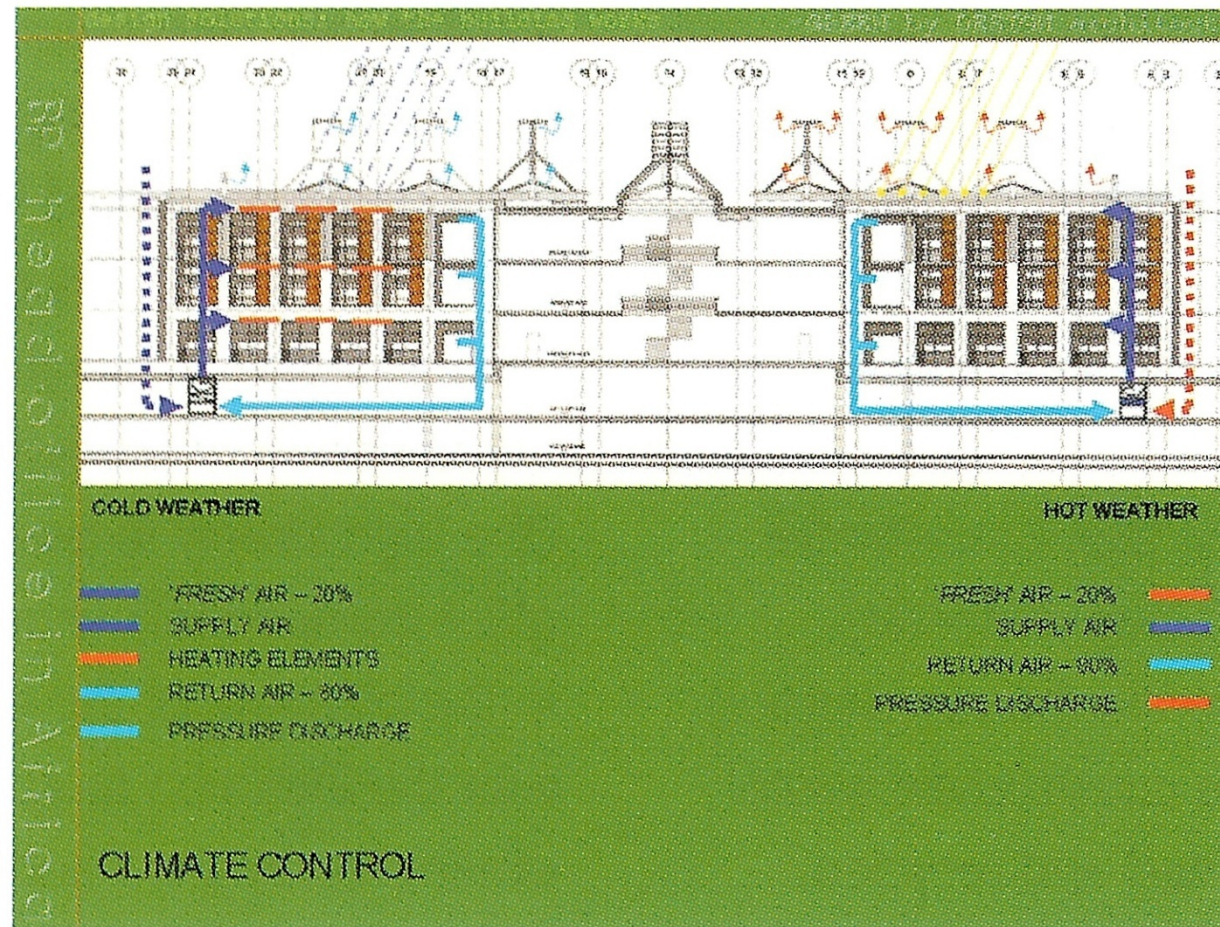


Figure B.4.08 BP Offices – diagrammatic illustration of climate control in building (Noir and Roos, 2005:38)

