

THE ARCHITECTURE OF SCIENCE CENTRES
RECOMMENDATIONS FOR DURBAN, SOUTH AFRICA
PAULETTE BARBEAU

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RECOMMENDATIONS FOR DURBAN, SOUTH AFRICA
PAULETTE BARBEAU**

A dissertation submitted to the School of Architecture, University of KwaZulu-Natal, Durban,
South Africa in partial fulfilment of the requirements for the degree of Master of Architecture
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DECLARATION

I hereby declare that this dissertation is my own unaided work. All citations, references and borrowed ideas have been duly acknowledged. It is being submitted to the School of Architecture, Town Planning and Housing, University of Kwazulu-Natal, Durban, South Africa for the degree of Master of Architecture, and has not been submitted before for any degree or examination at any other university.

Paulette Barbeau

Signed on 21st January 2008

DEDICATION

To my parents for their unending support, for encouraging my curiosity and wonder about the world around me and for fostering a love for learning.

“Wonder is the seed out of which knowledge grows”
Francis Bacon

ABSTRACT

Under apartheid in South Africa a large portion of our society was been denied access to science education. This has led to a generally low public understanding of science and a poor scientific skills level, which has a negative impact on our country's economic growth. In a world that is increasingly hi-tech and relies on technology for day-to-day living, this lack in science knowledge and technology is alarming (The Presidency,2006:9). A poor knowledge of science hampers people's ability to actively participate in a democratic society and produces a future generation that is scientifically illiterate . A large part of our population needs to be more scientifically literate but this situation cannot be rectified by purely improving school science education. For this reason the Department of Science and Technology has proposed a network of science centres across South Africa. This network consists of flagship science centres in all the major cities, which support smaller science centres in outlying areas. The aim is to increase people's access to science and technology in a non-threatening environment that appeals to all ages.

The purpose of this research is to look at the method proposed by the Department of Science and Technology to improve the current situation - a network of science centres. The research investigates the philosophies and aims of science centres and the architectural responses necessary to accommodate these. This study focuses on the architectural response of a science centre for Durban. The aim of the study is to generate architectural recommendations to guide and inform the design of a science centre for Durban.

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BACKGROUND

At the age of nine, I spent a few months travelling with my parents visiting various museums in Europe, the wealth of which was unbelievable. Yet I can vividly recall my incredible delight and enjoyment when we visited the Science Museum in London, it had a section specifically for children where everything was made to be handled and in doing so demonstrated a scientific principle. My enjoyment was immense and it awakened a curiosity about the world around me as I looked at it from an entirely different perspective than I had ever seen in a classroom. It awakened in me a love of science, which still exists today. Currently in South Africa, a large portion of our society has limited access to scientific education. Science centres, like the one I encountered that had a profound influence on my life, are being used as vehicles to make science more accessible and to reach beyond the misconceptions about science, which are rife in our society. As science centres are a new phenomenon and as yet no purpose built science centres exist I have chosen to explore the type of architecture to assist in the aims of a science centre and facilitate this kind of learning.

In South Africa , a large portion of our society has been denied access to science education. This has led to a generally low public understanding of science and a poor scientific skills level, which has the impact of negatively effecting our countries economic growth. In a world, which is increasingly hi-tech and relies on technology for day-to-day living, this lack of science and technology knowledge is alarming. (The Presidency,2006:9)
A poor knowledge of science hampers people's ability to actively participate in a democratic

society and produces a future generation that is scientifically illiterate. A large part of our population needs to be more scientifically literate but therefore this situation cannot be rectified by purely improving school education. For this reason the Department of Science and Technology has proposed a network of science centres across South Africa. This network consists of flagship science centres in all the major cities, which support smaller science centres in outlying areas. The aim is to increase people's access to science and technology in a non-threatening environment that appeals to all ages.

A Science centre can be defined as: "a permanently established educational facility that offers an informal educational experience in science, technology, engineering and mathematics (STEM) by providing interactive exhibits and displays; and interactive programmes" (DST, 2005:10). A science centre is a facility that exists to educate the general public about scientific principles and phenomenon through the use of interactive exhibits and programmes.

Within South Africa, there are currently no custom-designed science centres. There is a dearth of literature on the architectural design of science centres. This dissertation aims to investigate the architectural requirements of a flagship science centre specifically for Durban, South Africa, in order to meet with and assist the philosophy and aims of the science centre as well as to meet the objectives of the Department of Science and Technology. This dissertation also aims to contribute to the existing body of knowledge on the architectural design of science centres.

RESEARCH QUESTIONS

This research questions the current state of science literacy in South Africa and the government's response to rectifying the situation. It then questions what the role of the

science centres in the context of South Africa, its past education policy and as a means of rectifying the state of science knowledge in South Africa . This document seeks to gain an understanding of the philosophy, method and aims of the science centre. It enquires as to the appropriate architectural response to meet the needs/requirements of science centres in order to meet its aims. Lastly, it questions the requirements of a science centre specifically for the local context of Durban, South Africa.

HYPOTHESIS

Science education in South Africa is poor and science skills and knowledge are at a low level. Science and Technology Centres can play a vital role in improving this situation by providing a valuable resource of information in a non-threatening and enjoyable way. Through analysis of the method and philosophy of science centres, architectural implications can be derived, which will be looked at specifically in the context of Durban, South Africa.

AIMS AND OBJECTIVES

The objective of the research is to establish what is required of a science centre for Durban in terms of its architectural response to meet the needs, philosophy and methods of a science centre, in a South African context.

The aims are to

- gain understanding of the state of science knowledge/education in South Africa
- establish the government policy that has been formed to address this problem
- look at the philosophy/method and aims behind science centres

- establish from this the resultant architecture necessary to accommodate the philosophy/ method of the science centre and to assist in achieving the aims of a science centre
- establish what is specifically required of a science centre in the context of South Africa
- develop a set of recommendations for the design of a flagship science centre for Durban.
- ultimately this research aims to derive information that can inform and develop the design of this building.

ABBREVIATIONS

The following abbreviations have been used in this dissertation

DST: Department of Science and Technology

DACST: Department of Art, Culture, Science and Technology

NNSNSC: National Norms and Standards for a Network of Science Centres

STEM: Science, Technology, Engineering and Mathematics

DEFINITION OF CONCEPTS

The following definitions will be used in the course of this document;

Science is used to encompass all elements of science including Physical Science and Natural Science. On the whole “science” has been used to refer to both science and technology. The definition used by the National Norms and Standards for a Network of

Science centres in South Africa of science as including “natural sciences, biological sciences, technology, engineering and mathematical science” (DST, 2005:11).

Science centre: The National Norms and Standards for a Network of Science Centres in South Africa defines a science centre as: “*a permanently established educational facility that offers an informal educational experience in science, technology, engineering and mathematics (STEM) by providing interactive exhibits and displays; and interactive programmes*” (DST, 2005:10). The term science centre will for this document refer to science and technology centres.

Interactive: According to the National Norms and Standards for a Network of Science Centres in South Africa

“The notion of ‘interactivity’ was unpacked and understood to cover exhibits and displays that can be handled and require a response which ideally should be manual, mental, emotional and social. Given this definition of interactivity, interactive exhibits could include the environment and botanical gardens. Interactive exhibits and displays would be used to excite and entertain, as well as link educational experience to learning outcomes.” (DST, 2005:10).

Black box exhibition: This term is used to refer to exhibition spaces which are totally enclosed and artificially lit and ventilated. The ceiling is painted black and the services left exposed

METHODOLOGY

This research uses both primary and secondary data. Due to the nature of the research topic, this research will be qualitative not quantitative.

Secondary research forms the foundation for the research on science education, government policy and the philosophy, ethos and method of science centres and the resultant architectural implications in South Africa. This was achieved by a survey of relevant books, journals, theories and government policies. They were critically analysed to form the basis of the criteria by which the precedent and case studies were analysed.

International precedent was critically analysed. These were selected through a review of journal articles and books. Unfortunately as a science centre is a recent phenomenon the number of published science centres is limited and selection was limited by the lack of sufficiently published work for the purpose of study. Three precedents from different countries and architectural periods were selected. These include the National Museum of Science and Technology in Canberra, the California ScienCentre in Los Angeles and Techniquet in Cardiff, Wales. All three are of a fair size and are purpose-built science centres. The photographs, plans and sections available have been analysed.

The primary data was formed from interviews with those involved with science centres. These key informants include Prof Dan Archer who is involved in setting up science centres and who helped establishing Olwazini in Pietermaritzburg, Derick Fish the director of Unizul in Richards Bay and a past president of the South African Association of Science Centres. Prof Mike Burton set up the MTN ScienCentre in Cape Town and Nicholas Sacks the Architect involved in the development of Sci-Bono were also interviewed. As well as interviews with those involved in the day to day running of these science centres. These interviews have provided valuable insight and understanding of the role, ethos, methodology and philosophy of science centres, as well as providing practical insight into

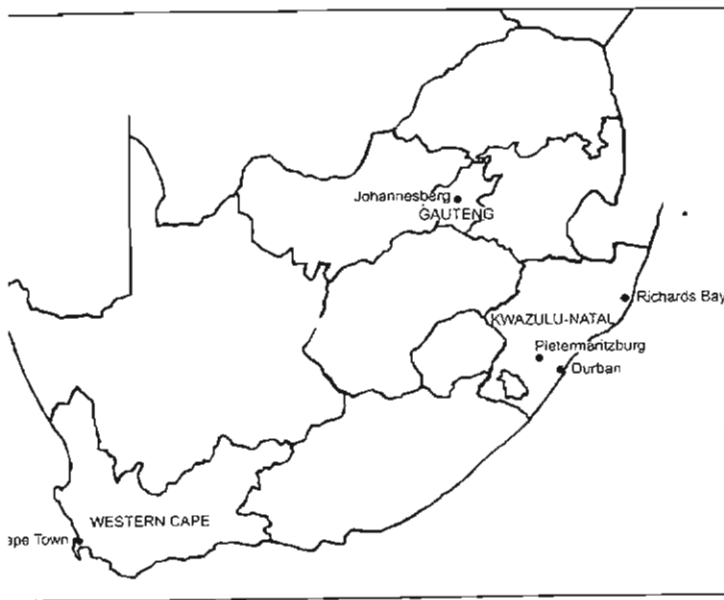


Fig 1.1: Map of South Africa showing the focus area of the research (source: author)

their day-to-day running and the requirements of a science centre. A set of questions was drafted and used to guide the interviews.

The focus area of the research was South Africa (Fig 1.1). There are currently only three science centres in KwaZulu-Natal, none of which custom designed structures. The science centre in Gateway Shopping Centre was ruled out as a case study option as it is in Gateway Theatre of Shopping and is a large open space containing exhibits and has very few of the elements under discussion in this document. Unizul in Pietermaritzburg and Unizul in Richards Bay have been analysed as case studies. Sci-Bono in Johannesburg which is located in a converted power building and MTN ScienCentre in Cape Town located in a shopping centre were studied. The case studies were observed and a photographic study made. The relevant people as previously discussed were interviewed and the plans obtained and analysed. As none of these case studies were custom designed this study has chosen to focus on the precedent studies.

Through a survey of secondary data: of the aims, method of learning in science centres, environmental psychology, architectural theory and writing on the design and running of science centres conclusions were reached about the architectural requirements of science centres. These were used to develop a set of criteria to analyse the precedent studies and case studies and to test the criteria. Through this process conclusions have been derived to inform the design of a science centre for Durban.

CHAPTER 1: SCIENCE IN SOUTH AFRICA AND THE HISTORICAL DEVELOPMENT OF THE SCIENCE CENTRE

SCIENCE IN SOUTH AFRICA

During the Apartheid period a large portion of South African society was denied access to science education. This has led to a country with a very low level of public understanding of science and engineering and a very low skill level in these areas. The Accelerated and Shared Growth Initiative of South Africa has established that “for both the public infrastructure and private investment programs the single greatest impediment is a shortage of skills-including professional skills such as engineers and scientists” (Presidency, 2006:9). This needs to be rectified for South Africa needs a technically fluent work force, as “it is a prerequisite for economic growth which underpins job creation and improved quality of life – our national goals.”(DACST, 1996a:77)

Due to past government policy there is a very small percentage of woman and previously disadvantaged groups, in science and engineering-based professions. (DST, 1992: 36) This has been identified as a problem, which will not resolve itself, but an active attempt has to be made to improve this situation (DST, 1992: 36). A further dilemma faced by South Africa is that 50% of those involved in scientific fields are over the age of 50 with an insufficient number of people entering the field to replace those who leave (DST,1992: 45).

Strategies need to be developed to increase public understanding of science and so bolster the technical knowledge in the work place. Informed citizens that can participate in society and who can make informed decisions about science are needed. (DST, 1992:76). Parents

also need to be sufficiently informed about the value of science, engineering and technology so that they can encourage their children to study science and mathematics at school and pursue careers in these fields (DACST, 1996a:84).

Only a small percentage of matric students finish with university exemptions in mathematics and science (only 3, 4% of all students in 2002) (DST, 1992:32). A very small percentage of this group come from previously disadvantaged areas. Strategies need to be adopted to make science more attractive, accessible and relevant (DST, 1992:36) so that students will study science and mathematics and pursue careers in science. General knowledge about science needs to be improved.

The Government's solution to the inequalities and lack of skills in science fields is to try to increase the number of pre-tertiary students studying mathematics and science. This has resulted in the development of the Youth into Science Strategy. The main objectives are "to enhance science and technology literacy among the public in general and the youth in particular" and to "enrol more respective youth with talent and potential into science, engineering and technology-based careers."(DST, 2006:6) This strategy has identified science centres as a means to achieve this.

A network of science centres across South Africa has been proposed by the Department of Science and Technology. It is hoped:

"that this infrastructure will serve to help redress the historical legacy, support the building of a strong science culture and provide enriching interactive experience for the majority of people who have limited access to science, technology and mathematics" (DST, 2005:3)

The National Norms and Standards for a Network of Science Centres in South Africa define a Science Centre as:

“a permanently established educational facility that offers an informal educational experience in science, technology, engineering and mathematics (STEM) by providing interactive exhibits and displays; and interactive programmes” (DST, 2005:10)

HISTORICAL DEVELOPMENT OF SCIENCE CENTRES AS A TYPOLOGY

The origins of the Science Centre and its development cannot be exactly pinpointed. Various museums have contributed towards its development and contained elements of interactivity, which is the hallmark of today's Science Centres. There are some generally agreed upon views as to sources of inspiration for the modern day science centre.

The oldest of these is the Palais de la Decouverte in Paris, established in 1837. It broke away from being collection-based and used models to demonstrate concepts in physics, chemistry, biology, medicine and astronomy to students and the public (Hein, 1990:4). Hein comments that this provided an important model in the establishment of the Exploratorium.

The Munich Deutsches Museum founded at the beginning of the 1900s was the result of a succession of world fairs that displayed the latest in industrial machinery. The museum exhibited and explained how historical scientific apparatus and industrial machinery worked, demonstrating scientific laws and their application in science and technology to a wide audience (Hein, 1990: 5) Similar to the modern day science centres, “Machines moved, demonstrators explained and visitors handled apparatus” (Grinell, 1992:6)



Fig 1.1 : The Munich Deutsche Museum established in the early 1900's (Source: http://en.wikipedia.org/wiki/Deutsches_Museum: 28/10/08)

Fig 1.2: Ontario Science Centre, which opened in 1969, was one of the first purpose-built science centres. (Source: <http://www.mtarch.com/mtaosc.html:24/03/07>)

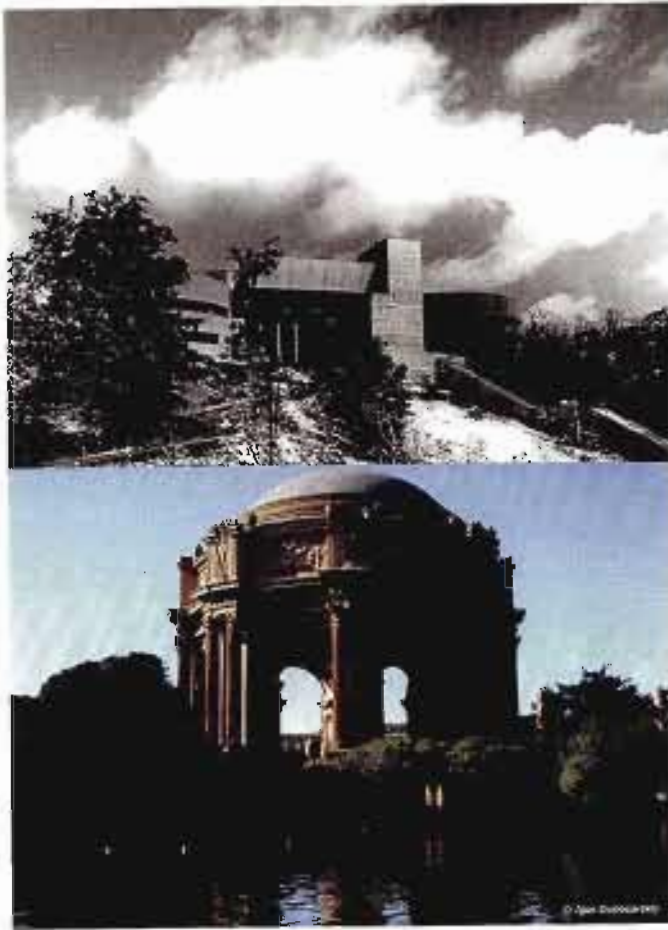


Fig. 1.3: The Exploratorium is housed in the Palace of Fine Arts building built as part of an exhibition. (Source: <http://www.igord.com/images/cityscape/exploratorium.jpg.jsp> 25/03.07)

This ethos of populist education involving interactive techniques had by the 1930s spread to Europe and the U.S.A., including museums in Chicago, Philadelphia and Los Angeles (Mc Lean, 1993: 94; Yahya, 1996:124) which made use of interactive exhibits. The development of the concept was slow and remained an aspect of science museums predominately explaining the working of industrial machinery.

The 2nd World War and its atrocities saw the alienation of the public from science. After this an attempt was made to socialise science and to engage the public with science. The launch of Sputnik in 1957 in particular saw a renewed public interest in science and technology.

In 1969 the Ontario Science Centre (Fig. 1.3) and the Exploratorium in San Francisco opened. They were to form the modern day definition of the science centre, focusing on the explanation of scientific principles and phenomenon and concepts through the manipulation of exhibits by the public. These science centres were born out of a desire to make science accessible to the public, in a manner that could be easily understood and enjoyable. While some of the techniques were not new, having an entire centre devoted to this method of education was.

Ontario Science Centre and the Exploratorium saw the popularisation of the concept of the science centre. This was perpetuated by the development of the Exploratorium Cook Books, which explained how to develop interactive exhibits. With these the philosophy and methods of the Exploratorium spread around the world.

These two science centres depict two different approaches: the exhibit/phenomenon based approach and the themed approach. Typically most centres in the United Kingdom have followed the Exploratorium approach which is exhibit based. European and Indian science centres have followed the themed approach (Yahya, 1996:124). The distinction in the approach has architectural ramifications and some science centres have opted for a combination of the two approaches referred to as the Centrum approach.

The 1970s and 1980s saw the spread of science centres. The science centre is a relatively recent phenomenon of the last 3 decades. As a result the amount of literature and research is not as extensive as that on art galleries. However the last 3 decades has seen an explosion of the concept around the world.

CHAPTER 2: THEORETICAL AND CONCEPTUAL FRAMEWORK

INTRODUCTION

As science centres are a relatively new phenomenon as discussed earlier there is very little literature about science centres. In order to establish a theoretical framework for this thesis I have consulted an eclectic mix of literature. I started by reviewing literature on the aims and the method science centre use to accomplish these aims, as an understanding of science centres and their unique learning context is necessary to establish the architecture required to house a science centre. This consisted of reviewing writings by those involved in the establishment and running of science centres and those involved in studying the learning that occurs within. This led to a review of the method of learning in science centres as a science centre is primarily an educational tool. This included a review of literature on learning and more specifically learning science in a science centre. The requirements of this specific learning environment and the theory behind it has a direct impact upon the architectural environment. This led to the establishment of architectural requirements needed to meet the needs of this environment. These architectural requirements were then explored in the context of architectural theory with a variety of sources from environmental psychologists to architectural writers. This included writing on children and their interaction with their environment.

PHILOSOPHY AND METHODS BEHIND SCIENCE CENTRES

The aim of science centres

One of the primary aims of science centres is to improve the public understanding of science and technology. Grinell (1992:6) claims that science centres share a mission and a philosophy:

“Their mission, broadly speaking, is to help familiarise members of the public with the objects and ideas of science and technology; their philosophy is that learning flows most effectively from situations that foster active participation in handling, observing, and asking questions about artifacts and phenomena.”

However, a poor public understanding of science is a global phenomenon, not just specific to South Africa. This is causing widespread concern in an increasingly hi-tech world in which a basic knowledge of science is necessary for daily life. According to Miller, 5-6% of adult Americans are scientifically literate (Grinell, 1992: 11). But this problem cannot be corrected by just teaching school-going children as their attitudes are determined by their family, friends, media and their own experiences. Education of science and technology needs to encompass more than just this age group. (Grinell, 1992: 11)

Informal learning environments

Science centres exist as an educational tool for all age groups. They form an important part of informal learning, which is the way we learn outside of an institution. It is an important environment devoid of testing or set learning agendas. This system of informal learning can help augment formal learning. It provides a context for people to learn without pressure or fear of failure but for the pure pleasure of learning. More recently, the term “free choice learning environment” has been used to refer to this type of learning environment as people are free to choose what, when and how they learn.