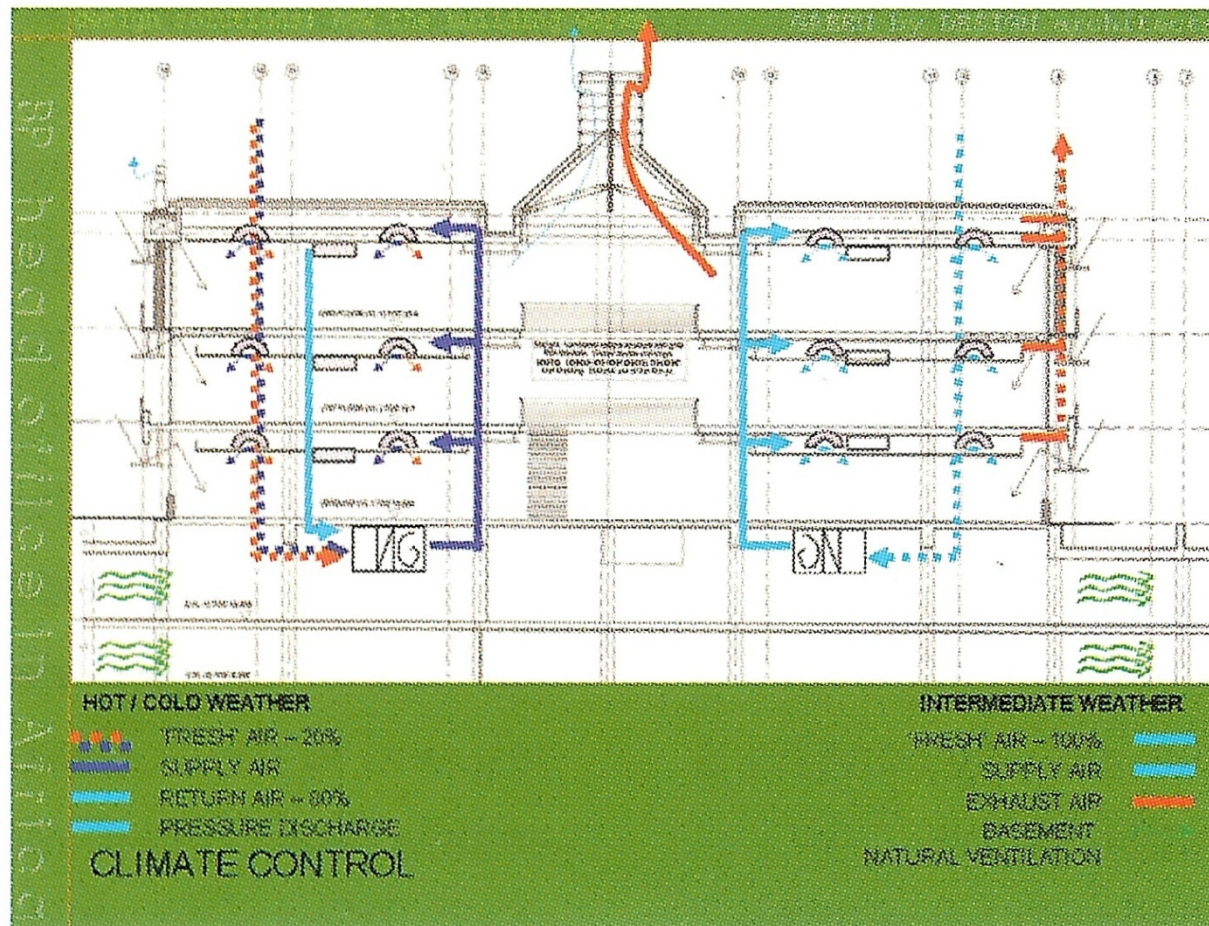


Figure B.4.09 BP Offices – diagrammatic illustration of climate control in building (Noir and Roos, 2005:38)