[The] Science centre has been recognised as an important informal learning environment that plays a significant part in shaping public awareness of science and technology. (Grinell, 1992: 10)



Fig. 2.1: A variety of ages interacting with the exhibits at the Exploratorium, learning in a hands on manner

Source:

http://en.wikipedia.org/wiki/Image:Exploratorium_Exhibits_1.jpg :25/03/07)

Science centres provide a context, that appeals to all ages (Fig. 2.1), where people can actively experience and experiment with science, technology and engineering and derive conclusions for themselves in an enjoyable manner. Their aim, through making science more accessible, is it to demystify science and to break down the preconceptions and cultural perceptions about science. They try to bridge the chasm that exists between science and the public by having scientists give talks, answer questions and perform demonstrations. Their aim is to arouse a sense of curiosity and wonder about science. Francis Bacon said “wonder is the seed out of which knowledge grows.” The aim of science centres is to create wonder and curiosity about science in the hope that knowledge and a love of learning will develop.

Science centres take complex subject matter about science and technology and communicate it in such a way that the public can understand. They provide the public with access to science and scientists. They give the public an opportunity to encounter science in an environment in which they can feel comfortable and not intimidated. Thus they make science resources available to the community and give science a presence in the community.

Science centres are strategically positioned between the science community and the public. As Durant (Pearce, 1996:161) succinctly expresses it:

“Science centres are uniquely well placed to serve a public which is both fascinated and slightly frightened by science and technology. Their collections provide an unparalleled resource for interpreting a notoriously inaccessible aspect of modern industrial culture, and their exhibitions and programs offer an invaluable point of entry into the world of science for visitors who feel remote and even alienated from it. Science museums have the potential to be a meeting ground between the scientific community and the public.”

Educational theory

The method of learning in science centres is based in experiential education (Barry, 1998:98), that people learn best through experience of a phenomenon/ concept. It has long been held by educationalists that “concrete experience is a more effective route to learning than abstract contemplation”. (Durant, 1996:156) Based on Piaget’s theories on learning, Yahya argues that effective learning only occurs from manipulation and interaction with the environment. (Yahya,1996:131). By making this process of learning fun and attainable and demystifying science principles and theories it encourages curiosity and a love of learning. (Bruman,1991: v)

The approach that science centres use to achieve this is interactivity, which distinguishes science centres from other museums. McLean (1993:93) defines interactive exhibits as those “in which visitors can conduct activities, gather evidence, select options, form conclusions, test skills, provide input and actually alter a situation based on input”.

The method of learning through interactive exhibits is considered to be very similar to that of learning in science, by developing a hypothesis, conducting an experiment, observing the results, establishing relationships and deriving a conclusion (Pitman-Gelles,1986: 35). It is this which makes interactive exhibits complementary to the study of science.

By being actively involved, people tend to enjoy learning more. Fun and play is a crucial part of learning in a science centre. This is the most important aspect of informal learning (Grinell, 1992:18). It blurs the line between education and entertainment, in order for the

education to be effective there needs to be a certain amount of entertainment. Yahya asserts that:

“Entertainment and education can be effectively combined in the science centre to generate playful and learning activities, both of which are essential to make the experience enjoyable and at the same time useful.”
(Yahya,1996:129)

In today’s society, there are many options, which compete for people’s leisure time (Tressel, 1992: 39), particularly for families who want to participate together. The result is that museums have to become more consumer orientated. This makes entertainment and enjoyment an important element. In order for science centres to support themselves, they need to be able to draw visitors to their exhibits.

Science centres are not limited to using interactive exhibits to teach people about science. The methods range from planetariums, demonstrations, talks, films, puppet shows to laboratory science (Yahya, 1996:129). The methods of education are vast and appeal to a wide audience.

Constructivist theory

How people learn in the context of a science centre has been the subject of much research and discussion. Constructivist theory has generally been the basis for most science centres. This theory holds that people construct their knowledge for themselves, “knowledge is a complex result of a long process of personal construction and interpretation”. People interpret new knowledge based on their existing understanding and build onto it (Resnick & Chi, 1992: 80). Based on constructivist theory Falk and Dierking

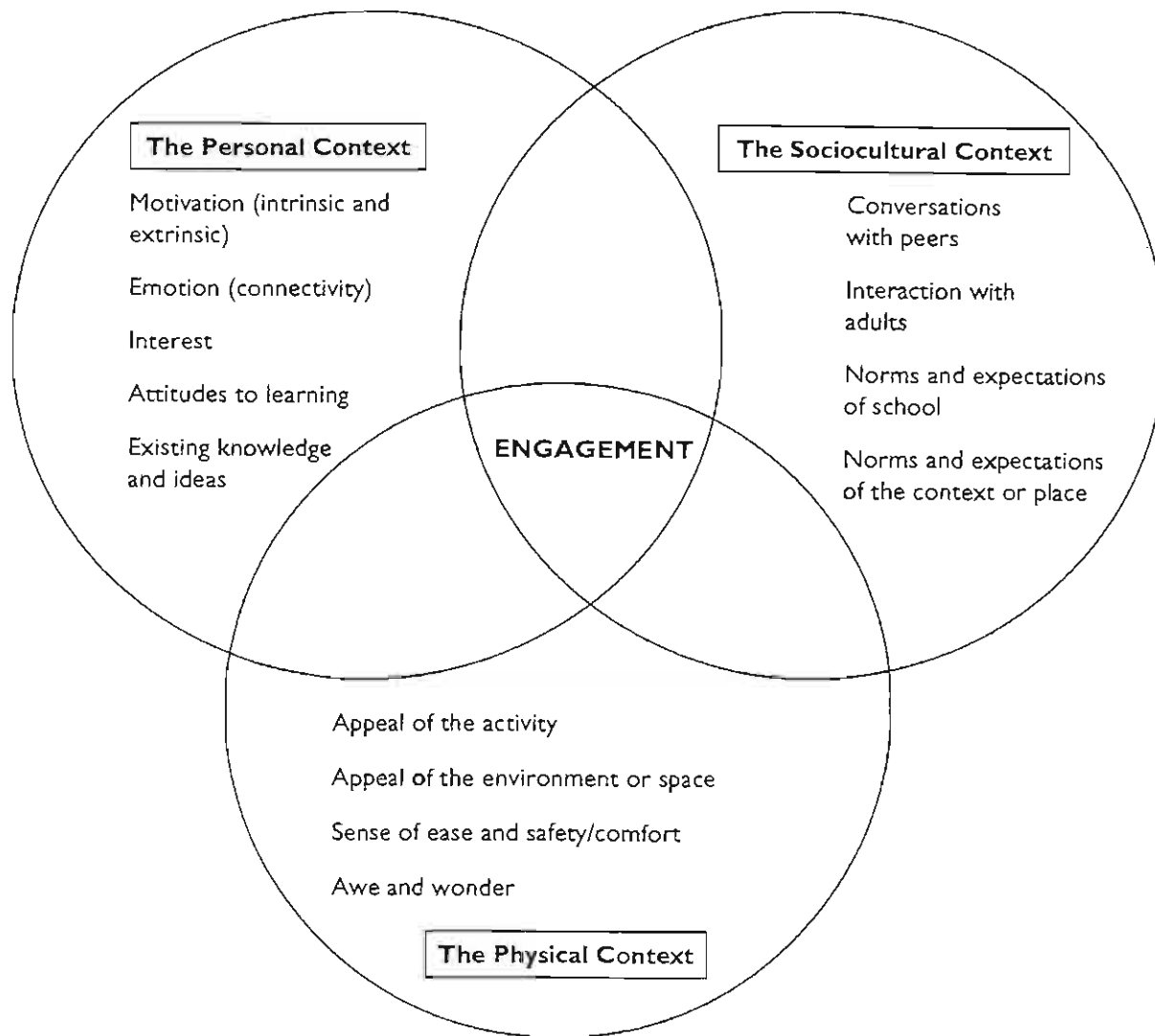


Fig 2.2: Illustration based on Contextual Model by Falk and Dierking, depicting the three contexts that affect learning. (Source: Braund,2004:8)

developed The Contextual Model which seeks to examine the factors which impact upon learning in a free choice learning environment.

Important attributes of this learning context is that there is some choice as to what people learn and the amount of time and effort they use and that it is a voluntary activity. Research has shown that personal choice improves science learning (Grinell: 1992:12).

The Contextual Model for Learning

Falk and Dierking, the director and co-director of the Institute of Learning Innovation Annapolis, research on learning in free choice environments forms the basis of most research in this field have devised a model (Fig. 2.2) for how people learn in free choice learning environments (Braund& Reiss, 2004: 8).

This model was drawn up specifically for science centres and museums. This is a model for thinking about learning in museums, which is different from learning in any other environment as a result of the unique context of the museum. It is based on the premise that learning is situated, a dialogue between

the individual and their environment. (Dierking, 2002:5) Braund has drawn up this illustration based on this model (Fig. 2.2). It consists of 3 overlapping contexts, consisting of different factors which interact to impact on the quality and quantity of people's learning and what they gain from the experience (Braund, 2004: 115). These contexts contribute to and influence visitors' interactions and their experiences.

They identify 8 key factors which are particularly fundamental to museum learning experiences and influence the quality of learning that occurs. These factors can be grouped into three contexts These consist of the personal, socio-cultural and physical contexts which overlap to determine the quality and quantity of the educational experience.

The personal context, deals with the person's attitude or approach to learning and the socio-cultural deals with the interaction with surrounding people and social norms. The third context the physical context which is the focus of this research and includes;

- advance organisers and orientation
- design
- reinforcing events and experiences outside the museums

Research has shown that long after an experience people frequently most vividly recall the physical context in which the learning occurred Dierking elaborates "The physical context , accounts for the fact that learning does not occur isolated form the objects and experiences of the real world. The physical context includes the architecture and 'feel' of the situation-in other words, the sights, sounds and smells, as well as the design features of the experience" (Dierking, 2002:6). According to Falk and Dierking a range of architectural and design factors including lighting, colour, sound and space influence the learning experience

(Falk & Dierking,2002:5).They comment that the ambiance and comfort of the environment impact upon the quality of the learning experience. When children feel comfortable in an environment their learning is enhanced (Dierking, 2002:9)

Falk and Dierking stress that orientation is a key element as people learn better when they feel secure in their surroundings "Museums tend to be large, visually and aurally novel settings. When people feel disorientated, it directly affects their ability to focus on anything else; when they feel orientated in museum spaces the novelty enhances learning" (Falk & Dierking, 2004:142)

"One of the striking things about museums is that they are physical settings unlike those most people encounter in their daily lives. Since museums are typically free-choice learning situations, the experience is generally voluntary, non sequential and highly influenced by the features of the setting (Falk & Dierking,2000). As such visitor learning has been shown to be strongly influenced by how successfully visitors can orientate within the space (eg Evans,1995; Kubota &Olstad,1991), being able to confidently navigate within a complex 3D environment turns out to be highly correlated with what and how much an individual learns."(Falk & Dierking,2007:5)

Braund elaborates on this model to include the appeal of the science centre's atmosphere, the appeal of the exhibits, the sense of ease and safety that people feel in the environment and the ability of the physical context to create feelings of awe and wonder as factors of the physical context that impacts upon the quality of learning. Braund comments that: "the environment of the museum or hands-on centres and galleries have a significant impact on the quality of the experience, and hence the amount of engagement and learning that takes

place” (Braund, 2004:119) He commented that the Science museum and galleries have invested much to produce “a comfortable, safe and friendly environment in which reluctance to act and engage and reticence about “having a go” are dispelled.”

The contextual model highlights and identifies the physical environment as something which impacts upon the learning experience. The aspects of the physical environment which affect how people learn can be summarised as;

- orientation/ navigation
- safety, security and comfort
- design: appeal of the environment

From this model of learning in a free choice environment it can be concluded that in order to create an environment conducive to learning learn the environment needs to be easy to navigate and orientate oneself within. It needs to make the user feel comfortable safe and secure and the design of the environment needs to create an appealing context with a sense of awe and wonder. Added to this the architecture needs to assist in and provide a context in which other aims of the science centre can be met. These attributes and how they how this can be achieved are discussed below.

DESIGN RAMIFICATIONS

Free choice principles of organisation and way-finding

“Since museums are typically free-choice learning situations, the experience is generally voluntary, non sequential and highly influenced by the features of the setting (Falk & Dierking,2000). As such visitor learning has been shown to be strongly influenced by how successfully visitors can orientate within the space” (Falk & Dierking,2007:5)

The contextual model stresses that this is an informal environment in which there is certain amount of free choice involved as to what people learn, the sequence they choose to follow and the amount of time spent. Visitors should be free to choose what they learn and to develop their own route of learning thus implying that there should be multiple options. The organisation needs to therefore be non linear and non sequential. As Grinell (1992:13) comments, science centres do not expect visitors to move systematically through exhibits but rather to browse as they see fit. Therefore the architectural design should allow for this to occur. Semper (2006) suggests that free choice should be allowed for by providing clear visual linkages which allow people to develop their own routes through the exhibits according to what attracts them (Fig 2.9).

In order to facilitate this free choice it is essential that a science centre be clearly and simply organised to allow for way-finding and orientation. Way-finding can be defined as the ability to navigate through a museum, and orientation as the ability to locate oneself in the museum (Bitgood, 2002:7). The ability to orientate oneself and find one’s way is a crucial part of the sense of ease and safety that is created by the physical context. Getting lost can cause considerable stress and it negatively impacts a person’s ability to learn. When people feel disoriented, affects their ability to focus on anything else; when they feel

oriented the novelty enhances learning.” Lynch (1972:5) stresses that a distinct and legible environment makes people feel secure which enables a much greater depth of experience. In order to assist in orientation, Rosenblatt, (2001:206) suggests that circulation which overlooks the exhibits (Fig 2.9) allow visitors to orientate themselves. This concurs with Semper’s suggestion that there should be clear visual linkages. This also allows for objects to be viewed from another perspective. Views out into the surrounding context also helps the visitor to orientate themselves within the greater context.

Planning

Semper likens the layout and structuring of science centres to that of urban planning and suggests that this should form the basis for the design of science centres. He draws on Kevin Lynch’s theories of cognitive mapping that the legibility of space is: “The ease with which its parts can be recognised and can be organised into a coherent pattern” (Lynch, 1972:52) This means establishing a coherent framework which Lynch identifies as a series of paths, nodes, districts and landmarks that allows us to navigate an unfamiliar space. These can be defined as paths: routes of movement or circulation; edges: linear elements-boundaries between parts; districts: recognisable/visibly graspable sections; nodes: focal points that can be entered and landmarks: a point of reference not entered. Semper likens this to learning in a science centre so that the conceptual outline of the subject overlaps with the outline of the building. Though an urban design theory it can be applied in a science centre by considering public spaces where people gather as nodes, the circulation routes as paths , the various exhibition spaces as districts and vertical circulation points or large exhibits as landmarks. By clearly arranging these it will allow people to easily navigate by forming a coherent pattern.

Bitgood (2002:7) asserts that there are established layouts which people anticipate and that museums should therefore adhere to. For example in the entrance, people expect that the ablutions, phones and baggage storage will be grouped together. Conforming to these expectations gives people a sense of ease in navigating through a science centre as well as a sense of comfort in that they know what to anticipate in an unfamiliar environment.

Therefore it can be concluded that to allow for easy wayfinding science centres should;

- allow for free choice of route by providing multiple routes and allowing people to view the various options available to them
- provide overlooking spaces so people can easily orientate themselves
- provide views into the surrounding context so visitors can orientate themselves within the greater context and therefore give clues as to where they are in science centre
- create gathering spaces and provide visual clues with landmarks and nodes to allow for people to form a mental framework
- use simple circulation routes which are easily understood
- use established or expected patterns which allow people to easily find required elements

Design and ambiance of the environment

The appeal of the architectural environment can be described as our delight in our environment. Roth expounds that delight: “involves how architecture engages all our senses, how it shapes our perception and enjoyment of (or discomfort with) our built environment” (Roth, 2007:67) Roth establishes that our delight in built form is determined by our perception of the space which is determined by light, scale, texture and sound. It can also be concluded that our delight is determined by how comfortable we are in a building.

Fig 2.3: Santa Fe Children's museum steps down in scale so as to not intimidate the approaching child and make the entrance more appealing (Source: Crosbie, 1991)

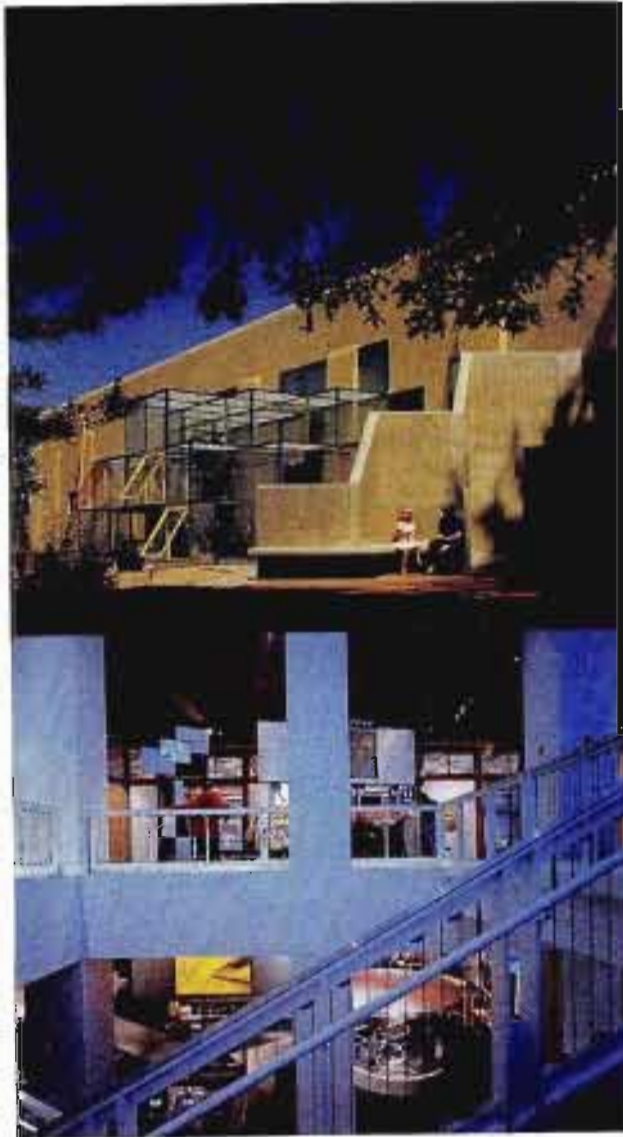


Fig 2.4: Overlooking spaces in California Science Centre acting as an orientation device (Source Stein, 1998)

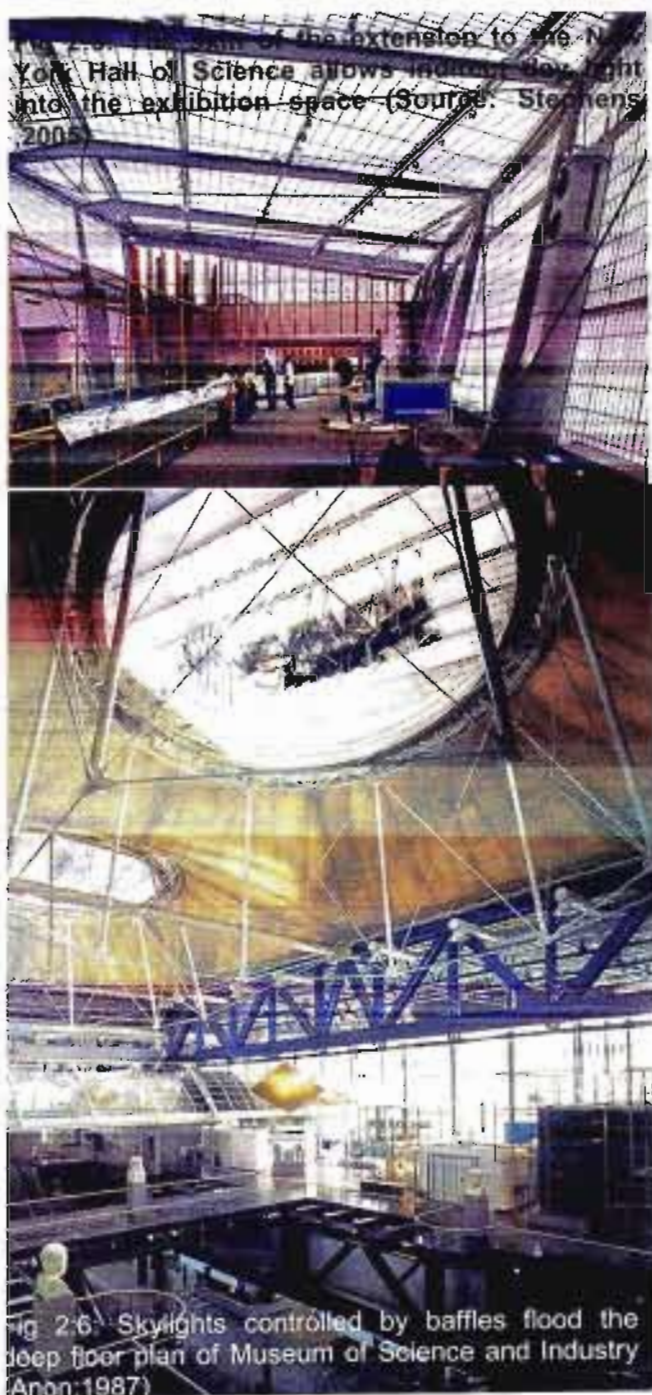
According to Falk and Dierking the physical context includes the architecture and 'feel' of the situation-in other words, the sights, sounds and smells, as well as the design features of the experience" (Dierking, 2002:6) Falk and Dierking elaborate that a range of architectural and design factors including lighting, colour, sound and space influence the learning experience (Falk & Dierking, 2002:5). The ambiance and comfort of the environment impact upon the quality of the learning experience.