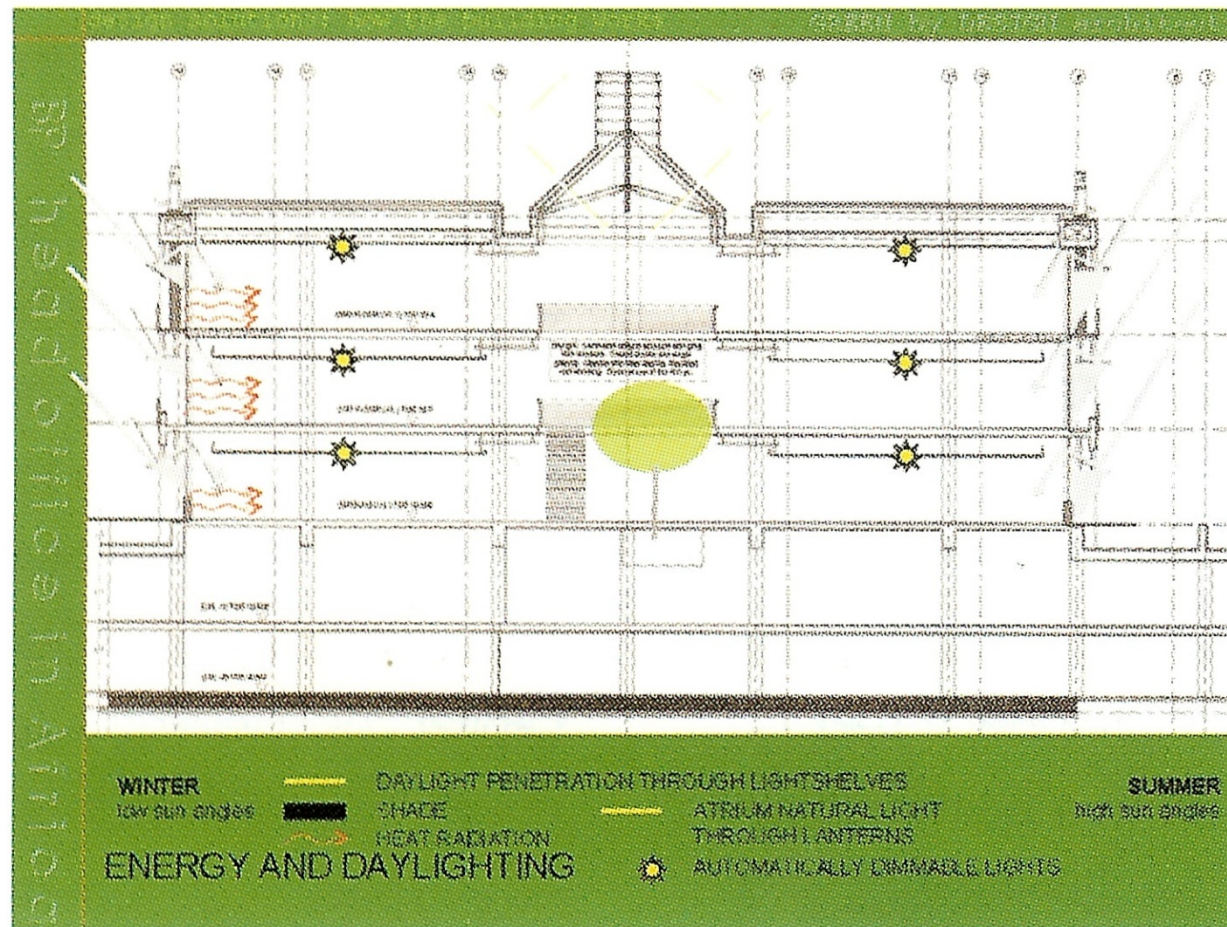


Figure B.4.10 BP Offices – diagrammatic illustration of energy and daylighting in building (Noir and Roos, 2005:38)



Figure B.4.11 *BP Offices – view of roof lanterns and photovoltaic panels on roof (Kruger Roos Architects, 2004:90)*



Figure B.4.12 *BP Offices – close-up view of roof lanterns on roof (Noir and Roos, 2005:36)*



Figure B.4.13 *BP Offices – interior view of roof lanterns on roof (Noir and Roos, 2005:39)*



Figure B.4.14 *BP Offices – interior view of atrium and office space (Kruger Roos Architects, 2004:90)*



Figure B.4.15 *BP Offices – interior view of office space (Digest of South African Architecture, 2006:137)*



Figure B.4.16 *BP Offices – interior view of atrium (Digest of South African Architecture, 2006:137)*

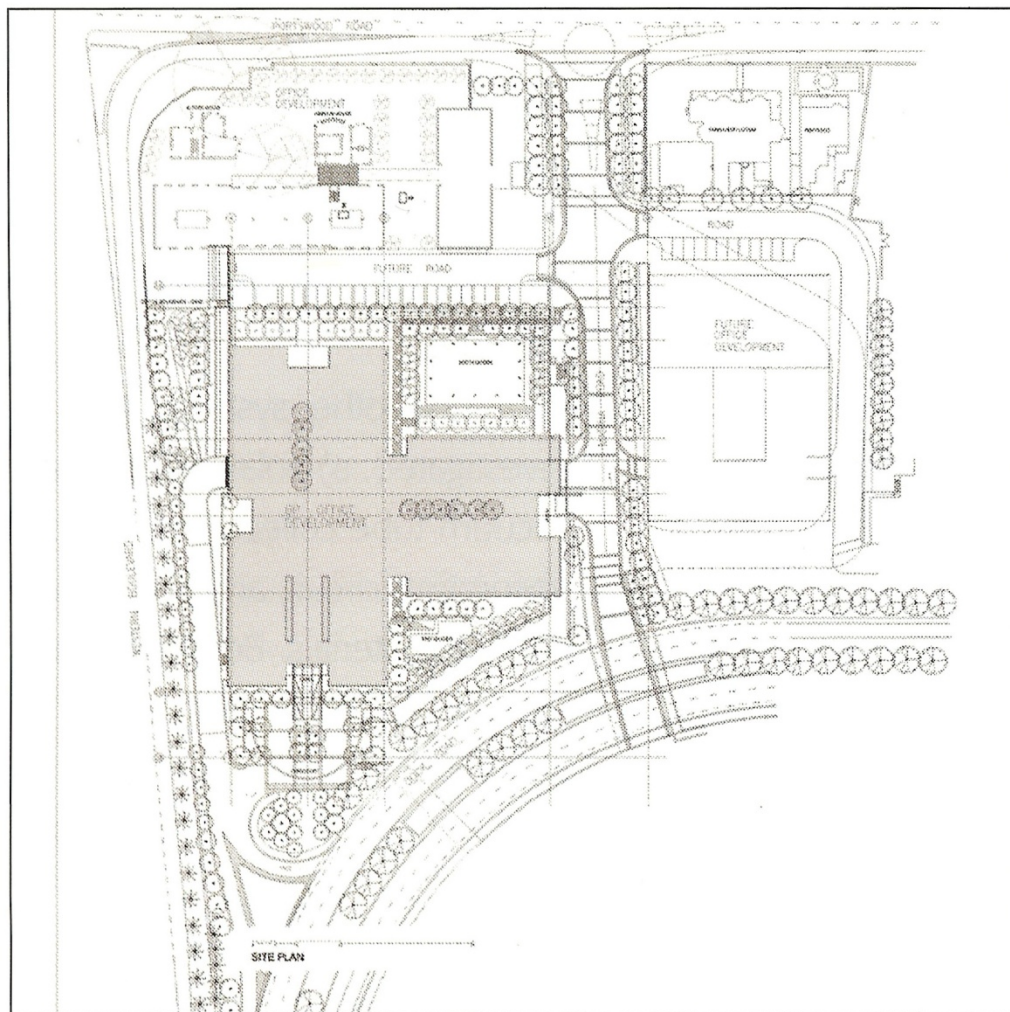


Figure B.4.17 BP Offices – site plan (Noir and Roos, 2005:37)