It can therefore be concluded that the following design factors can impact upon our comfort and as a result affect our delight in the environment of the science centre and therefore influence the quality of the learning experience;

- Scale
- Space
- Design features
- Lighting
- Colour
- Texture
- Sound
- Smell

Scale, awe and wonder

Roth (Roth 2007:6) suggests that large scale buildings can create within us a sense of awe such as the immense interior of the Pantheon. Creating a feeling of awe and wonder without intimidating or discouraging people from touching and experiment is an important part of the balance necessary in a science centre. As Braund (2004:119) comments



The extension to the New York Hall of Science allows indirect day light into the exhibition space (Source: Stephens 2005)

Fig 2.6: Skylights controlled by baffles flood the deep floor plan of Museum of Science and Industry (Anon:1987)

science centres should be, “a comfortable, safe and friendly environment in which reluctance to act and engage and reticence about “having a go” are dispelled.” In the past museums have achieved a sense of awe and wonder by using imposing classical architectural styles or as in the case of the London Natural Science Museum, the architecture of cathedrals (Fig 2.10). Large volumes are necessary in science centres to contain large exhibits, but these voluminous spaces can tend to dwarf human scale.

Children are particularly sensitive to scale. Environmental psychologists have suggested that large spaces can tend to overpower children particularly when in a stimulus rich environment. In order to assimilate and process information children will frequently retreat to smaller spaces. Small places of retreat should be allowed for in the architectural design in order to facilitate this.

Lighting

Roth suggests that light is the most powerful element in our perception of architecture as it determines how we see architecture and creates a psychological response (Roth, 2007: 85) Alexander (1977:645) suggests that people are phototropic, in that they move towards light and that this should be used as a means to move people around a building. A sufficient light level should be provided for people to move around the building, with lighting highlighting focal points, and used to draw people on.

Sufficient light needs to be provided to allow people to focus on fine details of exhibits therefore ambient lighting should be provided in the exhibition spaces with task lighting on specific areas where emphasis is desired. Day lighting is the preferable solution as it not only saves on the buildings energy consumption, but also creates a pleasanter

environment. Daylighting can create problems in exhibitions as it limits the exhibit designer's ability control and manipulate the environment to create dramatic effects and place emphasis (McLean, 1993:146). Therefore natural light needs to be able to be carefully controlled through baffles, reflectors and filters to create indirect light (Fig 2.6). Furthermore, glare and direct sunlight which can damage the exhibits which should be avoided as well as causing visual discomfort for the visitor which would negatively affect their learning experience. Means do need to be provided to exclude light from some exhibition areas as some exhibits require darkness.

Transition areas should be provided when moving from areas of contrasting light levels, as from the auditorium into more light filled areas. As flexibility is required in the exhibition space as the exhibits change a lighting rig should be supplied overhead so that the lights can be altered as required.

Materials, colour and texture

Studies have shown that colour is a powerful element affecting all other aspects of the designed environment (McLean,1993:131) but the selection of colour needs to be carefully considered. Bright colours have been found to over-stimulate children and an environment composed of primary colours can tend to look like a play ground. The colour scheme used needs to act as a background to the exhibits which are frequently multi-coloured in primary colours. Colour can be used to create emphasis or a focal point. The emotional and cultural value of colours needs to be taken into consideration.

As Science centres are interactive and hands-on, the choice of materials selected becomes significant. They need to be hard wearing and easy to clean. The textures also become

important and can be a useful tool in distinguishing between areas. Texture adds another layer of sensation to the visitors experience. Tactile experiences can be created where people come into contact with the building, on handrails, benches, floors or door handles

Sound

Architecture shapes acoustical spaces, sound it is determined by the shape, volume and materials in a space. Sound can give a sense of orientation with different areas responding differently to noise, and in doing so highlighting the unique aspect of each area with different areas having different requirements for sound. A deadened area, in other words an area with sound absorbing surfaces such as upholstery, carpets and curtains, is not ideal as science centres seek to encourage conversation which is an important part of learning so a quiet space in which people feel the need to whisper is counteractive, however studies have shown that noisy environments in which there is too much noise can cause aural distraction and prevent people from focusing. Exhibits themselves can have sound affects. Therefore in exhibit spaces it is important to have a balance, some surfaces such as carpeting and banners which absorb sounds and some which reflect sound such as concrete. Smaller areas where people can retreat to can provide a space which is quieter for reflection. Ideally pause spaces should be quieter as these help to avoid museum fatigue these include rest areas such as cafes.

Design ambiance

As identified by the contextual model, museum atmosphere which should be intriguing, creating a sense of curiosity and interest. The entrance area (Fig 11) is vital in establishing this appeal as it creates the first and last impression and should “intrigue, stimulate and reassure” (Rosenblatt, 2001:206) This can be achieved by using eye catching exhibits that

arouse peoples curiosity, by providing visual linkages to the rest of the science centre so people can quickly and easily see their options and orientate themselves. Conforming to expected patterns can provide this reassurance.

Science centre should not be dull and typical architecture but something special and inspiring. As any form of building is actually the result of science and technology the building in itself becomes an exhibit. Science centres go to great lengths to ensure that each exhibit is exciting and engages with the visitor. In the same manner the architecture should be an exciting exhibit which engages with the visitor revealing how ventilation and plumbing etc work. However it should not be forgotten that it is also there to house exhibits and should fulfill this practical function first, this should not be compromised. Nor should it be too distracting. There needs to be a careful balance between being an exhibit and the container for exhibits.

ARCHITECTURAL REQUIRMENTS TO MEET AIMS OF SCIENCE CENTRE

As discussed earlier while one of the primary aims of a science centre may be to provide a learning context, there are other aims which need to be provided for by the building envelope. In order to meet the requirements of a science centre based on its aim and methodology and practical requirements the following architectural requirements need to be considered

Public architecture for improving public understanding

The science centre is a building which exists for the improvement of the public understanding of science, therefore it exists for the benefit of the public. Public or civic



Fig. 2.7: New York Science Museum follows the retail trend in museum design with a glazed ground floor allowing the passerby a glimpse into the exhibition space, revealing its contents (Source: Stephens 2005)



Fig 2.8: Imposing temple front entrance of British Museum indicating to the visitor not to touch (Source: <http://richard-seaman.com/Wallpaper/Travel/Europe/index.html#BritishMuseumFront> :14 March 2007)

architecture carries with it an established architectural language. Civic architecture is generally of a large scale in an elaborate architectural style symbolizing the success and governance of the governing body. It is generally centrally located and is fronted by public open space. The ground floor is usually open to the public. As a science centre is a public building, cognisance should be taken of these elements of the architectural language and should be incorporated to convey that this is a public building.

As the science centre is a civic building and provides an educational resource to its community, it should ideally be located so that it is accessible to all. It is important that in the context of South Africa no one be excluded or denied access to this educational resource, therefore it needs to be easily accessible from public transport and to people coming by private means.

The architecture should not be that of domination. Instead it should portray an image that is approachable and welcoming. It should rather tend towards the architectural language of retail which is transparent and welcoming. This has translated itself in architecture as glazed entrances revealing a hint of the content and glimpses into the science centre (Fig 2.3). The aim of the science centre is to demystify science, thus transparency in making the contents of the science centre visible, contributes to this. This preview allows for instantaneous appeal, which is a vital part of the science centre. According to Rosenblatt (2001:206) preview enhances excitement and interest.

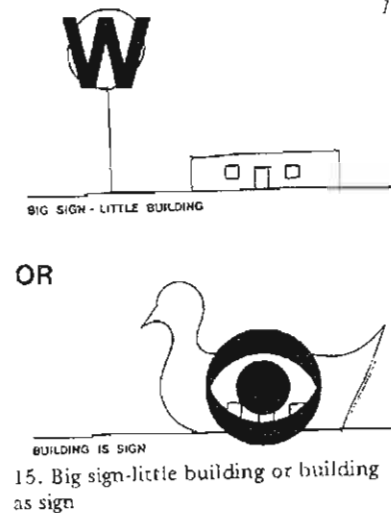
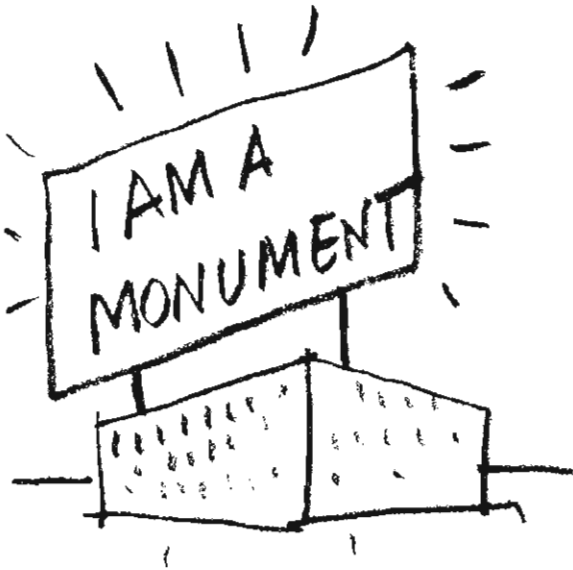


Fig 2.9: Big sign-little building or building as a sign (Source: Venturi, 17)



Identity and image

An important part in altering the public's perception of science is the image of the science centre. The architectural expression sets the tone for the visit to the science centre and determines the visitor's expectations (Semper, 2006). The architectural style conveys meaning to the visitor. For example, historically the temple front with its imposing columns has been used for art museums to create feelings of "awe and reverence" (Fig 2.4). The message communicated to the visitor is not to touch (Bitgood, 2002:16-17) whereas Children's' Museums are designed with bright colours and engaging activities encouraging the visitor to touch. The architecture and the style conveys meaning to the visitor and the meaning conveyed should be in line with the ethos of science centre which is to encourage the visitor to touch and get involved.

Function

As Roth comments we usually expect there to be a link between the appearance of the building and it's contained function (Roth 2007:16). Venturi (1977: 13) identifies two types of approaches that buildings use to convey their function (Fig 2.5); either a building with a sign or a building which is itself a sign and architectural symbol. Venturi goes on to elaborate that there are two systems of identification; the duck- "where the architectural system of space, structure, and program are submerged and distorted by an overall symbolic form" and the decorated shed which applies ornament- "where systems of space and structure are directly at the service of program and ornament is applied independently of them" (Venturi, 1977: 87).

There are different approaches to architectural image either a building with a sign, a building which is a symbol in itself or a shed with applied ornament to convey its function.

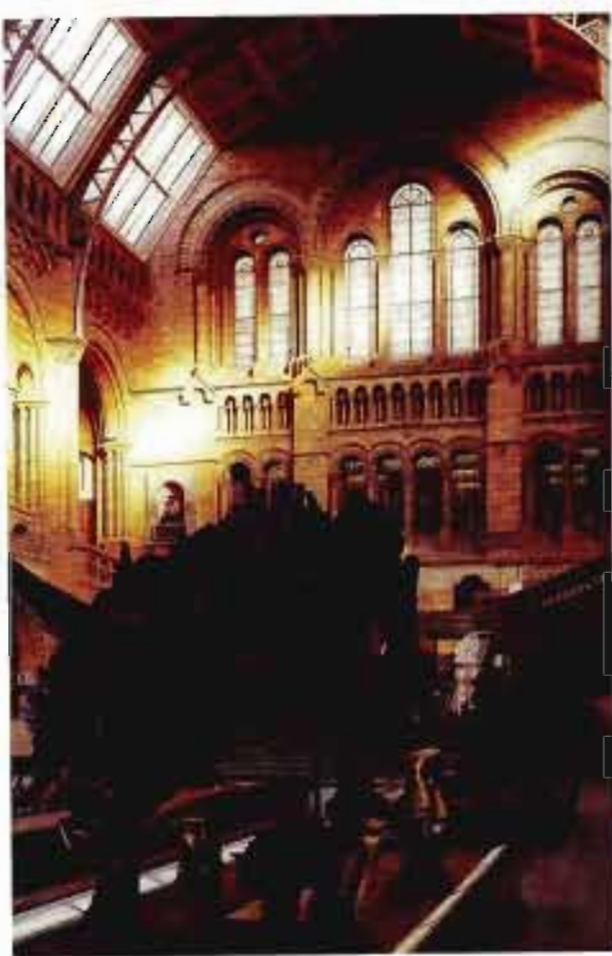


Fig 2.10: Cathedral like interior of the London Natural History Museum (Source: Charles, 1985: 55)

The building needs to portray an image to the public which communicates that it is public building while at the same time communicating that it is a science centre. But the function of the building should not be compromised for the sake of form. In a country with eleven official languages and a high rate of illiteracy the sign approach is most likely inappropriate. Rather the exterior appearance of the science centre should communicate its content to the public By revealing its content through transparency and revealing its content through a technological architectural language.

Anderson (1992:23) maintains that science centres are “destination attractions” in that people know about the centre and decide to come and, unlike shops, do not rely on the attracting powers of its neighbours. It is therefore not necessary for the building to advertise itself or make explicit its content as people know what it is. Therefore the architecture does not have to express its content, but should perhaps reflect its function. He maintains that “it helps to have a grand and distinctive building prominently located...landmark buildings and their sites become symbols of their towns or areas. This attracts free publicity and patronage from various sources” (Anderson, 1992: 26) It is important that the building has a distinct architectural image to encourage patronage and provide free advertising as part of a city's architectural image.

The question arises as to whether there is an appropriate architectural image for a science centre. In addition, whether a science centre should be a neutral container or an exhibit of technology in itself? The approaches of various science centres to these questions have varied over the last 30 years. Ideally a science centre should be a building which functions well “where systems of space and structure are directly at the service of program” (Venturi,

1977:87) but is still a landmark building with a distinct architectural image which does not intimidate or dominate but rather welcomes all, and reads as a public building.

Flexibility

In keeping with this important balance between the functional role of the building and its role as an exhibit, is the issue of flexibility. In a day and age where science and technology changes at a rapid rate that is hard to keep up with, science centres need to allow for continual updating and changing of exhibits to stay current. Montaner (1990:18) comments:

“In keeping with this continual transformation of the world of science and industry, any museum of science needs to have a provisional internal arrangement, and even a form, which allows for growth. New interpretations and inventions will call for future reorganisation and extra space. These museums should be constantly rearranging themselves and putting on exhibitions on new themes.”

Science centres need to be designed in such a way as to allow for flexibility in their exhibition space. This requires easy access and storage facilities as well as spatial volumes that allow for a variety of exhibition sizes and flexible lighting and power supply.

Context

Montaner (1990:18) argues that we have come to understand museums, “as a centre of activities intimately related to its context”. Science centres have tended towards having exhibits that are related to their local context, for example the science centre in Richards Bay, KwaZulu-Natal has exhibits on the local industry. But the building as an exhibit should be “intimately related to its context”. Some science centres have been built to re-generate

areas as there is a financial spin-off from science centres which provide jobs and draw people into areas, boosting the surrounding context.

Apart from a purely economical and social context, there is also a climatic context. A science centre should as an educational building model good climatic response. It should also respond to the local built environment, taking into consideration local materials, skills, traditions, meanings and symbolism.

The question arises as to whether or not there is a local South African identity and if there is an image for a South African science centre. The global scientific phenomenon and principles that the science centre illustrates tends to steer the image of the building towards reflecting global technology.

Sustainability

An increasingly important element in the design of museums today is sustainability. As a public facility “Museums are in a unique position to lead by example and proactively address these challenges in a non-threatening, educational, and public way” (Greenexhibits.org.) The call has gone out to museums to be at the forefront of sustainable design, it cannot be ignored as a public building and particularly a science centre it needs to exhibit and explain principles of sustainability. This has far reaching effects from the choice of materials to the method of ventilation.

CONCLUSIONS

Semper, the current director of the Exploratorium concludes that the “entire architectural package of a museum, from the outside building design to the interior colour scheme, plays a role in visitors’ intellectual approach to the exhibits.” (Semper, 2006) Studies have shown that the architecture, as discussed above can also affect the amount of learning that occurs, which is the main focus of the science centre. As such the architecture and all design decisions should be underpinned and informed by the educational philosophy, methods and aims of the science centre.

As a science centre is primarily a context for learning, the design of the facility needs to be determined by factors which create an environment conducive to learning. Being able to easily orientate oneself, affects visitors ability to learn, furthermore as this is a free-choice learning environment the movement patterns are non-linear and non-sequential and the organisation of the facility should accommodate this. An environment which delights and in which people feel comfortable and secure, creates an environment which is conducive for learning and factors which affect this can be defined as scale, sense of space, the ambience, lighting, colour, texture and sound.

Apart from being an environment for learning, the facility has an important aim in demystifying science, making it more approachable and improving public understanding. In order to do this the science centre needs to create a welcoming and appealing atmosphere and portray an image of approachability. As suggested above that the architectural language of retail, which provides glimpses into the context, can achieve this.

However a science centre also needs to meet its functional requirements in order to achieve its aims. It needs to be a flexible space to allow for a variety of ever-changing exhibits that accommodate the varying needs of science centres.

A science centre does not occur in isolation but exists in a context. A science centre is a destination attraction and has the ability to uplift the area it is in, and should enhance its surrounds as discussed above.

Various aspects of an architectural design can have a large impact on a science centres ability to meet its aims and therefore it is imperative that the architectural design of a science centre is underpinned by the educational theories and aims of the particular science centre.



INTRODUCTION

Science Centres as discussed earlier are a relatively new phenomenon, which break away from the traditional pattern of museums as a result of a different approach to education and are still developing a typology of their own. There is a resultant dearth of published science centres, which have been adequately published for the purposes of study. The options available are therefore not as strong a precedent study as would have been ideal. I have therefore chosen a range of Science centres from different locations and time periods that are sufficiently published but not necessarily the best examples of science centres. I will look at three examples of science centres built in the last 20 years. The context and architectural approaches vary. These will be analysed according to the criteria discussed

below, derived from the conceptual and theoretical framework and will be individually analysed. The precedent studies have been selected as purpose built science centres.

CRITERIA FOR THE EVALUATION OF PRECEDENT AND CASE STUDIES

Architectural Expression

This will study the image of the building, how it is identified as a science centre, the architectural language used to do this and the conformity of the built environment to the language of civic architecture its response to context. The expression of form and structure and the treatment of the facades will be analysed. It will focus on the entrance and internal spaces in terms of creating an awe inspiring context that makes the visitor feel comfortable and welcome. This will also look at how the building is experienced and interacts with the user and the exhibits.

Spatial Organisation/ Functional requirements

This will examine how the spaces are organised and their relationships to one another and the quality of internal and external spaces created. It will analyse way finding, the ability to orientate oneself within the building and the local context and the establishment of an overall coherent framework. The opportunities for free choice for people to determine their own routes and process of learning as well as the creation of exhibition spaces will be analysed.

Environmental/ technical response

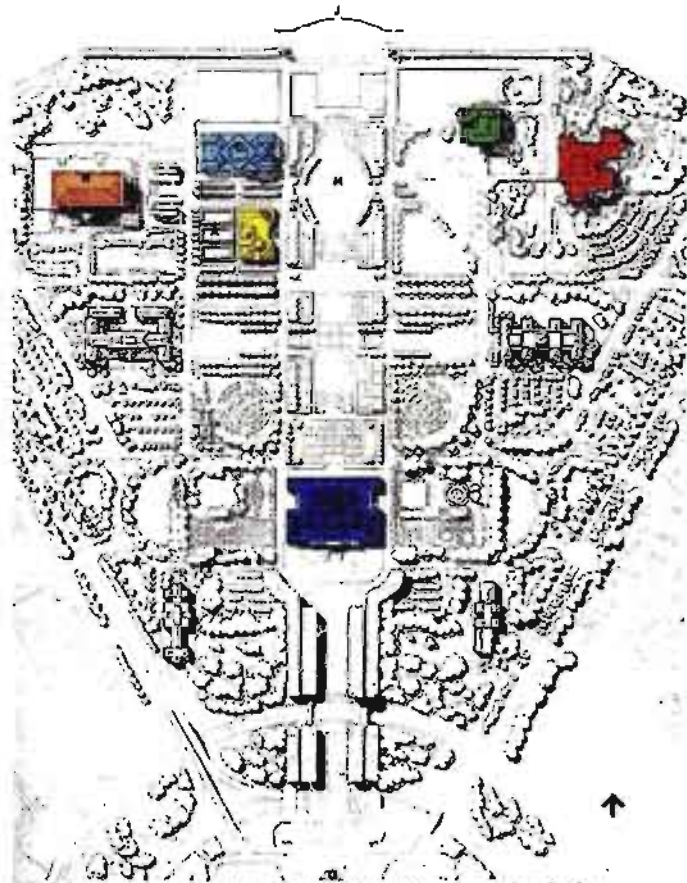
This will focus on the physical aspect of the building, its climatic response and provision of physical comfort, from ventilation, lighting, glare, places to pause etc. It will look at the structural resolution of the architecture and its ability to be flexible and provide for a number of requirements. The sustainability of the building in terms of choice of materials and climatic response will be looked at.

Contextual response

This deals with the building's response to its local context in terms of location and accessibility. It will also look at the response to the architectural context. How the building responds to the passerby and provides for the public in terms of public plazas etc. as well as the cultural and heritage context

NATIONAL SCIENCE AND TECHNOLOGY CENTRE (QUESTACON), CANBERRA

Questacon is located in Canberra, Australia's capital city. In a strategic move to elevate science in the nation, the science centre was built on the Parliamentary Triangle (Fig 3.1) along with the National Library, High Court, National Gallery and Provisional Parliament House. Questacon has been used to define the edge of the intended Land Axis (Fig 3.2) designed by Walter Burley Griffin. The building was designed by Lawrence Nield and Partners and was completed in May 1988.



3.2: Plan of context depicting the Lands Axis
1 surrounding building (source: Spence, 1989:

Y TO PLAN

Questacon
National Library
National Archives
High Court
National Gallery
Provisional Parliament House
Forecourt of New Parliament House
Oval on Land Axis
Lake Burley Griffin



(source Nield: 1989:30)



The central rotunda around which the floor is organised (source Nield: 1989:30)



Fig 3.5. Back entrance with curvilinear glazing and outdoor science court (source Nield: 1989:30)

Architectural Expression

The building was essentially designed as 6 cubes with two cubes removed to form the entrances. These have been defined by free form glazing which contrasts with the elementary forms of the remaining cubes. The sixth cube was transformed to create a quadrant to house the auditorium and administration block. The three remaining cubes pivot around a rotunda. The architecture is based upon classical ordering devices and cubic forms informed by the National Gallery and High Court. The building has a cubist aesthetic, making use of strong forms.