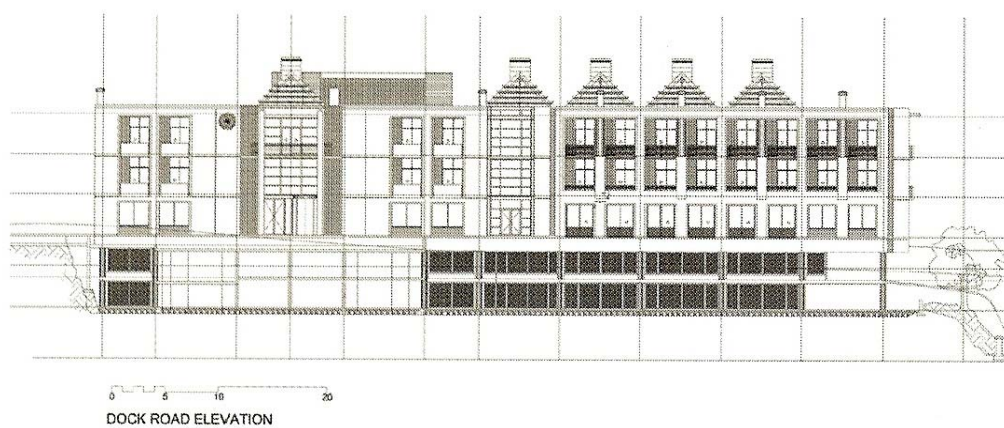


Figure B.4.18 BP Offices – Dock Road (south) elevation (Noir and Roos, 2005:38)

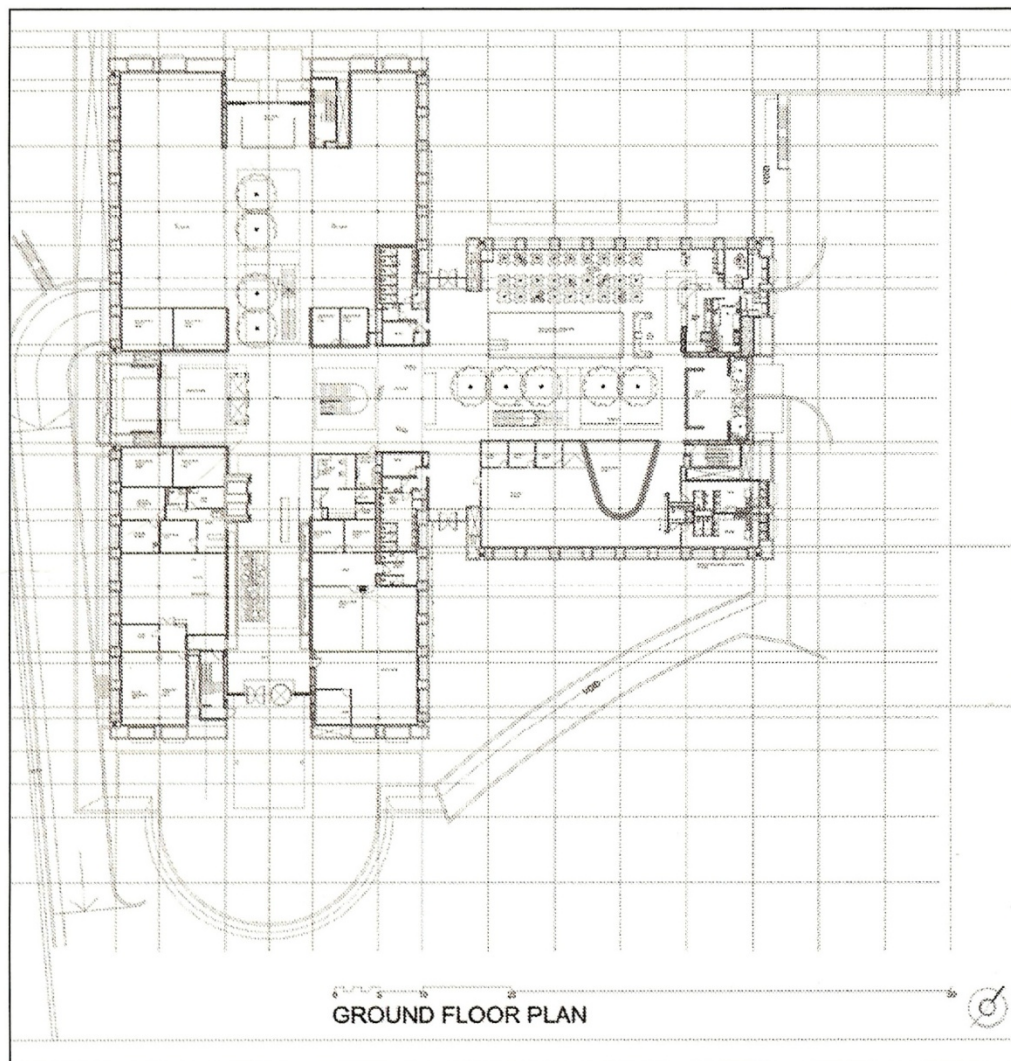


Figure B.4.19 BP Offices – ground floor plan (Noir and Roos, 2005:37)



Figure B.4.20 BP Offices – sketch perspective view of south elevation (Noir and Roos, 2005:39)

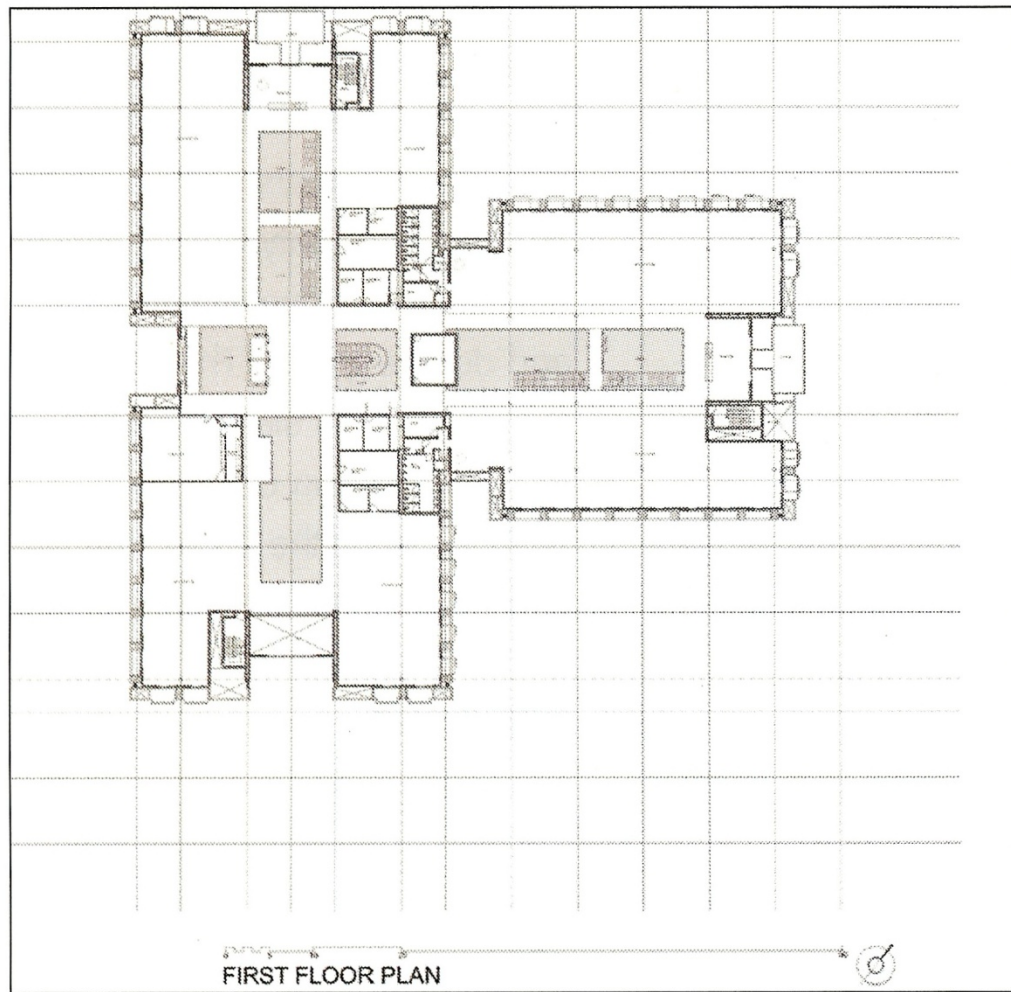


Figure B.4.21 BP Offices – first floor plan (Noir and Roos, 2005:37)



REFERENCES

- ARUP. (2007) SPeAR®: *Product overview*. INTERNET. <http://www.ARUP.com/environment/feature.cfm?pageid=1685>. Cited 2007/04/07.
- BILD Architects. (2005a) *Drawings and model photos of the DST Office Building*. CD-ROM. Pretoria, RSA: BILD Architects.
- BILD Architects. (2005b) *High-performance Green Buildings*. E-MAIL. [Green Buildings - 24-08-2004 - Eddie.doc](#). Cited 2005/02/27.
- BILD Architects. (2005c) *Sustainable Building Assessment Tool*. E-MAIL. [SBAT Targets.xls](#). Cited 2005/02/27.
- Bogenstätter, U. (2000) Prediction and optimization of life-cycle costs in early design. *Building, Research and Information*, Vol. 28, no. 5/6, Sept. – Dec. 2000, pp. 376 – 386.
- Boogertman + Partners Architects. (2005a) *MTN Green Building Checklist*. E-MAIL. [green building criteria.xls](#). Cited 2005/08/17.
- Boogertman + Partners Architects. (2005b) *Photos and drawings of the MTN Office Building*. CD-ROM. Johannesburg, RSA: Boogertman + Partners Architects.
- Bordass, B. (2003) Learning more from our buildings – or just forgetting less? [Review of the book “Learning from our buildings: a state of the practice summary of post-occupancy evaluation” by Federal Facilities Council.] *Building, Research and Information*, Vol. 31, no. 5, Sept./Oct. 2003, pp. 406 – 411.
- Bordass, B., Leaman, A. and Ruyssevelt, P. (2001) Assessing building performance in use 5: conclusions and implications. *Building, Research and Information*, Vol. 29, no. 2, Mar./Apr. 2001, pp.144 – 157.
- Bothwell, K. (1997a) *A model format for case studies using common indicators of sustainability*. Proceedings of the “Florence 2° International Conference for Teachers of Architecture”, Oct. 1997. Florence, Italy: Alinea Editrice.