Glazing is used to define the foyer (Fig 3.3), using shop front methods to entice the passerby to view the activity within. The ground floor of the museum contains the cafeteria and gift shop. It is open to the public so people can take a short cut through the building to a parking area. Thus this building conforms with the norm of public buildings with the ground floor open to the public. This forms an active foyer and creates an architecture which is inclusive. A forecourt is formed at the rear of the building which is used for outside exhibits, creating a public plaza.

The 27m high rotunda (Fig 3.4) provides an easily identifiable iconic element which aesthetically holds the science centre together. The strong cubic forms provide a distinct image and the overall effect is a clear and memorable building. As a criticism, this building could contain anything and could be a museum for anything, anywhere. Apart from the architectural references to surrounding architecture there is nothing specifically local about this building or that communicates that it is a science centre.

The scale of the building is very large. Lighter elements like the portico (Fig 3.3) at the entrance help to add a sense of scale to the building and make it less intimidating. The vast scale of the foyer is humanised by a ticket booth, shop activity and exhibits.

Spatial Organization/ Functional requirements

The spatial organization is very clear in this building. The main entrance is from the Land Axis but most people approach from the parking lot at the rear of the building. It is here that this project can be criticized. The information and ticket desk are orientated for those coming from the main entrance, which is not the direction from which the majority of people come. This causes some confusion and congestion. People buy tickets and climb the ramp which takes one to the top of the rotunda (Fig 3.4) from which one winds down to access the various galleries. There is a strong processional route, which is a metaphor for the voyage

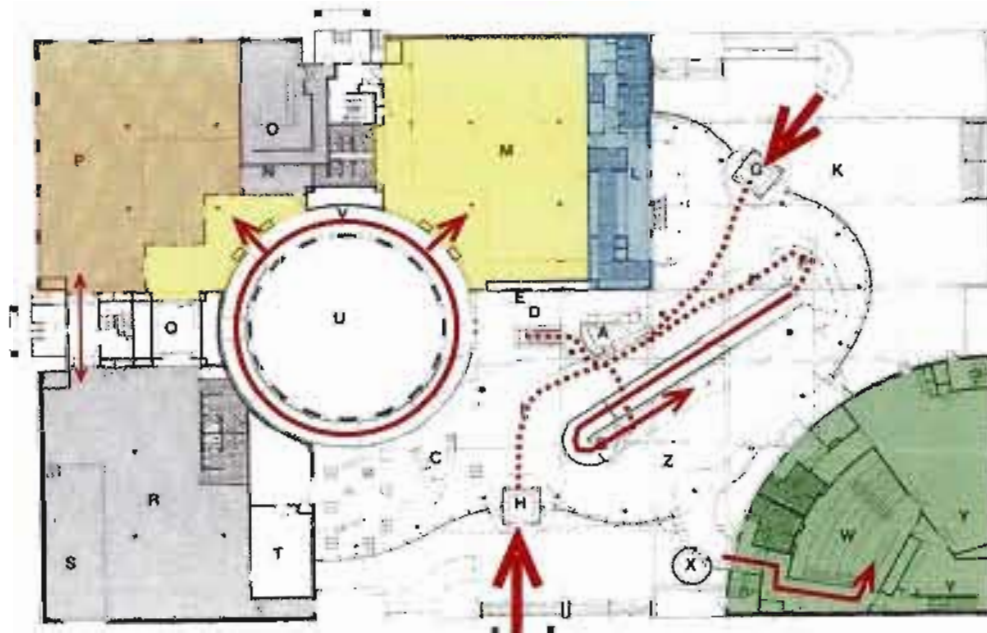


Fig 3.6: Ground floor plan of Questacon
(source: Spence, 1989: 71)

Key:

- | | |
|---------------------------|--------------------------------|
| A: reception desk/tickets | N: main switch |
| B: cloaks | O: sub-station |
| C: science shop | P: workshop |
| D: stairs to car park | Q: lift |
| E: balcony overhead | R: store |
| F: base of main ramp | S: loading dock |
| G: western entry | T: science shop store |
| H: main eastern entry | U: drum/exhibition |
| I: foyer | V: base of drum/ramp |
| J: porte cochere | W: theatre |
| K: science court | X: admin lift |
| L: servery cafe | Y: preparation area |
| M: exhibition | Z: administration balcony over |

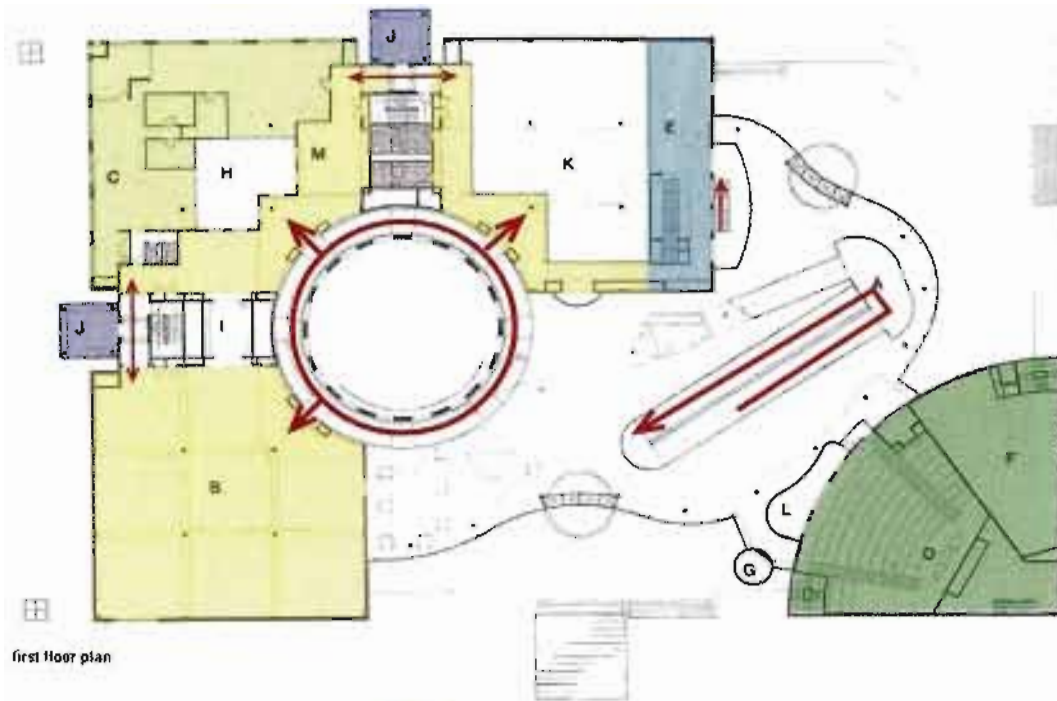


FIG 3.7: First floor plan of Questacon (source: Spence, 1989: 71)

- Key:
- A: access ramp
 - B: exhibition galleries
 - C: exhibition design
 - D: theatre void
 - E: cafeteria
 - F: preparation void
 - G: administration lift
 - H: void over workshop
 - I: Lift
 - J: longes
 - K: exhibition void
 - L: projection room
 - M: circulation space overlooking workshop and exhibit design areas

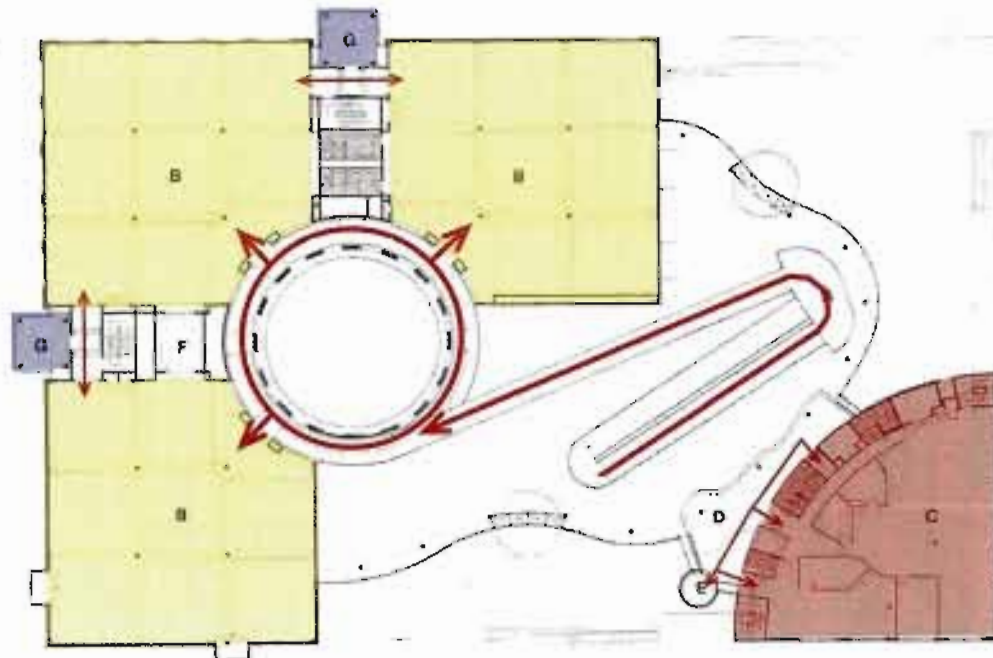
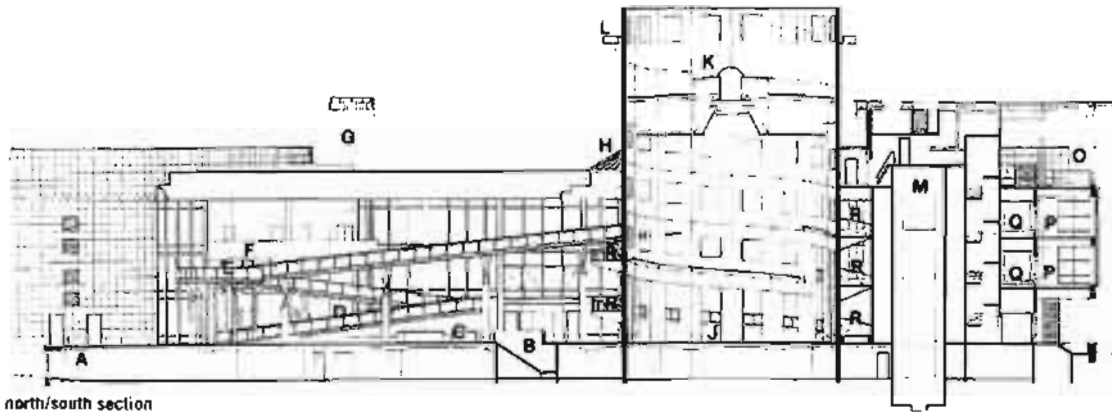


Fig 3.8: Second floor plan of Questacon (source: Spence, 1989: 71)

- Key:
- A: access ramp
 - B: exhibition galleries
 - C: administration
 - D: administration balcony
 - E: administration lift
 - F: lift
 - G: lounges



north/south section

Fig 3.9: Cross section through Questacon depicting the circulation
(Source: Spence, 1989:71)

of discovery that a trip to the science centre takes one on. The system of ramps orientates the visitor within the building and within the context with views out of the glazed foyer walls onto the Land Axis and surrounding buildings. It was concluded by the architects that this was the best method to move large crowds of people. The ceremonial route created by the ramps is legible and clear and creates a build up of anticipation to the exhibits(Fig 3.9).

Around the rotunda are organized a series of exhibition spaces and service spaces. The galleries are connected with bay windows with seating areas that provide rest points and views into the surroundings allowing one to orientate oneself. These also create places to pause and allow people to process the new information they have gained. Most of the exhibition spaces are windowless to allow for flexibility. The building is organized around the main circulation route, which is expressed as a central feature and an organizing element for the whole building. Free choice is not well catered for in this building as it has a

strong linear sequential movement, people are unaware of what exhibition spaces contain and the lack of overlooking spaces further reduces people's choice in where they go.

Environmental/ technical response:

The exhibition spaces have been divided on a 25x25m grid with 4 columns. Servicing is supplied overhead with a catwalk and the exhibition spaces are neutral and most without fenestration. This is to achieve maximum flexibility. The heights of the galleries vary for flexibility and to provide for a range of exhibits. As a result the majority of the exhibitions are artificially ventilated and lit.

The delivery area is located on the ground floor with a double floor service wing containing exhibition development. This is open to the public so they can observe the development of exhibits.

The large glazed areas in the foyer are double-glazed with internal louvers. Apart from this gesture and the location of the cafeteria to receive sun, no other acknowledgement of climate has been made. It appears that the sustainability of the building was not a concern at the time of design.

Contextual response:

A concerted effort has been made to link the building into its architectural context. The same classical references have been made and white tiles and a granite base have been used to match the brick plinth of the Parliamentary building (Fig. 3.10). A modernist cubist language has been used to correspond to the National Gallery and High Court (Fig. 3.11). The building responds to the Land Axis with the main entrance on the Land Axis. The



Fig 3.1: Questacon situated in a park setting on the Parliamentary Triangle (source: Spence, 1989: 71)

Fig 3.10: The Science Centre echoes the architectural language of Parliament House (Source: http://www.search.com/reference/Parliament_House,_Canberra, 25/03/07)



Fig 3.11: Cubist language of the High Court (Source: http://benambra.org/gallery/Canberra_champions_trophy_2005/imgp3933, 25/03/07)

building provides glimpses out into the context so one's orientation with the greater context is good.

The building is orientated so that the glazed north elevation looks onto the river, and it is in this direction, with a north orientation that the restaurant faces. The east glazed façade looks onto the green of the Land Axis.

Conclusions

Despite the building's concerted effort to respond to its architectural context, it does little to respond further to its physical context, the building could be anywhere. Neither does it communicate its function as a science centre. The scale of the architecture and its location communicates that it is a public building yet its scale is overpowering. Lessons can be learnt from the simple clear circulation system that allows the visitor to be easily orientated within the building and the context. The processional route around which the building works is an efficient system however the linear sequential organization does not assist in creating a free choice environment. Black box exhibition spaces (exhibition spaces where light is excluded and services are revealed) with overhead servicing and varying exhibition heights create flexible exhibition spaces. Shop front techniques reveal the inner workings of the science centre. Access to the ground floor by the public as well as access to the restaurant and shop creates a busy active foyer. This welcomes all and allows people an opportunity to experience what is to come. This assists in making the architecture inclusive. For the South African context this inclusive approach is commended.

Fig 3.13: Context plan of California Science Centre

- 1 California Science Centre
- 2 Future phase of California Science Centre
- 3 Rose Garden
- 4 Natural History Museum of Los Angeles
- 5 Science Centre School
- 6 African American Museum
- 7 Los Angeles Memorial Coliseum
- 8 Los Angeles Sports Arena
- 9 Aquatic and Recreation Centre

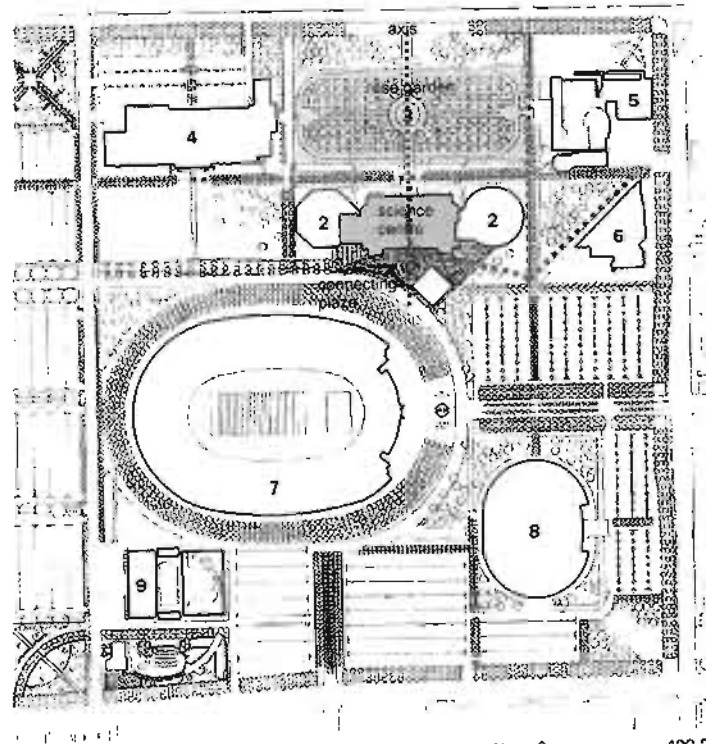


Fig 3.12: The main entrance to California Science Centre, depicting the three strong elements and the scale of the building. (Source: Stein:1998:177)

CALIFORNIA SCIENCE CENTRE, LOS ANGELES

The California Science Centre (Fig.3.12) was designed by Zimmer Gunsul Frasca Partnership and was completed in February 1997. It is located in Los Angeles between South Central Los Angeles (a low income area) and the historic core of the University of Southern California. It forms part of Exposition Park which contains a sport stadium, basketball arena and a swimming stadium as well as civic buildings (Fig. 3.13). These include the Natural History Museum of Los Angeles and the African American Museum. At the centre of the park are the Rose Gardens at the head of which sits the science centre.

Fig 3.14: Interior of the rotunda with art installation and coloured glass which creates an awe inspiring entrance. (Source: Stein:1998:177)



FIG 3.15: The entrance area formed by the rotunda, and the glazed entrance. (Source: Stein:1998:179)

Architectural Expression

Part of the design concept was to conserve and restore the historic façade of the Howard F Ahmason Building and incorporate it into the new building. Glass is used to link the existing façade with the new building. The architects felt that the new building needed to respond to the symmetry of the existing rose gardens.

The building consists of three distinct elements: the exhibition space, the IMAX theatre and a rotunda that links the two (Fig 3.12). It was concluded that the building needed an iconic element which led to the design of the rotunda (Fig 3.15). The rotunda forms the icon of the building and acts as a front porch for the science centre. It has a skylight of dichroic glass and contains an art installation of 1600 suspended gold and palladium spheres (Fig 3.14). The effect is magical and it creates an eye catching entry point.

The building is of a monumental scale (the IMAX is seven stories high) and has a dramatic public presence. Some concern was expressed about the scale of the building in comparison to the adjacent low income area. However the residents felt that they wanted a landmark of their own. The scale is quite intimidating.

Brick was used on the front entrance to correspond with the conserved façade. A pattern has been incorporated into the brick facade to bring a sense of scale. Curtain wall glazing is recessed in the brick façade to create a locus of transparency at the entry point (Fig 3.14). The building uses elements borrowed from retail architecture, an attractive glass front making the interior visible, enticing the user inside and large signage to indicate the contents of the building. No reference, except for the covering over the ticket area, is made to human scale.

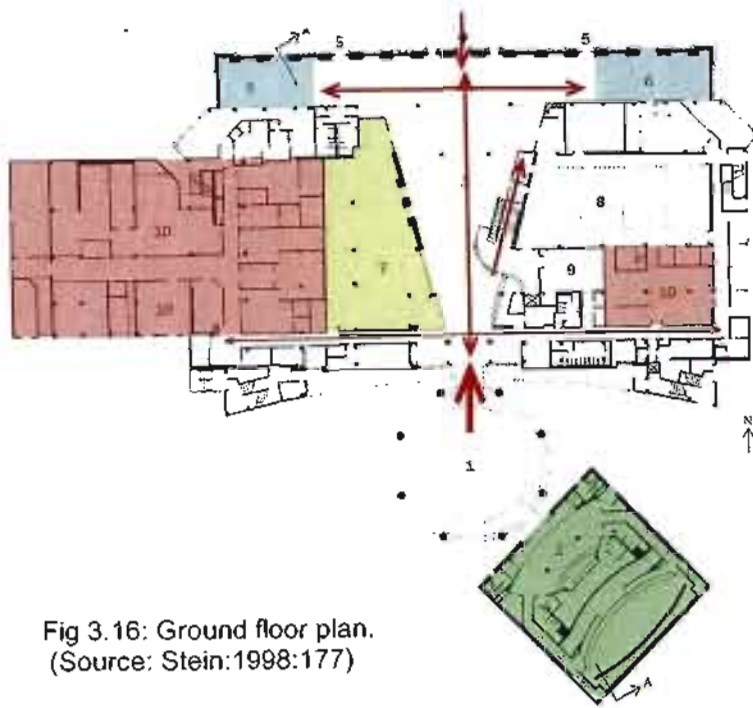


Fig 3.16: Ground floor plan.
(Source: Stein:1998:177)

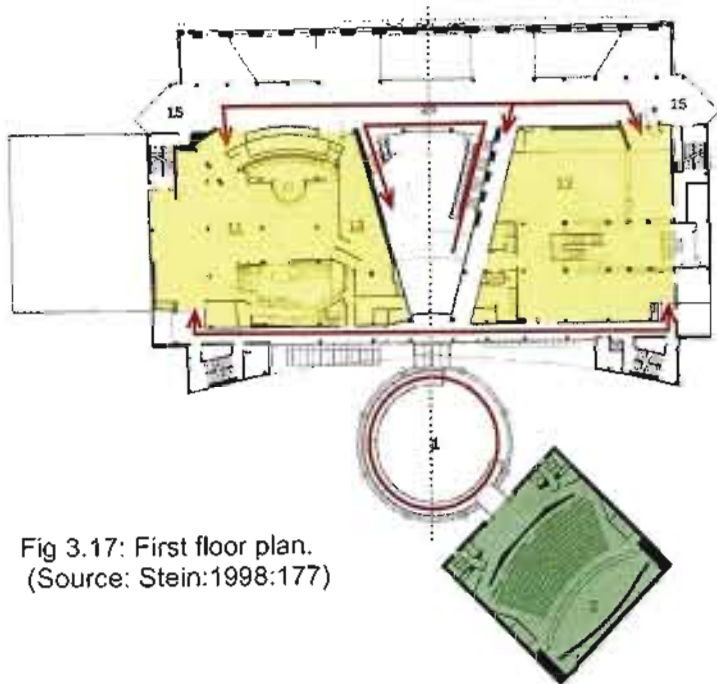
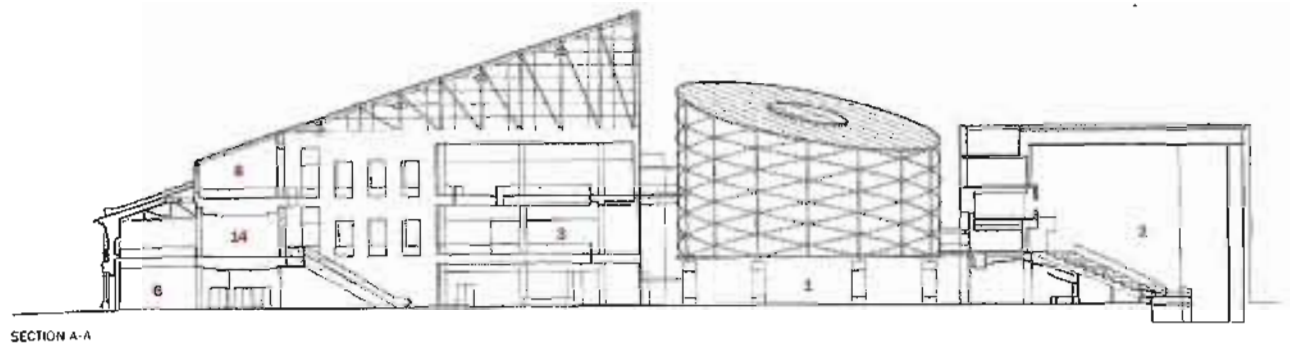


Fig 3.17: First floor plan.
(Source: Stein:1998:177)

Apart from the sign "California ScienCenter" there is no indication that this is a science centre. The monumental scale and public plaza suggest that this is a public building.

Spatial Organisation and Functional requirements



SECTION A-A

Fig 3.18: Cross section through the atrium of the Science centre (Source: Stein:1998:178)

The aims and objectives of the spatial organization are best expressed in the words of Ann Muscat the current deputy director of the science centre:

"We wanted a building that would be easy to read for visitors so that it would be simple for them to figure out where they need to go. We wanted a building that would capture visitor's imaginations grab their hearts- then we'd go after their minds" (1998, Stein: 183)

The spatial organization is very simple and easily understood. It is very simply organized with a central atrium (Fig 3.17) this has a glazed pyramidal skylight that builds up to the rotunda which is at the apex of the atrium. All circulation occurs within this atrium (Fig3.18), with escalators and stairs to move large groups of people. The exhibits and IMAX theatre are accessed off the atrium. The atrium acts as a node of activity, people are drawn towards light. The use of the glazed atrium has this affect as people



Fig 3.19: Central atrium in which circulation occurs and acts as a node. (Source: Steir:1998:180)

are drawn from dark exhibition spaces into the light. Off the atrium space a circulation spine runs laterally along the building along the old facade and contains the dining areas. There are vertical circulation routes within the exhibit spaces. The circulation within the exhibition spaces provides free choice of route with overlooking spaces to help the visitor orientate themselves and make choices.

Environmental and technical response

The exhibition spaces are large black boxes with no fenestration and are artificially lit and ventilated. The large glazed skylights are areas of concern in Los Angeles's hot climate as there appears to be no form of sun shading (Fig3.17). This puts heat loading on the air cooling system. Apart from the semi-enclosed rotunda which Los Angeles's weather allows for there is no reference or response to climatic considerations.

The building has a concrete frame and slabs, with a glass and brick façade and a glazed atrium. Considering that this building was built in 1998 it is surprising that very little attempt has been made to design a sustainable building, or one that is more climatically responsive.

Contextual response

The building has responded to the context by incorporating the conserved façade (Fig33) and responding to the symmetry of the Rose Garden. The building can be criticized in that the scale of the building is disproportionate to the surrounding context.. By separating the IMAX from the exhibition components a circulation route has developed linking the entry plaza to the rest of the park. This is a sensitive link, which is effective (Fig 3.13).



Fig 3.20: The listing conserved facade of the Howard F. Ahmanson Building which determined the symmetrical layout of the science centre. (Steir:1998:180)

A large urban public plaza with seating and art installations has been designed in front of the building. This creates a collection space where children can gather before entering the science centre. The hard landscaping creates a harsh environment devoid of vegetation. In the hot climate of Los Angeles this is less than desirable. Particularly in the context of a park this is not an appropriate response. The plaza is an unenclosed dominated space. More human scaled elements need to be introduced to scale and soften the environment.

Conclusion

The circulation is simple and effective, and the central-light filled atrium is a welcoming, pleasant space. The rotunda adds a monumental iconic element which gives the building a strong identity. The iconic element provides a distinct image for the science centre. The use of artwork and light creates an awe-inspiring entry that captures the visitors' attention. This massive seven-storey building with its masonry walls and strong forms does little to provide human scale and as a result it is overpowering, particularly in an environment predominately frequented by children. Introducing elements of a human proportion could alleviate this and make the building less intimidating. In terms of communicating it's function this building is not entirely successful. Its response to context in terms of symmetry and the conserved façade is appropriate.

TECHNIQUEST, CARDIFF, WALES, 1995, ABK

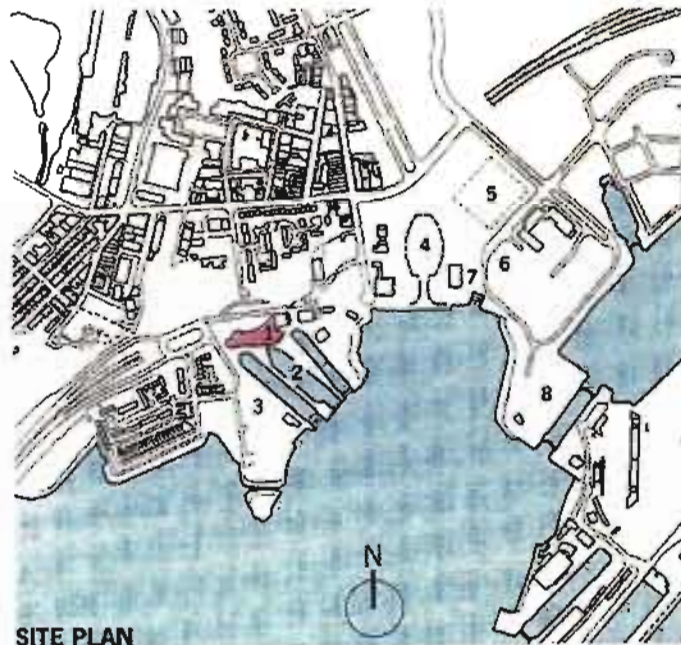


Fig 3.21: The entrance to Techniquest punctuated by the aluminium clad Starlab (Source: <http://www.techniquest.org/about/16/08/07>)

Fig 3.22: Context plan of Techniquest (Source: Hall, 37)

Key:

1. Techniquest
2. Graving docks
3. Site for temporary car park
4. Outline of Oval Dock
5. Site for Opera House
6. Site for Hotel
7. Pierhead Building



Techniquest in Cardiff was built in 1995 and was designed by Paul Koralek of Ahrens Burton and Koralek. The building provides a permanent home for the science and technology centre. It is one of three flagship buildings intended to revitalise Cardiff's inner harbour waterfront, including an Opera house and a maritime heritage centre (Fig 3.22). The building conserves and incorporates into it a nineteenth century heavy engineering workshop, made from cast and wrought iron.



Fig 3.23: Techniquest viewed from the docks in its industrial setting (Source: Hall 37)

Architectural Expression

The architectural expression of the building is strongly determined by the existing building, which is industrial (Fig3.23) This has been further enhanced by the use of space frames to support the shading system, further embedding the technical architectural style of the building. The north side of the building is more solid in nature with a series of curved and stepped walls in Staffordshire Blue bricks.

According to the architect, the two main considerations in the design of the building were “to create a dramatic and exciting waterfront exhibition space for Techniquest which would be sympathetic to its exhibits and above all to its educational purposes and ethos, and two, to retain the existing iron structure and to enhance and display its character” (Koralek,1995: 35)

The entrance is punctuated by the aluminium clad sphere (Fig3.21) of the “Starlab”, a mini-planetarium which contrasts with the glazed entrance. According to Hannay (1995:40) this not only marks the entrance but signals that science has arrived which he suggests is a more of an apt response for a science centre than an retaining the old workshop.

Hannay also comments that the entrance area constricted, and has been compromised in the design, and that vertical height does not correct this problem. He further points out that the geometry of the building that has been used to link either side of the entrance area draws the eye towards the café rather than towards the exhibits as required by the brief.



Fig 3.24: The entrance area lacks in generosity
(Source: Hall,195:38)



Fig 3.25: The cathedral like exhibition hall
(Source: Hall, 1995: 34)

- | | |
|------------------------|-------------------------|
| 1 main entrance hall | 6 demonstration theatre |
| 2 shop | 7 teaching laboratory |
| 3 cafe | 8 main workshop |
| 4 main exhibition hall | 9 electronics workshop |
| 5 wet exhibit area | 10 paint spray booth |

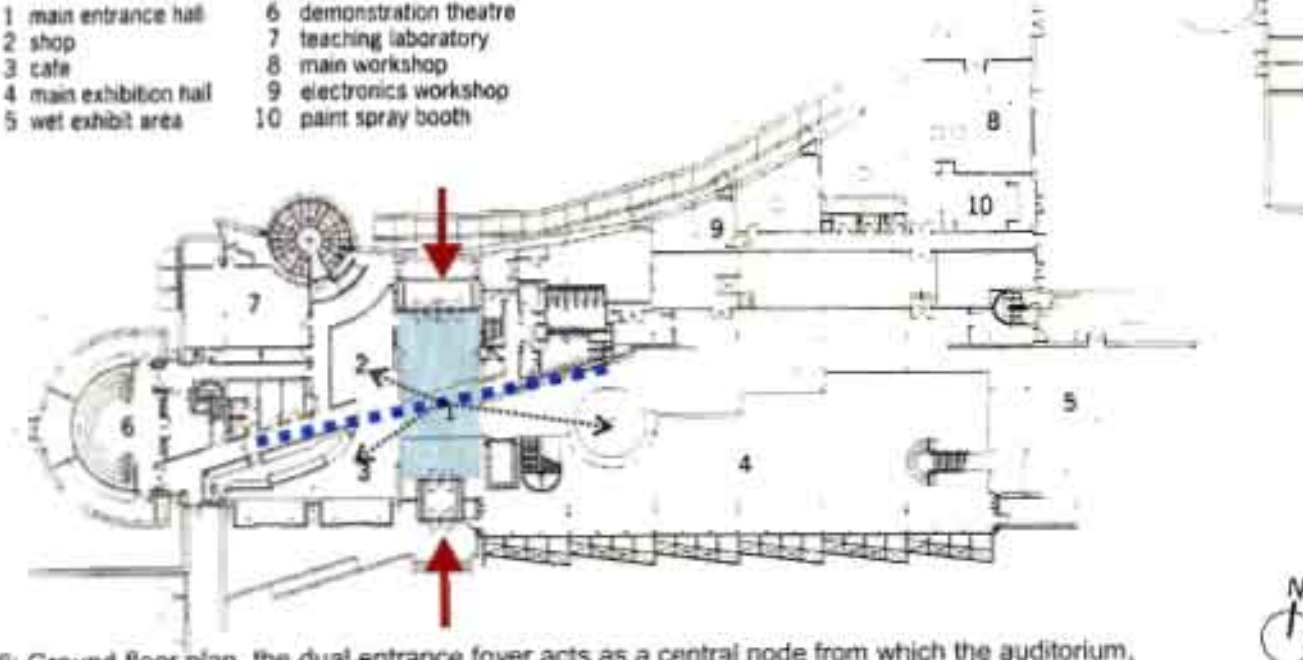


Fig 3.26: Ground floor plan, the dual entrance foyer acts as a central node from which the auditorium, exhibition and café are accessed (Source: Hall, 1995:46)

what occurs inside.

The exhibition hall is large and reminiscent of a cathedral, defined by the volume of the old workshop, eleven metres high and fourteen across. In contrast to this large space is a mezzanine floor which has been inserted into this space, used for more light-sensitive exhibits. This space required columns to support it resulting in a dense cluttered space. The glazing on the south allows the passerby into the science centre, thus making science visible and revealing



SPATIAL ORGANISATION

The building is organised around the central entrance zone from which all other activities are accessed. The entrance is a dual entrance accessed from the north and the south (Fig2.6). As this provides access to the exhibition space, demonstration theatre, shop, café and teaching lab it is a tight space. However the circulation is simple

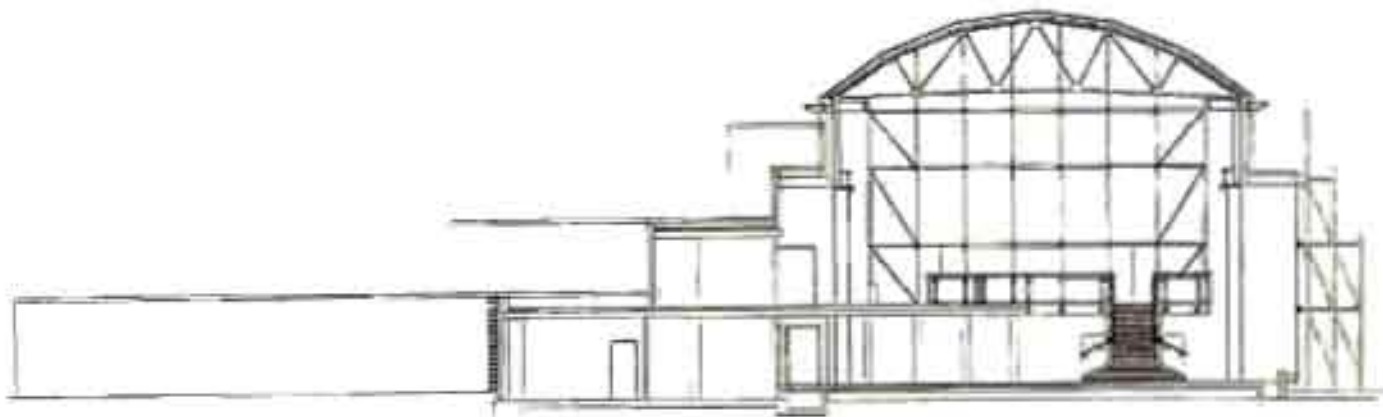


Fig 3.27: Cross section through the exhibition space and subsidiary spaces (Source: Hall, 1995:46)

and easily understood with the entrance acting as a node of activity from which to orientate oneself.

The exhibition space is open-plan with a staircase and lift at the entrance and at the end. As a result of being open-planed it is easy to navigate and allows for free choice in choosing one's path through the exhibits. The mezzanine levels (Fig 3.25) allow for space to be overlooked and other activities observed.

The café and exhibition space have large glazed areas on the south overlooking the graving docks but are also strategically positioned to exploit the sun on the southern façade.

ENVIRONMENTAL AND TECHNICAL RESPONSE

One of the aims of the science centre was to "produce a building which demonstrates the use of energy, materials and systems in an economic, innovative and responsible manner"(Moseley,1995:38). As a result the building is naturally lit where possible and naturally ventilated, using displacement ventilation in both the exhibition hall and the auditoria. Low level inlets in the exhibition hall lets in fresh air which escapes through clerestory lights. A high level of automation is used in the building to control the thermal environment. Sun shading is used on the south to control the amount of sun that enters the building.

The structure of the building is primarily determined by the existing structure. A reinforced concrete frame has been inserted in and around the existing structure. The new building



Fig 3.28: The existing façade is revealed and the added space frame further enhances the technical feel of the building. (Source: Hall, 1995: 38)

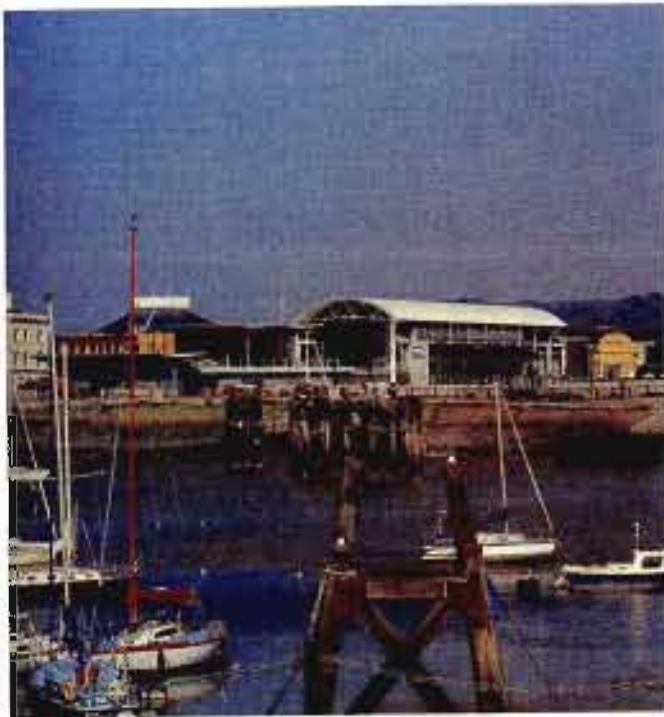


Fig 3.29: Techniquest viewed in the context of the docks with the glazed façade and sun shading overlooking the docks. (Source: Hall, 1995:39)

has an unusual shape resulting in an irregular column grid, forming a sea of columns, unfortunately limiting flexibility.

Neutral colours of grey and white were used throughout the building to provide a neutral backdrop for the colourful exhibits and so as not to detract from the exhibits themselves.

CONTEXTUAL RESPONSE

By maintaining the existing building, which was an established landmark, the building has responded well to context. It has an industrial feel appropriate for a harbour development (Fig3.29) Exposing the structure and technology is appropriate for a centre that showcases technology. The addition of space frames further endows the building with a technical feel suitable for the context.

The orientation of the café and exhibition space on the south is an appropriate response to the climatic context. By locating the glazing on the south it provides views of the harbour from the exhibition space and orientates the visitor within the context.

CONCLUSION

By grafting the building onto an existing building, Techniquest has a strong image of technology and is a landmark building. This is further enhanced by the addition of the “Starlab” sphere, which creates a distinctive entrance marker. The circulation system is simple and easily read with a central node of activity. However there is a general sense of tightness in the entrance area. The circulation appears to work well in the building. The

open plan circulation system with more enclosed areas which contrasts with the openness of the exhibition space creates a varied exhibition area.

CONCLUSIONS

California Science Centre and Questacon are open to the public on the ground floor and allow the public to wander through the building and to use it as a throughfare. They provide facilities for the general public. The result is a public building which encourages participation. This response is applicable to South Africa where most people have in the past been excluded from Science Education. To provide access to some exhibits and to create a welcoming atmosphere that is bustling with people is a solution applicable to our context. Techniquest on the other hand provides views into the main exhibition hall for the passerby and is a much more transparent building, revealing its contents

The rotunda entrance to California Science Centre with the use of coloured glass, and an art installation, with its large volume creates an intriguing spectacular place with an immediately appealing entrance. This approach elicits the important elements of, excitement and curiosity. Techniquest also uses a strong form to mark its entrance, however the confined entrance lacks the same feeling of awe and wonder.

All the precedents use elements from retail architecture with glazed fronts as this allows views of the interior and entices people inside. The function of the building is displayed not in its architecture but in its signage. All conform to Venturi's description of a decorated shed, subject to its function with applied ornament and a sign to declare its content. As Anderson (1992:23) comments: science centres are destination attractions and as such do not need to capture people's attention, as people know where the science centre is located.

All these buildings have simple, easy to understand organization and circulation patterns which are organized around a central element. In the California Science Centre the circulation is around an atrium. In Questacon it is organized around a drum. These systems appear to work effectively in that they still provide free choice but the central points (nodes of activity) provide a clear reference point. In Techniquest the foyer acts as the central node, albeit a confined one from which all other activities are accessed. The sense of discovery and the creation of a ceremonial procession on the voyage of discovery in Questacon create a sense of anticipation and which accentuates the experience. The simple device of a central point and distinct landmarks makes the layout easy to understand and map and therefore allows the visitor to easily orientate themselves.

While California Science Centre and Questacon make some reference to context in their architectural language and materials, there is very little to specifically locate them in their context. In terms of climatic responses or choice of material there is little in the building to indicate its particular location. Both buildings provide views out of the building which continually locates the visitor with the greater context. This is important where a black box approach to exhibition halls has been used as the visitor can become disorientated. It is interesting to note that both buildings are located in park settings in close proximity to other civic buildings.

Likewise Techniquest is located within the context of other cultural buildings. However the aesthetic and architectural language and its response is firmly imbedded in its context, from its climatic response to its orientation and in this regard is a more successful response. The more technical architectural language provides some clue to the buildings function.

The response of California Science Centre and Questacon are monumental in scale, both are quite large science centres. This is important in terms of giving science prominence. However In a context predominately frequented by children this is a less than desirable response. While science centres are large monumental civic buildings the scale should also take its users into consideration. Techniquet though eleven metres high manages to be a large landmark building without being overpowering, this may be as a result of the manner in which the building steps down to the entrance court or the use of smaller elements on the dockside elevation adding a sense of scale. Internally the insertion of a mezzanine level creates more intimate display spaces, providing spaces to retreat to. In terms of spatial experience Techniquet provides the best solution with large spaces balanced with smaller spaces of retreat. Internally California Science Centre is well balanced with a large circulation space that is well lit which creates feelings of awe through its scale but this is balanced by the smaller darker exhibition spaces.

It can be concluded from the precedent studies that opening parts of the building to the general public creates an environment in which people feel welcome. Transparency of facades allows people views in making people aware of what occurs within as well as orientating people within the greater context by providing views out . The architecture of the science centre should be rooted in its context and should portray its contents through a technological language to the passerby. A central circulation node which is punctuated by a landmark creates a simple method of organization which is easy to understand and therefore orientate oneself within.