- Bothwell, K. (1997b) *Towards a common specification for case studies using indicators of sustainability*. Proceedings of the "Florence 2° International Conference for Teachers of Architecture", Oct. 1997. Florence: Alinea Editrice.
- Building Research Establishment Ltd. (BRE). (2007a) *BREEAM Fact File Version 3/Revision 00*. INTERNET. http://www.breeam.org/filelibrary/Breeam_Fact_File_Version_3_February_2007.pdf. Cited 2007/04/06.
- Building Research Establishment Ltd. (BRE). (2007b) *Envest*. INTERNET. <http://www.bre.co.uk/service.jsp?id=52>. Cited 2007/04/06.
- BREEAM. (2007a) *The BREEAM Family*. INTERNET. <http://www.breeam.org/page.jsp?id=66>. Cited. 2007/04/06.
- BREEAM. (2007b) *The Environmental Assessment Consortium*. INTERNET. <http://www.breeam.org/>. Cited. 2007/04/06.
- BSD Global. (2005) *The triple bottom line*. INTERNET. http://www.bsdglobel.com/tools/principles_triple.asp. Cited 2005/12/03.
- Capra, F. (1982) *The turning point - science, society and the rising culture*. London, UK: Fontana Paperbacks.
- CEC. (1999) *A Green Vitruvius: principles and practice of sustainable architectural design*. London, UK: James & James.
- CIB, UNEP, CSIR and CIDB. (2002) *Agenda 21 for Sustainable Construction in Developing Countries*. Pretoria: CSIR Building and Construction Technology.
- CIRIA. (1993) *Environmental issues in construction: a review of issues and initiative relevant to the building, construction and related industries*. Vol. 1 – overview including executive and technical summaries. Special Publication 93. London, UK: CIRIA Publications.
- Cole, R.J. (2005) *Building environmental assessment methods: redefining intentions*. Proceedings of the "Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo", Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.

- Cole, R.J., Howard, N., Ikaga, T. and Nibel, S. (2004) *Building environmental assessment tools: current and future roles*. Issue paper for unit session 4 & 5 of the "Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo", Sept. 2005. INTERNET. <http://www.sb05.com/homeE.html>. Cited 2004/07/25.
- Cole, R.J. (1999) Building environmental assessment methods: clarifying intentions. *Building Research & Information*. Vol. 27, no. 4/5, Jul. – Oct. 1999, pp. 230 – 246.
- Cole, R.J. (1998) Emerging trends in building environmental assessment methods. *Building, Research and Information*, Vol.26, no. 1, Jan./Feb. 1998, pp. 3 – 15.
- Cooper, R., Kagioglou, M., Aouad, G, Hinks, J., Sexton, M. and Sheath, D. (1998) *The Development of a Generic Design and Construction Process*. INTERNET. <http://www.processprotocol.com/pdf/pdt98.pdf>. Cited 2007/08/04.
- CSIR. (2004) *SB'04 Africa - Regional Conference on Building and Construction, Sustainable Building Best Practice Awards*. INTERNET. <http://www.buildnet.co.za/akani/print/2004/nov/print08b.html>. Cited 2007/04/07.
- CSIR. (2003a) *The sustainable building CD – User Manual*. INTERNET. <http://www.sustainablebuildings.co.za/introduction/SB%20manual.pdf>. Cited 2004/07/25.
- CSIR. (2003b) *The Sustainable Building Assessment Tool version 2.0 (SBAT 2.0)*. INTERNET. <http://www.sustainablebuildings.co.za/index.htm>. Cited 2004/07/25.
- Darroll, L. (2002) *Sustainable building initiatives*. The Urban Green File, Vol. 7, no. 3, Jul./Aug. 2002. INTERNET. <http://www.urbangreen.co.za/archives/construction/7%2D3sustainableconst.htm>. Cited 2006/5/13.
- Darroll, L. (2003) Beyond the conventional: multi-functionalism in design to deliver sustainability. *The Urban Green File*, Vol. 8, no. 3, Jul./Aug. 2003. p.30 – 33.