INTRODUCTION

The nature of a masters requires primary research. Internationally Science Centres are still a developing typology and the same applies in South Africa with no purpose built structures existing. At the moment South African Science centres are not on par with international examples but I have used these case studies to gain a better understanding of how science centres work, more specifically how they function in South Africa. There are currently three science centres in KwaZulu-Natal, Unizul in Richards Bay, Olwazini in Pietermaritzburg and MTN-Old Mutual ScienCentre in Gateway Theatre of Shopping, Durban. Olwazini and Unizul are not purpose-built but rather retro-fit buildings. Sci-Bono, located in a converted power station in Newtown Johannesburg is the largest science

centre in South Africa, and extensions are planned. MTN ScienCentre in Cape Town is located in a shopping centre yet is potentially one of the most successful science centres in South Africa.

UNIZUL

Introduction

Unizul is an interactive science centre and forms part of the University of Zululand science development program. It was housed at the university until it was offered the use of a warehouse in Richards Bay. The warehouse was originally built as a canteen during the construction of an aluminium smelter. It forms one in a series of buildings located in an industrial area. Other buildings in the complex include a career guidance centre and a community hall.

Unizul is primarily aimed at secondary school Physical Science educators and learners from the schools surrounding the University of Zululand. The schools come from as far a field as Tugela River, Kosi Bay and Nongoma for a variety of programs. These programs include a planetarium, special events and science camps, matric workshops, educator enrichment courses, competitions, a resource centre and mobile exhibits.

There are currently 4 full-time staff, and 8 contract staff. These consist of a Director, a Schools' Programme Manager, a Resource Centre Co-ordinator, and an Exhibit Developer.

The centre caters for 30 000 visitors per annum with up to six schools visiting a day. These groups normally consist of 80 people each. An average visit will be divided up into five, fifty

minute sessions. These are: a science show, exploration of exhibits, a workshop and 2 sessions at the careers centre. So a total duration of the visit to the science centre is 150min. The science centre is currently undergoing extensions. A new wing similar to the old has been built.

Architectural expression

The building is a portal frame warehouse with face brick infill (Fig 4.1). There is nothing in the architecture to suggest that it is a science centre, it reads as a warehouse. The only indication of its function is a sign at the apex of the roof (Fig 4.1). There was some initial confusion as to where the entrance was, which is located between two buildings (Fig 4.2). The outside area forms a collection point for instruction before entry. One enters straight into the exhibits. There is no feeling of anticipation, or awe or wonder created. The building is purely functional. The building's legibility as a science centre and in terms of its entrance is poor.

Spatial Organisation

As Unizul is run on a tight budget the buildings have been altered as little as possible to suit the centre's purposes. Existing walls were maintained with extra doors added. The result is a compartmentalized science centre (Fig 4.3), which has been used to divide the exhibitions up into themes for example the puzzle exhibition. This is not ideal as it requires a staff member for each room to supervise, yet it stops the size of the exhibition areas from becoming overwhelming. It has also meant that the spatial organization is haphazard. In interviews with Derek Fish, the director, he stressed that free choice in visitor's exploration of a science centre is important. Therefore there is not a set route but people are free to

Fig 4.1: The front façade of Unizul, depicting the industrial nature of the building (source: author)



Fig 4.2: Entrance to the science centre, between two buildings (Source: author)

room. The new exhibition facilities consist of a single uninterrupted exhibition space, which is easier to supervise. The size of the building means that the layout is simple and easy to navigate. There are mezzanine levels that allow visitors to gain a new perspective on the space. Derek Fish commented that for children coming from rural areas a second floor and steps is an exhibit in and of itself, which provides great fascination.

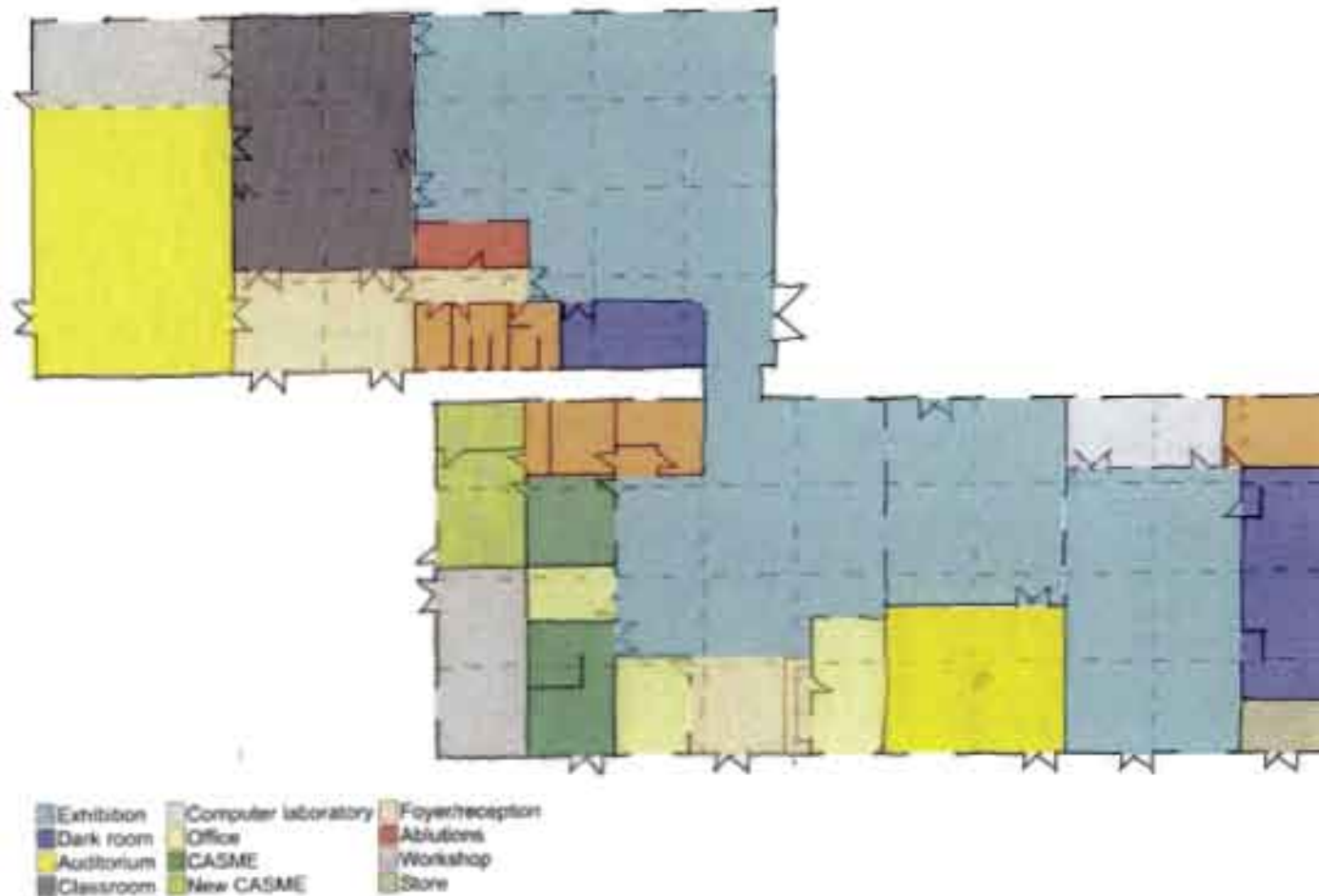




Fig 4.4: Power and lighting supplied from above which limits the height of the exhibits in the old wing. (Source: author)



Fig 4.5: The new exhibition space with day lighting and power supplied from below. (source: author)

Environmental and Technical Response

In mid-October the science centre was hot and uncomfortable. There is minimum insulation and poor cross ventilation. This has resulted in an uncomfortable environment that does not encourage the activity necessary to engage with interactive exhibits. Lighting and power are supplied overhead in the old building (Fig 4.4); this limits the flexibility by limiting the height of exhibits. In the new building services are provided under floor. Unfortunately this has also created limitations on flexibility. Derek Fish recommends that removable under-floor service panels are used instead. While the old section has no windows, only doors, and has a very low light level (both artificial and natural) the new wing is pleasantly well lit and ventilated by large windows (Fig 4.5). This is in strong opposition with the general approach in science centres to have black box exhibition areas. Naturally lit and ventilated exhibition spaces limit flexibility but it creates an environment that is more pleasant and has views connecting to the outside. The portal frame provides large clear uninterrupted spans, which are ideal for an exhibition area.

Contextual response

The science centre is isolated in the middle of industrial buildings. It is part of a complex with other community buildings. However it is only accessible by bus or car, and not by public transport. This means that access is limited and the location is not ideal.

There is no entrance foyer, apart from the entrance area between two buildings where games have been painted on the floor. There is an outside area that is underutilized consisting of ponds, a climbing wall and an Archimedes screw that is not operational. The outside area has not been developed and incorporated into the exhibitions. However this space could be an invaluable area which Derek Fish is in favour of developing.

Conclusion

This building meets with the basic needs of the science centre. Apart from this it does not promote the aims and objectives of a science centre. It makes no indication of its function, nor does it read legibly. Its provision of thermal comfort is poor. It is a make-do facility. However the new wing is a marked improvement on the old wing, but basic elements, like the entrance, have been disregarded. The entrance area and providing a public space where groups can assemble before entry have not been considered.

This case study stresses the importance for a science centre to be located in an area, which is accessible to the general public. It highlights the importance of an entry area where people can gather and a distinct entrance that clearly indicates the entry point. It emphasises the need for a comfortable learning environment. It also indicates that a naturally lit exhibition space can be a pleasanter learning environment.

OLWAZINI

Introduction

Olwazini Discovery Centre is located underneath the grandstand of a race course (Fig 4.6) and is part of the Golden Horse Casino Complex. It forms part of a public contribution by the Casino. Unfortunately due to lack of support by the Casino it has not reached its full potential. The location of Olwazini in the Casino complex is a disadvantage. It is located off main circulation routes in a restricted access area. It was intended to be a free standing building which would have been better as it would have given it its own identity distinct from the Casino.

Currently the science centre does not have a manager. As a result the centre is under-utilised. Olwazini is currently under-staffed with a floor manager and a part-time receptionist. There are no programmes being run and a fair number of the exhibits are in need of repair or elements are missing.

An attempt was made in Olwazini to integrate culture into the exhibits. The large Zulu beehive hut and large African drums in the foyer are a few remnants of this. Olwazini currently contains 50 exhibits. An average visit would consist of three 45-minute sessions; a science show, a workshop experience and time to interact with the exhibits.

Architectural expression

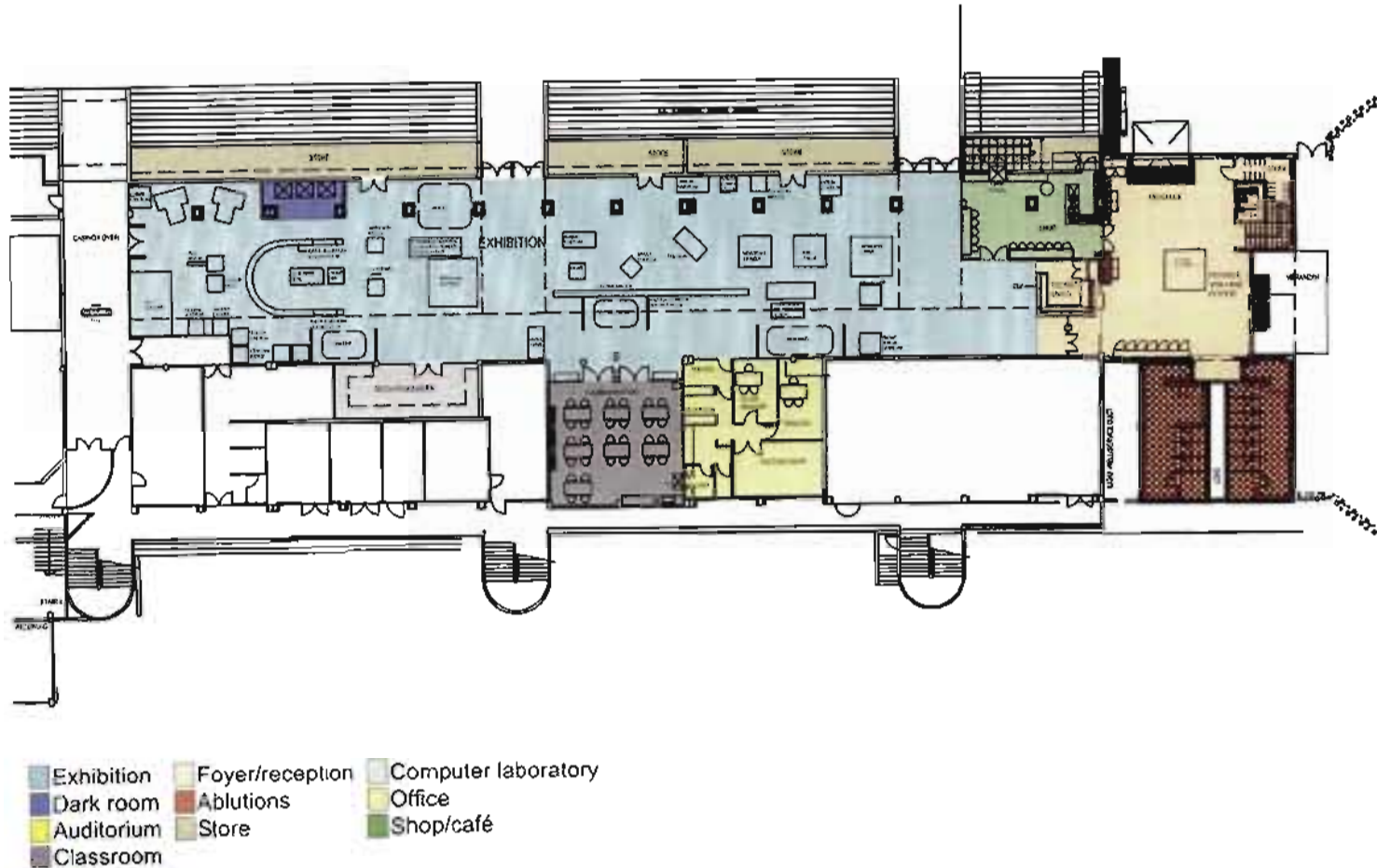


FIG 4.6: The entrance to Olwazini is located under a grandstand. (Source: Author)



Fig 4.7: The entrance foyer which is well lit, spacious and contains interesting exhibits. (Source: author)

The building is located under the racecourse grandstand, thus the rake of the stands forms



the spatial experience of the science centre. A 'box' was added on the edge of the grandstand to accommodate the entrance foyer, ablutions, air conditioning plant and foyer to the auditorium (Fig 4.6). This addition is simple with floor to ceiling glazing and large overhangs over the entrances. The sign indicates the building's content as the architecture does not indicate its use. The foyer is a large naturally-lit welcoming space that contains interesting exhibits. From the foyer the contents of the exhibition can be glimpsed, creating a sense of expectation (Fig 4.7)

Spatial Organization

The spatial organization is simple and easy to understand therefore the building is easy to navigate. The café/shop, auditorium, garden exhibition, exhibition and toilets are accessed



Fig 4.9: The exhibition space is long and narrow with services supplied overhead. The interior design has been well executed. (Source: author)

off the foyer, which acts as a node. This means that the auditorium can be rented out to generate income without the rest of the science centre being affected. The remainder of the space consists of a long narrow exhibition space. As a result of the length and narrowness of this space it has been criticized as being inflexible. The open plan and undivided nature of the exhibition space ensures a free choice environment. Running down the length of the exhibition space are the classroom, computer room and offices. The downside of this layout is that there is no privacy for the service spaces or the exhibition spaces.

Environmental and Technical Response

The services are supplied overhead with cable trays (Fig 4.9) which allows for flexibility. The way they have aesthetically been treated is pleasing. The classrooms and offices have no natural light which creates an unpleasant environment. Some natural light is provided by the glass emergency exit doors. This is quite pleasant as it allows views out onto the race course and stops the interior from otherwise being a dark space. In comparison the new wing at Unizul which is naturally lit is a much pleasanter space even though it may be less flexible.

Contextual response

Located in the casino and race course complex, the locality of the science centre excludes people. The centre is not accessible to pedestrians and needs to be accessed by vehicle or bus. The result is that the passerby cannot wander in and access to the centre is controlled. In terms of meeting the aims of a science centre to educate people this location is counterproductive. It isolates and excludes people. Access is directly from a parking lot,

which highlights that this centre is purely accessed by vehicle. No public space or access from public transport is provided

An outside exhibition space ,containing a sun dial and a beehive hut, has been formed but this is underutilized and underdeveloped,. This is unfortunate in a climate which allows for outdoor exhibits. This space is also removed and has no relationship with the rest of the exhibits.

Conclusion

The large naturally-lit foyer creates a welcoming first impression of the science centre, and establishes the tone for the rest of the visit. The foyer works well as a node and a point of information and orientation. The location of the science centre and it lack of linkage with its surroundings is inadequate particularly in the context of South Africa where the aim is to make science accessible to all. Rather, this centre's location reinforces the existing problem, that people have been excluded from a science education. The dimensions of the exhibition space are not ideal. Internally the interior design creates an aesthetically-pleasing environment. The careful choice of finishes and materials enhance the feel of a technological environment.

SCI-BONO, NEWTOWN, JOHANNESBURG

Introduction

Sci-bono is the largest science centre in Africa with an exhibition space of over 6000 square metres. It is located in a converted electric workshop (Fig 4.10) in the cultural precinct of Newtown, Johannesburg. The science centre is funded by the Gauteng department of education and the private sector. It is currently under construction with only phase one complete, resulting in not all the required facilities being present. The science centre appears empty and is under-utilised.

Architectural Expression

The architectural expression is formed by the converted powerhouse. This conversion has been carried out by inserting platforms into the building (Fig 4.11). The industrial nature of the building has been further enhanced by the choice of finishes, raw concrete, exposed steel and the detail design. Large portions of the building have not been completed for example the entrance canopy. The lack of canopy, which would help to decrease the scale of the building, results in a very large overpowering building.

Spatial Organisation

The spatial organisation is simple. At the front of the building are the entrance facilities, café, career counselling and explainers room. At the back are classrooms and offices. The bulk of the space is occupied by the exhibition space. The exhibit circulation was intended to be as follows, visitors take one of the two industrial lifts up to the top exhibition platform and proceeds to view each floor as they wind down the central ramp (Fig4.12), which gives access to each level. Alternatively, visitors start winding up from the bottom. The ramps



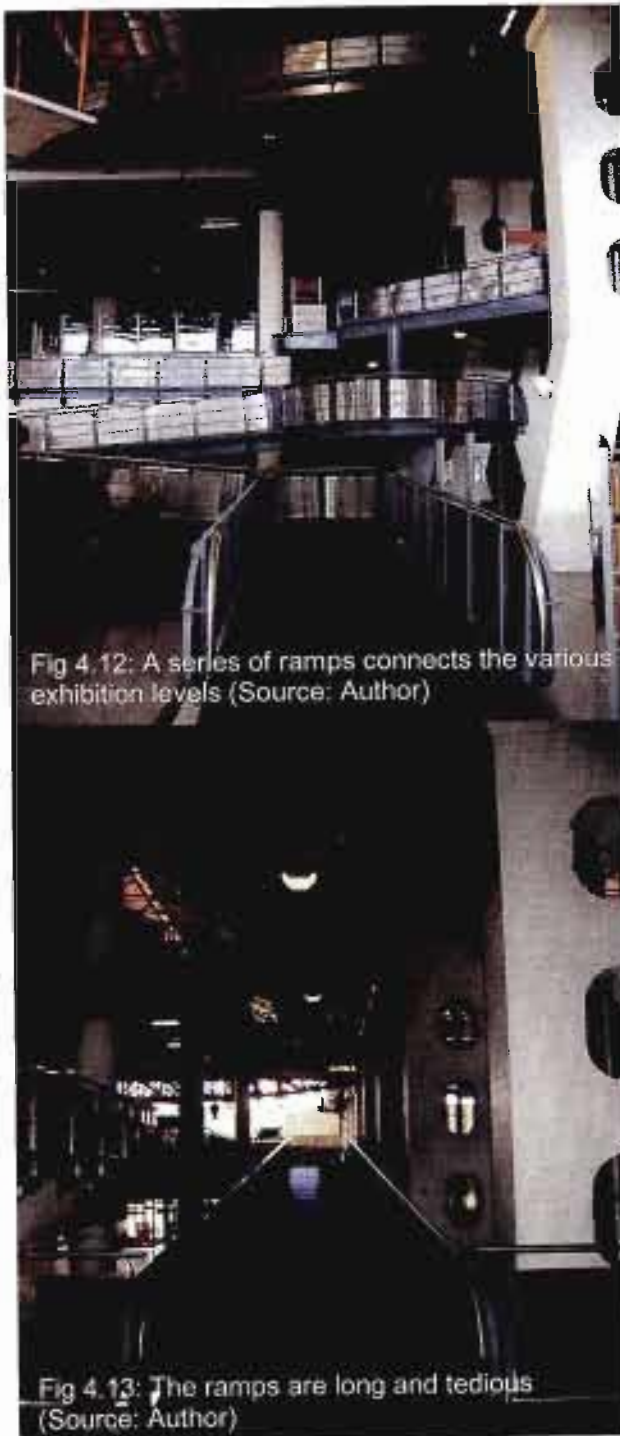


Fig 4.12: A series of ramps connects the various exhibition levels (Source: Author)

Fig 4.13: The ramps are long and tedious (Source: Author)

(which are 1:8) are long and steep (Fig 4.13), for both able-bodied people and people in wheel chairs. The circulation route is frustrating and tedious. The staggered system of levels allows areas to be overlooked. Some of the exhibition levels are only accessible by stairs therefore not all areas are universally accessible. The current temporary laboratories and classrooms are accessed via an escape staircase (hence not universally accessible) and are difficult to find.