- Digest of South African Architecture. (2006. BP Corporate Head Office, Cape Town. *Digest of South African Architecture*, 2005/2006. Cape Town: Picasso Headline. p. 136 – 137.
- Du Plessis, C. (2002) *The environmental impact of buildings*. Proceedings of the “Sustainable Buildings and Integrated Design” training workshop, Sept. 2002. Johannesburg: South African Solar Academy.
- Du Plessis, C. (2001) Sustainability and sustainable construction: the South African context. *Building Research & Information*. Vol. 29, no. 5, Sept./Oct. 2001, pp. 374 – 380.
- Encarta Dictionary. (2005) *Sustainable*. INTERNET. <http://encarta.msn.com/dictionary/sustainable.html>. Cited 2005/12/03.
- Fellows, R. and Liu, A. (1997) *Research Methods for Construction*. UK: Blackwell Science.
- Fowles, B. (2000) Transformative architecture: a synthesis of ecological and participatory design. In Fox, W. (Ed.), *Ethics and the built environment*. (pp. 102 – 114). New York, USA: Routledge.
- GBC. (2002) *The Green Building Challenge Process and the GBC ‘98 Conference*. INTERNET. <http://greenbuilding.ca/gbc98cnf/>. Cited 2004/08/31.
- Gibberd, J. (2003) *Integrating Sustainable Development into Briefing and Design Processes of Buildings in Developing Countries: An Assessment Tool*. PhD Thesis. Pretoria, RSA: University of Pretoria.
- Gibberd, J. (2002) *The sustainable building assessment tool. Assessing how buildings can support sustainability in developing countries*. INTERNET: http://www.buildnet.co.za/akani/2002/nov/gibberd_sandton.pdf. Cited 2006/05/22.

Gorgolewski, M. (2005) *Understanding how buildings evolve*. Proceedings of the “Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo”, Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.

Handler, B. (1970) *Systems approach to Architecture*. New York, USA: American Elsevier Publishing Company Inc.

iiSBE. (2007) *SBT07-ProjectAssess-Dsn-Jan07.xls*. (File extracted and tab AssB adapted). INTERNET. http://iisbe.org/download/sbc2008/SBTool/SBT07_Dsn3_Jan07.zip. Cited 2007/04/07.

iiSBE. (2006) *SBTool. (Slideshow Presentation)*. INTERNET. http://iisbe.org/download/sbc2008/SBTool/SBTool_overview.ppt. Cited 2007/04/07.

Irurah, D. K. (2003) *Materials and Products: performance criteria and embodied energy*. Lecture presented at the PIA “Design for Sustainability” CPD Training Workshop, Oct. 2003. Pretoria: Pretoria Institute for Architecture.

Irurah, D.K. (2002) *Embodied energy and its implications in sustainable buildings: a focus on specification*. Proceedings of the SBID Solar Academy “Sustainable Buildings and Integrated Design” Training Workshop, Sept. 2002. Johannesburg, RSA: South African Solar Academy.

Kaatz, E., Root, D., Bowen, P. and Hill, R. (2005) *Shifting from building assessment towards building enhancement: a specification for a South African model*. Proceedings of the “Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo”, Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.

Kaatz, E., Root, D. and Bowen, P. (2004) *Implementing a participatory approach in a building sustainability assessment model*. Proceedings of the Sustainable Building Africa 2004 Conference (SB04), Sept. 2004. Stellenbosch, South Africa. INTERNET. <http://buildnet.co.za/akani/2004/nov/pdfs/SB001.pdf>. Cited 2004/09/29.

- Kaatz, E., Barker, G., Hill, R. and Bowen, P. (2002) *A comparative evaluation of building environmental assessment method: suitability for the South Africa context*. Proceedings of the 2002 Sustainable Buildings Conference, Sept. 2002. Oslo, Sweden: SB02 National Conference Board.
- Kim, J. (2004) The sustainable built environment. In EOLSS, *Knowledge for sustainable development – an insight into the encyclopaedia of life support systems (volume 3)*. pp. 789 – 809. Oxford, UK: UNESCO Publishing/EOLSS Publishers.
- Kirk, A. (2002) *Nostalgic research reflections*. Building, Research and Information, Vol. 30, no. 1, Jan./Feb. 2002, pp. 1 – 4.
- Knoll, C. (1999) Embodying the principles of a green building: Munich Re-insurance Centre. *The Urban Green File*, Vol. 3, no. 6, Feb. 1999. p. 17 – 21.
- Kruger Roos Architects. (2004). University of Pretoria Law Faculty Building and BP Headquarters. *Architecture SA*. Special Issue, Nov./Dec. 2004, pp. 86 – 90.
- Lang, J. (1987) *Creating architectural theory*. New York, USA: Van Nostrand Reinhold Company Inc.
- Lawson, B. (1990) *How designers think: the design process demystified*. London, UK: The Architectural Press.
- Lipman, A. (2003) *Architecture on my mind: critical readings in design*. Pretoria, RSA: Unisa Press.
- Liu, Y., Prasad, D., Li, J., Fu, Y and Liu, J. (2005) *A holistic approach to developing regionally specific framework for green building assessment tools in China*. Proceedings of the “Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo”, Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.

- Lollini, R. and Zampiero, P. (2005) *Integration of energy-environmental performance assessment tools in the building design process*. Proceedings of the "Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo", Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.
- Loots, M. J. and Irurah, D. (2005) *Towards integration of sustainability performance assessment outcomes into design decision-making processes for buildings in Southern Africa*. Proceedings of the "Action for Sustainability 2005 World Sustainable Buildings Conference in Tokyo", Sept. 2005. Tokyo, Japan: SB05Tokyo National Conference Board.
- Low, I. (2004) Design thinking – the design studio in the 'post-apartheid' era. *Architecture SA*. Special Issue Supplementary Edition, Nov./Dec. 2004, pp. 25 – 31.
- Noir, E. (2003) *Architectural competition for a corporate head office at the V&A Waterfront, Cape Town: the winning entry*. Proceedings of the third conference in the series on Sustainable Built Environments entitled "Technology and management for sustainable building", May 2003. Pretoria, South Africa: CSIR.
- Noir, E. and Roos, P. (2005) The new corporate head office for BP Africa. *Architecture SA*, Mar./Apr. 2005. p.36 – 41.
- Pakose, J. and Schneider, M. (2004) *Because your property world is evolving. General issues in SA Real Estate*. INTERNET. [http://www.eprop.co.za/news/article.aspx?idArticle=1614ProposedSAPOAOfficegrading\[1\].pdf](http://www.eprop.co.za/news/article.aspx?idArticle=1614ProposedSAPOAOfficegrading[1].pdf). Cited 2005/10/31.
- Raman, M. (2005) *Sustainability and SPeAR*. Presentation at the Workshop for NSF Self-Sustaining High-Rise Building Project, Jan. 2005, State University of New Jersey. INTERNET. http://highrise.rutgers.edu/workshop/SPeAR_Raman.pdf. Cited 2007/04/07.

- Rappaport, N. (2005) [Interview with] Bruce Fowlee, Robert Fox, and William Browning: It's not easy building green. In D. Gissen (Ed.), *Big & Green: toward sustainable architecture in the 21st century*. (pp. 178 – 181). New York, USA: Princeton Architectural Press.
- Reed, W.G. and Gordon, E.B. (2000) Integrated design and building process: what research and methodologies are needed? *Building, Research and Information*, Vol. 28, no. 5/6, Sept. – Dec. 2000, pp. 325 – 337.
- Robert, K.-H., Schmidt-Bleek, B., Aloisi de Larderel, J., Basile, G., Jansen, J.L., Kuehr, R., Price Thomas, P., Suzuki, G., Hawken, P. and Wackernagel, M. (2002) *Strategic sustainable development – selection, design and synergies of applied tools*. INTERNET. <http://www.sciencedirect.com/science/journal/09596526>. Cited 2004/10/14.
- Robson, C. (1993) *Real world research*. Oxford, UK: Blackwell.
- Schön, D. (1985) *The design studio: an exploration of its traditions and potentials*. London, UK: RIBA Publications Ltd.
- Stauch Vorster MOM Architects. (1998) *Munich Re-insurance, Parktown. Info brochure*. Johannesburg, RSA: Stauch Vorster MOM Architects.
- USGBC. (2007a) *What is LEED®?* INTERNET. <http://www.usgbc.org/DisplayPage.aspx?CategoryId=19>. Cited 2007/04/07.
- USGBC. (2007b) *LEED for New Construction Checklist*. INTERNET. <http://www.usgbc.org/ShowFile.aspx?DocumentID=2245>. Cited 2007/04/07.
- USGBC. (2006) *Candidate Handbook – LEED Professional Accreditation Exam*. INTERNET. <https://www.usgbc.org/ShowFile.aspx?DocumentID=2158>. Cited 2007/04/07.
- Yin, R.K. (1994) *Case study research: design and methods*. California, USA: SAGE Publications, Inc.
- Van der Ryn, S. and Cowan, S. (1996) *Ecological design*. Washington D.C., USA: Island Press.

- Wells, M. (1999) Design Theory. In: F. E. Stitt (Ed.), *Ecological Design Handbook*. p. 23 – 30. New York, USA: McGraw-Hill.
- Williamson, T., Radford, A. and Bennetts, H. (2003) *Understanding sustainable architecture*. London, UK: SPON Press.
- Wilson, A., Uncapher, J., McManigal, L., Hunter Lovins, L., Cureton, M. and Browning, W. D. (1998) *Green development: integrating ecology and real estate*. New York, USA: John Wiley & Sons, Inc.
- Winch, C. and Giesen, M. (1999) Head Office for Munich Reinsurance of Africa, Parktown: A 'green building' in Africa. *Planning*, vol. 161, no. 1, Jan./Feb. 1999. p. 82 – 88.
- Wittmann, S. (1998) Architect's Commitment regarding Energy Efficient/ Ecological Architecture. *Architectural Science Review*, Vol.41, no. 2, June 1998, pp. 89 – 92.
- Woolley, T. (2000) Green Building: establishing principles. In Fox, W. (Ed.), *Ethics and the built environment*. (pp. 44 – 56). New York, USA: Routledge.
- World Commission on Environment and Development (WCED). (1987) *Our Common Future*. Oxford: Oxford University Press.