Environmental and Technical Response

At the beginning of May the science centre which has a sheet metal roof and no visible insulation was exceptionally cold. The roof lights, which also provide ventilation in summer, make the building quite cold. The building is naturally ventilated and lit. Natural light is provided from the large windows, however the exhibition platforms obstruct light from entering, despite the fact that the platforms have been pulled away from the windows. Black out curtains were being installed for an exhibit, which required darkness. Lighting rigs are provided above the exhibition spaces to allow for flexible lighting. Unfortunately the lighting is currently insufficient which creates a dull space, lacking accent on areas to provide focal points. Power is supplied under-floor by access flooring. The meter room and security room are contained in glass boxes as exhibits. The space is large with very few exhibits; this can result in a very noisy space with insufficient absorbent surfaces. The platforms are 12x12 metres platforms with heights ranging from 10-12 metres. Currently deliveries come through the front door as the delivery area is under construction and exhibits are stored on the exhibition floor.



Fig 4.14: The green plaza outside the main entrance to Sci-Bono

Contextual Response

The main entrance of the science centre is off a green plaza (Fig 4.14) surrounded by buildings and is ideal for school groups to eat lunch. The problem with this lies in the distance of the entrance from the bus drop off area, which could be problematic in Highveld afternoon downpours. The bus and vehicle entrance is poorly marked. The science centre is located in an area predominately frequented by tourists and is in the centre of Johannesburg far removed from any schools, which use it.

The science centre is housed in a large building, which opens up onto a large green plaza. The scale is imposing and the lack of an entrance canopy to add a scaling element is felt. There is nowhere to retreat to. The envelope of the building remains predominately unaltered.

Conclusion

Sci Bono is a large science centre, due to management and funding it is sorely lacking in exhibits and visitors. The size of the building is too big, the space overwhelming, one large shed with no sense of division. The exhibits and visitors get lost within the space. There is little diversity in ceiling heights. The building is overwhelming both internally and externally. The circulation route is long, tedious and awkward with lots of double backing required. The staggering of the exhibition floor levels is effective in achieving spaces overlooking each other. The classrooms are temporary spaces, which are awkward shapes with columns in the way and no natural ventilation or light. Similarly, the office spaces are internal and overlook the exhibit spaces. The service spaces required are sorely lacking, with storage occurring in the exhibition space. The lighting is insufficient creating a dark dull space, and yet there is too much light for exhibits requiring lower light levels. The location while in a

cultural precinct and in central Johannesburg is less than ideal as it is far removed from any of the schools that frequent it, and the through flow of people in the area is very low.



Fig 4.15: The shop front entrance to MTN ScienCentre (Source: author)

Introduction

MTN ScienCentre is located in Canal Walk shopping centre in Cape Town. The space it occupies is determined by the shopping centre layout and grid and occupies a single floor. It is in the author's opinion one of the most successful science centres in South Africa, with the highest number of visitors and provides the most enjoyable science centre experience.

Architectural Expression

Due to being located in a shopping centre its architectural expression is limited. Its front entrance is formed by an entrance desk and a ticket office with a narrow view of the maize of exhibits that lie beyond (Fig 4.15). This is just enough to create intrigue. The rest of the view is obscured by colourful graphics with a miniature train, which chugs past and disappears into the science centre. According to Prof Burton, who established the science centre, this deeply intrigues children who want to dash into the science centre to see where it goes. Prof Burton recommends movement at the entrance to catch children's attention.

Spatial Organisation

The shape of the science centre is irregular with minimum shop frontage, widening towards the back. The grid is determined by the shopping centre grid, which is a 10x10 metre grid. The large single storey space forms the exhibit space (Fig 4.16) with the temporary exhibition, auditorium, activity spaces and café on the periphery of the exhibition spaces. The temporary exhibition space has the ability to be closed off to allow exhibitions to be



Fig 4.16: The large open plan exhibition space (Source: author)



Fig 4.17: The delivery entrance used as the school entrance (Source: author)



Fig 4.18: The overhead services are left exposed (Source: author)

dismantled and set up. The exhibition area is broken up into areas by the exhibits. This creates intimate spaces within the large exhibition area resulting in the space not being overwhelming and allowing attention to be focused on specific areas. The maximum ceiling height of 5m, and in general a 3,5m head height makes the space more intimate. There is no prescribed circulation route, allowing people to choose their own route according to what interests them, in accordance with the philosophy and free choice learning environments of science centres.

The entrance for school groups is from an undercover area where the bus can pull up. Learners proceed up the delivery stairs (Fig 4.17). There is no sense of arrival and one arrives at the back of the science centre. This situation is less than ideal.

The offices are located remotely from the science centre, on the roof of the parking area.

Environmental & Technical Response

The exhibition spaces are in effect black boxes, artificially lit and ventilated. The underside of the slab is painted black and the services exposed (Fig 4.18). The 10x10 metre grid creates a flexible space, the suspended lighting rig allows for further flexibility but this also limits head height to 3,5 metres. Power is supplied at the columns and is hence available on a 10 metre grid, which limits flexibility. The carpeted floors act as good sound absorbers. Storage occurs off site, unfortunately many exhibits are damaged in transit.

Conclusion

MTN Sciencentre is one of the most effective science centres. Its low ceilings mean that the exhibit and visitor do not get lost in the space. The open plan exhibition space allows the visitor to choose their own route, yet the demarcated areas stop the exhibition space from being too cavernous. The space filled with exhibits is exciting and the activity of the children and visitors makes the space come alive. Being in a shopping centre does however stop the science centre from creating its own image. The schools entrance is very dismal and is the low point of the science centre, especially seeing that the majority of visitors are school groups.

CONCLUSION

The deficiencies of Olwazini and Unizul in terms of location, in that they are incorrectly sited, stresses the importance of a science centre being well positioned to be easily accessible. Olwazini and Unizul and MTN ScienCentre prove Anderson's statements that science centres are destination attractions in that the building does not necessarily need to indicate its function, but for clarity this is advisable. The scale of Sci-Bono and the refurbishment of a historical building gives the science centre a distinct image which is used as a marketing element.

The lack of a clear distinct entrance to Unizul stresses the importance of clearly defined entrance to alleviate confusion and anxiety in the visitor. Olwazini indicates that the foyer plays a vital part in orientating the visitor and creating first impressions.

The scale of the science centre is a vital part of the science centre experience, the large cavernous spaces in which visitors and exhibits get lost such as at Sci-Bono are less than ideal, and become distracting environments. More intimate spaces such as at MTN ScienCentre, Olwazini and Unizul are desirable. However flexibility is an important element so a variety of ceiling heights in the exhibition spaces is a good solution.

As experienced at Unizul (too hot) and at Sci-Bono (too cold) a physically uncomfortable environment detracts from the learning experience. Although black boxes for exhibitions are the norm, a naturally lit environment creates a much more pleasant learning environment, particularly with views of the surrounding context as at Sci-Bono which allows the visitor to orientate oneself within the surrounding context. The instillation of block out curtains at Sci-Bono indicates that it is important that light can be excluded from some exhibition areas to ensure flexibility.

Therefore it can be concluded that in order to achieve the aims of science centres in South Africa to redress the wrongs of the past and to provide access to science education science centres should be located in an area which is easily accessible to all. The entrance which creates the first impression and sets the tone for the rest of the visit should be a clear and welcoming space. An entry plaza, which provides a scaling element provides a valuable point to gather before entry or exit. In order to provide an environment conducive to learning the science centre needs to be comfortable, particularly in South Africa's climate the facility needs to be thermally comfortable. The science centre should delight in terms of its use of colour, light, materials and scale and therefore the experience of the building should delight. The spatial organization should be simple and easy to navigate and therefore provide a non-threatening and enjoyable environment which fulfills the aims of the science centre.

CHAPTER 5: CONCLUSIONS & RECOMMENDATIONS

Considering South Africa's current science status quo and the importance that science and technology plays in our current society, science centres are in a strategic position to play an important role in developing South Africa. As such they are important public buildings. As has been established, the architecture of science centres can have a significant effect on the visitor's experience.

As noted in Olwazini and Unizul, an important element of a public building is that it is accessible to pedestrian and public transport. Inaccessibility results in the science centre becoming isolated and discourages visitors. This is the opposite of the intention of the science centre. The building should be welcoming and inviting. As observed at Questacon, allowing the public access to some of the facilities, creates an inclusive welcoming approach. This generates a sense of activity and excitement. People attract people.

The image of the science centre should be welcoming, it should encourage the visitor to touch and get involved. As a flagship science centre it should attract people. It is a landmark building and should have a clear distinct image, which provides opportunities for publicity, it should be an icon for science. As with Questacon and California Science Centre a strong image is desirable. The building should indicate its function. It should be exciting architecture. It should reflect science and technology, which is global in nature. The architectural expression should take its cue from retail architecture and be transparent, creating appeal and interest. It should also be approachable and of a human scale. It

should not dominate. The building should be imbedded in its context and enhance its surroundings. It should respond to its climatic context.

The entrance should be legible and the visitors able to orientate themselves easily. This avoids confusion and anxiety. As Questacon and California science centres, indicate a central circulation space which acts as an orientation point works well, acting as a node of activity with paths leading to it.

It is crucial that the architecture meets the functional needs of the science centre. This requires flexibility in the layout of exhibition spaces and delivery of services, power and lighting. The science centre needs to be thermally comfortable devoid of glare, well lit and with good acoustics to avoid being a distracting environment.

As we live in an increasingly information-based society with science and technology changing rapidly, science centres play an important role. The architecture of the science centre is an integral part in aiding the aim of the science centre by creating an environment which caters for its many needs, displaying its philosophy, that all are welcome and that science and technology are important to our society. A science centre needs to be underpinned by its educational theories in order to create an environment conducive for learning.

These conclusions are discussed in light of the development of a brief and accommodation schedule, for a science centre for Durban, in the following chapter.

GOVERNMENT POLICY: A NETWORK OF SCIENCE CENTRES

The South African Department of Science and Technology has proposed a network of science centres. The National Norms and Standards for a Network of Science Centres in South Africa (DST, 2005:11) defines a network of science centres as “a group of science centres that are interconnected, aligned to and supported by the Department of Science and Technology.” It is proposed that there will be at least one full service science centre (flagship science centre) in each Province by 2032. These shall be located in energy nodes with a critical mass of people. Full service science centres have been defined by The National Norms and Standards for a Network of Science Centres as science centres that have an exhibition floor area greater 1800m² and more than 50 000 visitors per annum. It is hoped that in the long term these centres will be comparable with those found in developed countries. These will conduct outreach programmes into surrounding areas and will provide services and support to Limited Service Science Centres. These will be located in outlying areas where there is a critical mass of people. These shall have an exhibition area of 600-1800m² and shall reach 25 000-50 000 people per annum through visits to the centre or through outreach programmes.

It is hoped that the network would achieve the following goals (DST, 2006:7-8): The promotion of science and technology literacy among the youth and the population in general; enhance learner participation and performance in science, technology, engineering and mathematics (STEM); identify and nurture talent and potential in STEM; and provide career education in STEM. It is also hoped that these science centres will act as tourist

attractions, contribute to urban renewal, rural development and contribute to uplifting depressed areas (DST, 2005:10).

The recommended minimum features for these science centres proposed by the Department of Science and Technology are (DST, 2006:14);

- Exhibition hall to house interactive science exhibits of different science disciplines.
- Auditorium to host science shows, talks, workshops, theatres, etc.
- Computer laboratory, which in addition to providing computer literacy programmes to the public, will enable science centres to conduct computer based curriculum support programmes in mathematics, science and technology.
- Mini-workshop to enable a science centre to carry out normal maintenance and repairs of interactive exhibits, as well as research and development of new exhibits.
- Mobile Unit to deliver science centre's outreach activities.

DEVELOPMENT OF THE BRIEF

THE CLIENT

The DST has identified Full Service Science Centres to be run by Public Private Partnerships (PPP) (DST, 2006:15). This involves a partnership between a public sector institution and a private party. The science centre will be run by the municipality and will fall under the management of museums, which is part of the Department of Parks and Recreation. Therefore the municipality will act as the client.

FUNDING

The DST, has proposed to subsidise 30% of the running cost of the science centres. The Full Service Science Centres, which will be run by PPP, will be funded by the private sector. This includes naming rights and sponsorship of various exhibits. The science centre will also be partially funded by the municipality. The aim is for the science centre to be self-sufficient. It is therefore important that the science centre has some ability to generate income apart from entrance fees. Means of income generation will be discussed later. Primarily construction will be funded by a combination of the DST, eThekweni municipality and the private sector, which is an international norm.

SITE SELECTION CRITERIA

As discussed earlier science centres are destination attractions and are not dependant upon their neighbours. The site should be attractive, accessible and safe. It should also be prominent and highly visible. People should know where it is and how to get there. It needs access for both cars and buses. It should be accessible by public transport. As the aim of the science centre is to provide facilities for all, it is important that it is easily accessible. The roads to access the science centre should have carrying capacity and should be simple allowing for easy flow of vehicles so that congestion is avoided. The site or surrounds should allow for parking and service access and ideally bus parking, if not on the site, then parking should be available nearby. The site should be secure and should be perceived as safe, else this will hamper evening programmes. It should be centrally located and have the ability to expand.

Ideally the science centre should link into an existing network of schools which acts as a support base for the science centre, and is readily accessible to students. The support of

these schools helps to keep the science centre financially viable and supports outreach programs into rural areas. Close proximity to tertiary institutions is ideal as they provide both lectures and demonstrators as well as the explainers on the floor who explain to people how the exhibits work. A link to a park is advantageous as exhibits can filter into the park.

USERS

According to Anderson (1991: 27) 10-20% of all users are school groups. However according to The Roll out Plan (DST, 2006:11) 70% of visitors to science centres IN South Africa are of school-going age. According to Hood (1992: 39) half the people who attend science centres are older than 18 and the other half younger. Ideally a science centre should attract all ages. In South Africa it appears that most science centres are aimed at children. But to meet the aims and objectives of DST they need to appeal to all age groups. It is ideal if more family groups can attend. Most school groups that do attend come from Grade 9 or below, before subject selection occurs and it is easier to remove children from other subject classes.

VISITOR PATTERNS

Science centres need to be designed for extremes; there can be very few people on one day and uncomfortably packed the next. According to Anderson (1991:28) on a busy day there can be 10 times the number of people present on a low day. Seasonal and daily variations occur depending on school holidays, and special programmes.

Science centres are peak-load operations, similar to world fairs. According to Anderson (1991:28) 10% of annual attendance can occur on the heaviest 15-20 days. On one day half

the centre's visitors for that day are in the building at 1:30pm (Fig 43). As Hood (1993:39) points out few people come early or late in the day so the visitor density is greatest in the mid-afternoon. The building needs to be designed for the busiest day, but it also needs to be able to run efficiently on quieter days. Both Grinell and Anderson are writing in an American context, studies have shown that most 70% are school children who come on school field trips. According to the science centres interviewed this results in most attendance being between 9am and 1pm to coincide with the school day. Visitor patterns are more predictable as a booked time slot is organized.

However peak periods when they do occur require enough circulation space, sufficient ticket and food sales spaces, points, sufficient washrooms and a ventilation system designed for peak. Sufficient parking needs to be provided for these periods.

REVENUE GENERATORS

In order for science centres to be financially sustainable it is important that they can generate an income from sources other than ticket sales. It should be possible to have the theatre open with out the exhibits being open. Information should be available at points other than the ticket counter so people don't hold up lines deciding which show to see.

Food service and catering can be quite lucrative. Generally there is little need for table service but rather cafeteria/light service, including sandwiches and pre-made food. Most of the science centres in South Africa have small café areas which sell sandwiches, coffee and muffins, simple food.

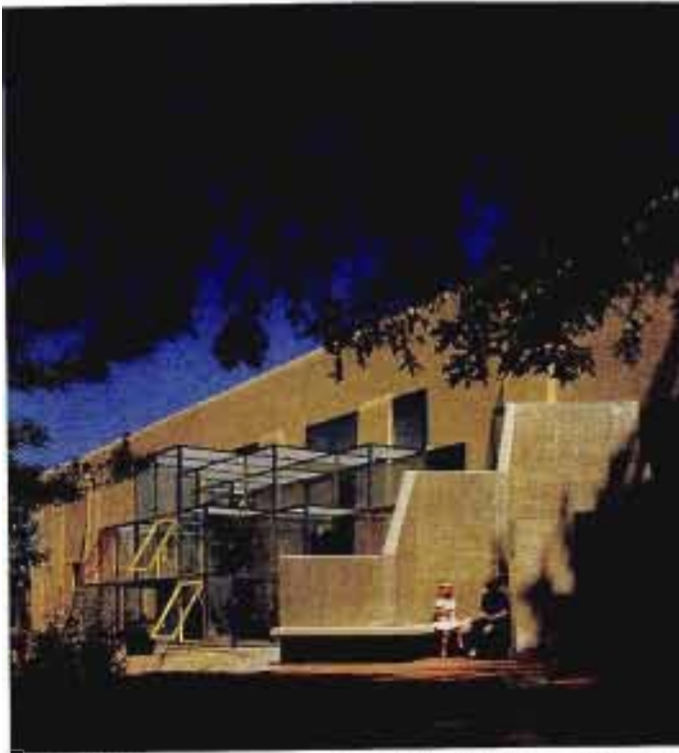


Fig 6.1: The entrance at Sante Fe Children's Museum steps down to reduce the scale for the child (Source:Crosbie, 1991:82)

Facilities rentals are another good income generator, for seminars, film shows, theatre performances, events and parties. Special or temporary exhibits provide variety to the exhibition and can draw people. These require space and storage space for shipping crates.

UNIVERSAL ACCESS

The science centre needs to provide for all people and consideration needs to be made for people with disabilities.

ACCOMMODATION DESCRIPTION

APPROACH & ENTRANCE

The entrance approach to a science centre should be an exciting experience, containing surprise and an unfolding view, a powerful and memorable experience. The entrance as seen at Unizul should be clear and legible. The entrance should not be dominating but welcoming and inviting. At Sante Fe children's Museum (Fig 6.1) the architect stepped the entrance down to the child. At the same time the entrance should be awe inspiring.

Some centres have a group entrance but it is the author's view that school groups should not be denied the experience of the unfolding entrance. However it should be possible to move the children through the space quickly.

There should be a drop off point for buses and an area for children to gather before entering. Ideally the route from the drop off area to the entrance should be covered.

A public place with outside exhibits and art works helps to establish the science centre as a public space where all are welcome and as a centre conforming to the language of public buildings.

RECEPTION & ORIENTATION AREAS

This space is important as it creates people's first and last impressions. It provides an intermediate zone between inside and outside. It should therefore be memorable. Visually the entrance should be varied and exciting. Appropriate lighting to highlight areas and draw people on should be used. This can be a very noisy area and should have good sound absorbency. The California Science Centre demonstrates that a dramatic sculpture can be very effective. It should be easy to find the ablutions, baggage store and information points. Rendezvous, resting and waiting points should be provided. There should be information points with touch screens as well as a person to provide information about shows, upcoming events etc..

This space should not be too large or a cavernous space, rather it should be filled with activity. This area should provide orientation and allow people to easily read what their options are.

PERSONAL BELONGINGS STORAGE

Storage for personal belongings should be provided in this area. International trends tend towards controlled lockers, with personnel to manage and observe the lockers. Facilities need to be provided, potentially big lockers for school groups and their lunches. Carrying bags around is counterproductive to the hands-on experience.



Fig 6.2: At Explore@Bristol the ablutions have been designed as a visible sculptural element which the stairs wrap around. This makes the cloakrooms easy to find. (Source: Anon, 2000)

PUBLIC FACILITIES

Water closets should be provided in this area, for people disembarking from buses. There should be disabled toilets provided. Entrances to male and female bathrooms should be in sight of one another. Mirrors should not be over the wash hand basins to avoid congestion. A drinking fountain and telephones should be near the bathrooms. The ablutions should be easy to find. (Fig 6.2)

CONNECTING SPACES

The connecting spaces between the exhibits and other functions provide an opportunity for architectural expression. They should also allow for resting points and orientate the visitor within the building and within the surrounding contexts, particularly if the exhibition spaces are black boxes. These spaces should be part of the voyage of discovery and could contain exhibits. However it is important that they are wide enough to handle peak flow. These spaces can also provide fresh perspectives with double volumes. The choices available to people should be made clear by these routes.

TEMPORARY EXHIBITION SPACE

This space should be close to the entrance, as some people will only come to see the temporary exhibits. It should be easy to close off to allow for exhibits to be packed and unpacked. It should have a storage area for packing crates; Anderson (1991: 17) recommends it should be 30% of the area of the exhibition area. If it is possible to stack and a forklift truck is available, the area can be reduced according to Anderson. This area should be easy to access for deliveries. As most traveling exhibits are never more than

500m², this should be sufficient for this space. The service provision should allow for flexibility.

EXHIBITION SPACE

It is this space which distinguishes science centres from other museums. In interviews with Dan Archer (involved in the establishment of science centres), Derek Fish (director of Unizul) and Mike Burton (established MTN Sciencentre) they recommended and stressed that this space should be designed for flexibility and not around exhibits as they change frequently. Rather it should provide the services for the exhibits.

There is some debate about black box design and exhibitions allowing for natural light. A black box provides greater flexibility particularly as some exhibits work best without light. If natural light is allowed for, the means to block out it out should be provided. At Unizul the naturally lit space demonstrates that this forms a much more pleasant environment. They have blocked off areas as light free spaces for exhibits which require darkness. With lots of computer display-based exhibits natural light is not always advisable. Questacon's solution is to provide a variety of exhibition spaces, some black boxes and others naturally lit. This probably provides the best solution. In the interest of flexibility where natural light is allowed for, facilities to block it out must be part of the design and the implications on the elevation considered.

Services need to be delivered to the exhibits and these need to allow for the greatest possible flexibility. The services required include, light, electricity, gas, ventilation and computer connection. According to Derick Fish and Mike Burton (Director of MTN

ScienCentre) under floor servicing works best as it does not limit the height of exhibits and provides maximum flexibility. However, an overhead lighting rig will need to be provided.

The sizes of exhibition spaces vary widely. Questacon's research revealed that a 25x25m space was the most efficient. Too large a size can be cavernous, as Sci-Bono demonstrates and on the other hand a small space limiting, Olwazini. Open plan is the usual layout for exhibitions as they allow for free choice. Large halls can be noisy and difficult to control. Studies by environmental psychologists have indicated that large open plan space can be distracting and counterproductive for learning but that these should rather be partly compartmentalised. (Weinstein, David, 1987:66) Long and narrow spaces such as Olwazini's exhibition space are not desirable as they are inflexible. Exhibition spaces should be able to be divisible with distinct entrances provided. If a themed exhibition approach is used, a linear circulation route is desirable. Anderson (1991:48) recommends a ceiling height of 6,6m as this allows for a mezzanine level. A mixture of heights is desirable, as the spaces should allow for flexibility.

THE EXHIBITS

The exhibition contents vary widely. There are over two hundred standard exhibits initially developed by the Exploratorium in San Francisco which are considered to be standard exhibits that every science centre should have. These vary widely in size from microscope to 100 meter long ropes. A current popular trend in exhibit design are themed exhibits. For example Questacon currently has a forensics exhibit which educates visitors about the body and techniques used in crime solving, explaining DNA and X-Rays. These thematic exhibits generally require a linear route as opposed to the free exploration encouraged by the above mentioned exhibits. A third option exists, an exhibition of objects, for example as

steam train which people can explore. The exhibition space needs to cater for all these options and the exhibition spaces be sufficiently flexible to allow for this.

DESIGN & WORKSHOP SPACES

Space is required for the design and development of exhibitions. Workshops are required for wood, metal and electronics/electrical as well as painting. They should have floor loading and full services. There should be good forklift access, ideally a door 3,6x3,6m. Design spaces, offices and ablutions need to be provided, as well as adequate storage for materials. The workshops maintain exhibits.

EDUCATION FACILITIES

These facilities should be designed for classes of 40, which is the average size of school groups and the maximum number that existing science centres recommend for smaller group activities. An average school visit will consist of three, 45-60 minute sessions consisting of a science show/film, exhibition exploration and a workshop experience. The exact programme is dependant upon each school and their desired objectives. Classroom or workshop facilities are required these can be separated from or adjacent to the exhibition space. As these classroom spaces can be rented out for seminars or used for adult education it is best for multi-function to have them separate. Cupboards are required for storage.

A resource centre to provide research facilities for the staff and for students and the general public on science related issues. A computer room is also required for training.

FOOD SERVICES

This is a small area which provides coffee for teachers who don't want to participate in activities or for tired parents, or those just wanting a quick snack. Menus generally include muffins, sandwiches cakes, coffees and cool drinks. Minimal kitchen space is required and if the activities in the kitchen can be revealed it acts as an exhibit.. This space should be accessible to the public The café should act as a place to rest from all the activity.



Fig 6.4: Kinetic Garden is an Outdoor exhibition area at Singapore Science Centre has been extremely successful (source: <http://www.science.edu.sg/ssc/events.jsp?type=7&root=0&parent=0&cat=95i>: 25/03/07)



Fig 6.3: Outdoor exhibition gardens, Science Parks which allow for larger exhibits have proved very popular in India and the planted gardens are established before the science centres (source: http://www.ncsm.org.in/science_park.html: 25/03/07)

OUTDOOR AREAS

The outside area is an important part in a climate like Durban's which allows for outdoor exhibit. In other science centres, for example Singapore Science Centre and New Dehli Science Centre where these areas have been incorporated they have been very successful (Fig 6.3 & 6.4). They allow for exhibits requiring sun, and large scale exhibit, including wet exhibits. Some shade should be provided. This can also provide a valuable rest point as well as a location for food carts in busy periods.



Fig 6.6 Skylights controlled by baffles flood the deep floor plan of Museum of Science and Industry (Anon:1987)

STAFF SPACES

This space needs to allow for staff to work undisturbed but also for them to have easy access to the science centre. It needs to provide all the standard spaces required by administration.

BUILDING SERVICES

Building services like ventilation need to be incorporated. In a science centre these can be made into an exhibit explaining how the building works, with fire prevention, plumbing and ventilation expressed. But these should not distract, so they need to be selectively expressed. A refuse area needs to be supplied, for easy collection.

LIGHTING

Day lighting is the preferable solution as it not only saves on the buildings energy consumption, but also creates a pleasanter environment. Daylighting can create problems in exhibitions as it limits the exhibit designer's ability control and manipulate the environment to create dramatic effects and place emphasis (McLean, 1993:146). Therefore natural light needs to be able to be carefully controlled through baffles, reflectors and filters to create indirect light (Fig6.7). Furthermore, glare and direct sunlight which can damage the exhibits which should be avoided. Means do need to be provided to exclude light from some exhibition areas as some exhibits require darkness.

A sufficient light level should be provided for people to move around the building, with lighting highlighting focal points, and used to draw people on. Alexander (1977:645) suggests that people are phototropic, in that they move towards light and that this should be used as a means to move people around a building. Transition areas should be provided

when moving from areas of contrasting light levels, as from the auditorium into more light filled areas. Sufficient ambient lighting should be provided in the exhibition spaces with task lighting on specific areas where emphasis is desired. As flexibility is required in the exhibition space as the exhibits change a lighting rig should be supplied overhead so that the lights can be altered as required.

MATERIALS, TEXTURE & COLOUR

Studies have shown that colour is a powerful element affecting all other aspects of the designed environment (McLean,1993:131) but the selection of colour needs to be carefully considered. Bright colours have been found to over-stimulate children and an environment composed of primary colours can tend to look like a play ground. The colour scheme used needs to act as a background to the exhibits which are frequently multi-coloured in primary colours. Colour can be used to create emphasis or a focal point. The emotional and cultural value of colours needs to be taken into consideration.

As Science centres are interactive and hands-on, the choice of materials selected becomes significant. They need to be hard wearing and easy to clean. The textures also become important and can be a useful tool in distinguishing between areas. Texture adds another layer of sensation to the visitors experience. Tactile experiences can be created where people come into contact with the building, on handrails, benches, floors or door handles

DEVELOPING THE ACCOMMODATION SCHEDULE

Annual Attendance: calculating the size

Anderson (1991,28) suggests that for a population of less than 1, 5 million it can be assumed that 40% of the population will attend. However as the population gets larger the percentage of the population that annually attends decreases. Durban currently has a population of over 3 million (www.durban.gov.za) If this figure were applied to Durban it would result in an annual attendance of 1 200 000. Considering the Durban Natural Science Museum has an annual attendance of 300 000 this figure is unrealistic.

Hood (1992, 38) asserts that attendance is based upon the amount of exhibition space and the amount of variety offered. The more exhibits there are the more people attend. However programmes and theatres impact upon attendance. Both Grinell and Anderson agree that the annual attendance of a science centre cannot be reliably predicted as there are so many factors involved.

To recap The National Role out plan suggests that an exhibit floor area 1800 square metres should have a minimum of 50 000 visitors per annum. This figure is used in conjunction with accommodation schedules supplied by Grinell and Anderson (based on information supplied and compiled by the American Association of Science and Technology Centres) for this size science centre to determine the accommodation required for a science centre for Durban. Design Data and Neufert have been referred to as well as SABS 044 to determine sizes.

ACCOMMODATION SCHEDULE

Entrance		sqm
public plaza		
entrance portico		
foyer		100
info desk/tickets/security		20
lockers		20
washrooms		
Cafe		
kitchen		20
store		8
seating area		80
Exhibition		
Temporary exhibition		500
Exhibition		1500
storage		500
Exhibition maintenance		
workshop		80
store		20
technical /maintenance office		15
theatre		
auditorium		150
storage		15
backstage		15
projection		8
ablutions		
education		
activity zone	2	120
store		15
computer zone	1	60
store		15
science resource centre		100

administration		
reception		15
boardroom		30
director		15
PR/marketing		12
Finance		15
Educational program director		15
Exhibits co-ordinator		15
Outreach co-ordinator		15
Schools liaison		15
Graphic designer		15
admin officers	2	24
records		10
tea kitchen		10
staff room		24
explainers room		24
services		
control room-security		12
electricity		12
generator		12
delivery area		40
cleaning		12
bin area		15
TOTAL		4015

Books

- ADLER, D. (2003) *Metric Handbook Planning and Design Data* 2nd Edition. Oxford: The Architectural Press Ltd.
- ALEXANDER, C. *et al.* (1977) *A Pattern Language, Towns, Buildings and Construction*. Oxford: Oxford University Press.
- ANDERSON, G. (Ed). (2004) *Reinventing the Museum: Historical and Contemporary Perspectives on the Paradigm Shift*. USA: Rowman Altamira
- ANDERSON, P. (1991) *Before the Blue Print Science Centre Buildings*. Washington: Association of Science and Technology Centres.
- BAICHE, B. and WALLIMAN, N. (Eds.) (2000) *Neufert, Architects' Data Third Edition*. Oxford: Blackwell Science.
- BARRY, A. (1998) On Interactivity: Consumers, Citizens and Culture. In MACDONALD, S. (Ed.) (1998) *The Politics of Display: Museums, science, culture*. London: Routledge. 98-117
- BITGOOD, S. (2002) Environmental Psychology in Museums, Zoos and other exhibition centres *In: BETCHEL, R. and CHURMAN A. (eds.) Handbook of Environmental Psychology*. London: John Wiley and Sons.
- BRAUND, M. and REISS, M. (Eds.) (2004) *Learning Science Outside the Classroom*. London: Routledge Falmer.
- BRAUND, M. (2004) Learning Science at Museums and Hands-on Centres. In BRAUND, M. and REISS, M. (Eds.) (2004) *Learning Science Outside the Classroom*. London: Routledge Falmer. pp 113-128
- BRUMAN, R. (Ed) (1991) *Exploratorium Cookbook: a Construction Manual for Exploratorium Exhibits*. vols 1. San Francisco: The Exploratorium.

- COOPER MARCUS, C., and FRANCIS, C. (Eds.) (1998) *People Places*. 2nd ed. London: Van Nostrand Reinhold.
- DIERKING, L.(2002) The Role of Context in Children's Learning from Objects and Experiences. In SCOTT, P G (Ed) (2002) *A Perspectives on Object-centered Learning in Museums*. USA: Lawrence Erlbaum Associates.
- DUDEK, M. (1996) *Kindergarten Architecture*. London: E & FN Spon.
- DUDEK, M. (2005) *Children's Spaces*. London: Architectural Press.
- FALK, J. and DIERKING, L. (EdS.) (2007) *In Principle, In Practice Museums as Learning Environments*. USA: Rowman Altamira.
- FARMELO, G. and CARDING, J. (EdS.) (1997) *Here and Now Contemporary Science and Technology in Museums and Science Centres*. London: British Cataloguing in Publication Data.
- GRINELL, S. (Ed) (1992) *A New Place for Learning Science: Starting and Running a Science Centre*. Washington: Association of Science and Technology Centres.
- HOOD, M G.(1992) Staying Away : Why People Choose Not to Visit Museums. In GRINELL,S (Ed) (1992) *A New Place for Learning Science: Starting and Running a Science Centre*. Washington: Association of Science and Technology Centres.
- HOOPER-GREENHILL, E. (1992) *Museums and the Shaping of Knowledge*. New York: Routledge.
- LYNCH, K. (1972). *The Image of the City*. Cambridge, Massachusetts: MIT Press.
- MACDONALD, S. and FYFE, G. (Eds). (1996) *Theorizing Museums*. Oxford: Blackwells.
- MATTHEWS, G. (1991) *Museums and Art Galleries*. London: Butterworth Architecture.
- MCLEAN, K. (1993) *Planning for People in Museums*. Washington: Association of Science and Technology Centres.

- MONTANER, J. (1990) *New Museums*. London: Architecture Design and Technology Press.
- NEUFERT, E. (2000) *Architects' Data*. Oxford: Blackwell Scientific.
- PEARCE, S. (Ed.) (1996) *Exploring Science in Museums*. London: The Athlone Press.
- PITMAN-GELLES, B. *et al.* (eds.) (1981) *Museums Magic & Children: Youth Education in Museums*. Washington: Association of Science-Technology Centers.
- RESNICK, L and CHI, MTH (1992) Cognitive Psychology and Science Learning. In GRINELL, S (Ed) (1992) *A New Place for Learning Science: Starting and Running a Science Centre*. Washington: Association of Science and Technology Centres.
- ROTH, L. (2007) *Understanding Architecture It's Element, History, and Meaning 2nd Edition*. USA: Waterview Press.
- ROSENBLATT, A. (2001) *Building Type Basics for Museums*. New York: John Wiley and Sons Inc.
- TRESSEL, G. (1992) The Role of Informal Learning in Science Education. In GRINELL, S (Ed) (1992) *A New Place for Learning Science: Starting and Running a Science Centre*. Washington: Association of Science and Technology Centres.
- WARD, C. (1978) *The Child in the City*. London: The Architectural Press Ltd.
- WEINSTEIN, C. and DAVID, T. (eds.) (1987) *Spaces for Children: The Built Environment and Child Development*. New York: Plenum Press.
- YAHYA, I. (1996) Mindful play! Or Mindless Learning! Modes of Exploring Science in Museums. In PEARCE, S. (Ed.) (1996) *Exploring Science in Museums*. London: The Athlone Press. pp123-164

Journal Articles

DAVEY, P. (2000) Bristol New Heart. *Architectural Review*, April 2000, p. 70.

BECK, H. and COOPER, J. (1989) The Briar Pipe Retrieved. *Architecture Australia*, 7, pp. 34-36.

CROSBIE, M. (1991) Santa Fe Children's Museum. *Architecture*, August 1991, 82.

ELLIS, Charlotte. (1986) Tomorrow's World. *The Architects' Journal*, 30 April 1986, pp. 28-29.

GARDNER, C. (1992) Fun Factory in Halifax. *RIBA Journal*, September 1992, pp. 44-46.

KORALEK, P. (1995) Techniquet. *The Architects' Journal*, 14 September 1995, pp. 34-43.

LANDECKER, H. (1996) Kid City. *Architecture*, November 1996, pp. 86-89.

MACDONALD, G. and ALSFORD, S. (1991) The Museum as Information Utility. *Museum Management and Curatorship*, 10, pp. 305-311.

MASELLO, D. (1990) New School of Thought: Children's Museum of Manhattan. *Architectural Record*, July 1990, pp. 68-70.

MOORHEAD, G. Karyakids at Play. *Architectural Record*, March 1993, pp. 78-80.

NIELD, L. (1989) National Science and Technology Centre, Canberra. *Architecture Australia*, July 1989, pp. 30-34.

SPENCE, R. (1989) Science Centre Canberra. *Architectural Review*, 11, pp. 71-75.

STEIN, K (1998). California Science Centre. *Architectural Record*, 5, pp. 177-183.

STEPHENS, S. (2005) Hall of Science. *Architectural Record*, 5, pp. 225-228.

Reports

Department of Arts, Culture, Science and Technology (1996a) *White Paper on Science and Technology*. Pretoria.

Department of Arts, Culture, Science and Technology (1996b) *South Africa's Green Paper on Science and Technology*. Pretoria.

Department of Science and Technology (2002) *South Africa's National Research and Development Strategy*. Pretoria.

Department of Science and Technology (2005) *National Norms and standards for a network of science centres in South Africa*. Pretoria.

Department of Science and Technology. 2006. *National Roll-out plan to establish a network of science centres in South Africa*. Pretoria.

The Presidency. (2006) *Accelerated and Shared Growth Initiative Summary South Africa*. Pretoria.

Internet Sites

SCOTT, D. [no date]. *Merging Architecture and Exhibits*. Available from: <http://www.gyroscopeinc.com/arch.html> [Accessed:18/01/07]

SEMPER, R. [no date]. *The Importance of Place by Rob Semper*. Available from: http://www.astc.org/resource/education/learning_semper.htm [Accessed: 20/01/07]

Interviews

ARCHER, D. *Personal Interview* (Olwazini Science Centre), 29/09/06.

BURTON, M. *Personal Interview* (MTN ScienCentre), 03/05/07.

FISH, D. *Personal Interview* (Unizul Science Centre), 24/10/06.

HOPWOOD,S. *Personal Interview* (SCI-BONO Science Centre), 02/05/07.

KRAMER,D. *Personal Interview* (SCI-BONO Science Centre), 02/05/07.

PHILLIPS,C. *Personal Interview* (MTN Sciencentre), 03/05/07.

SACKS,N. *Personal Interview* (Albonico Sack Mzumamar Architects and Urban Designers), 02/05/07.

design drawings

science and technology centre:

"an educational facility that offers an **informal educational experience** in science, technology, engineering and mathematics (STEM) by providing **interactive exhibits and displays**, and **interactive programmes**" (DST, 2005:10).



LOCATION



CONTEXT

site selection criteria:

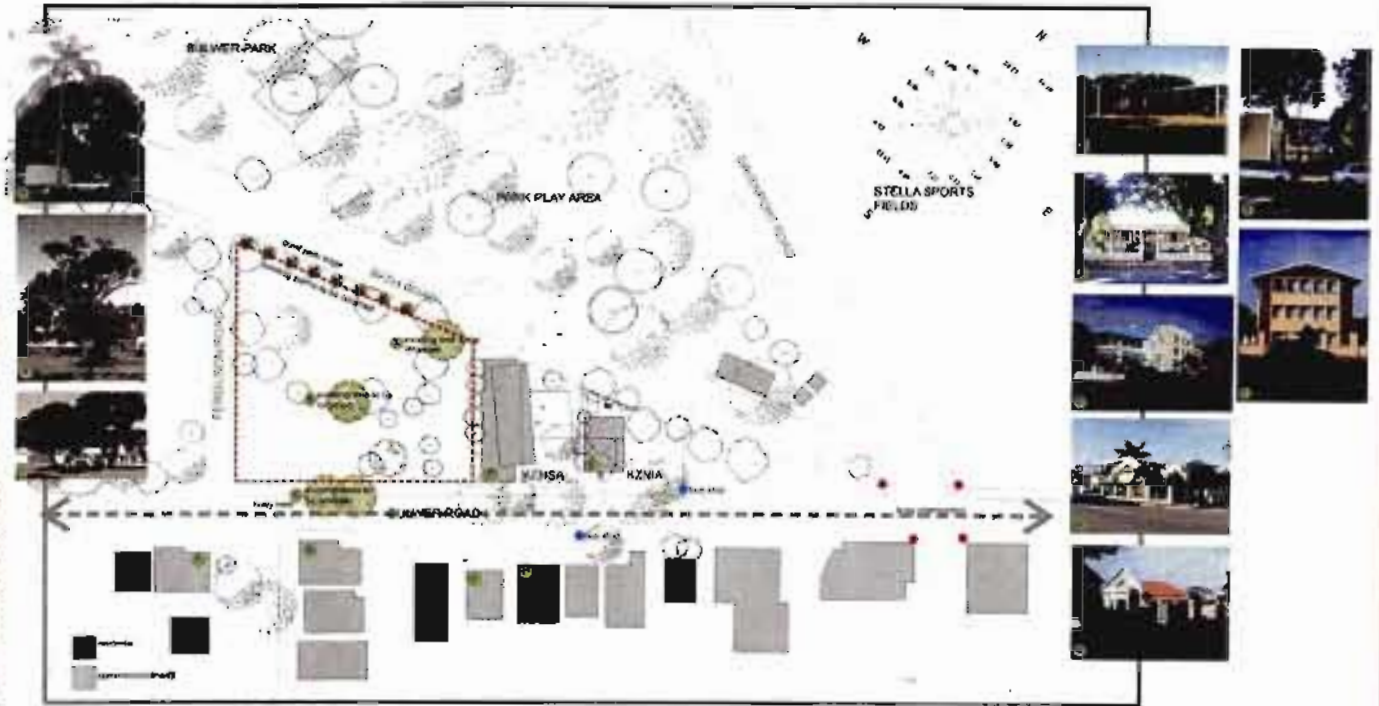
- easily **accessible** by bus & public transport
- link to an existing **network of schools**
- link to **open space**
- a **visible** site

key words:

- simple circulation
- safe
- visible
- free choice
- flexible

design criteria:

- demystify & promote science & technology
- free choice learning environment: multiple routes
- flexible exhibition space: variety of heights, services
- safe learning environment: single entrance
- simple easy circulation system: easy to orientate
- places to retreat to assimilate information & avoid museum fatigue



SITE & CONTEXT ANALYSIS

SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE multitecbarbed

site & context

ATERIALS ELEMENTS PRECEDENT



timber screens



green screens



metal screens



concrete wall



circulation tower



technique: daylight exhibition spaces large clear span with mezzanine



new york science centre: daylight exhibition spaces with clear span

DESIGN GENERATORS

MASSING/ORIENTATION

large exhibition spaces to south of site smaller units on north elevation to avoid overshadowing south light in exhibition spaces



CIRCULATION

single clear circulation routes around courtyard



EXISTING TREES

building pulled back around existing trees



COURTYARD

built to edges hard external edge will perforated interior green courtyard



SAFETY

hard exterior single entrance

VISIBILITY

ground floor transparent on busier road to allow glimpses into the spaces centre and exhibits



PLACES TO PAUSE

small spaces to provide to assemble information to avoid museum fatigue



PARK

smaller elements on park edge to reduce the scale, gardens and planting to create a soft edge along the park



FLEXIBILITY

large exhibition spaces to allow for flexibility



DESIGN DEVELOPMENT: FOOTPRINT SKETCHES



DESIGN DEVELOPMENT: CONCEPT MODELS

SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE concept architects

design development



perspective of bulwer road viewed from kznisa: building stepped back around trees



perspective of bulwer road entrance viewed from kznisa



view of seating area below trees looking towards kznisa



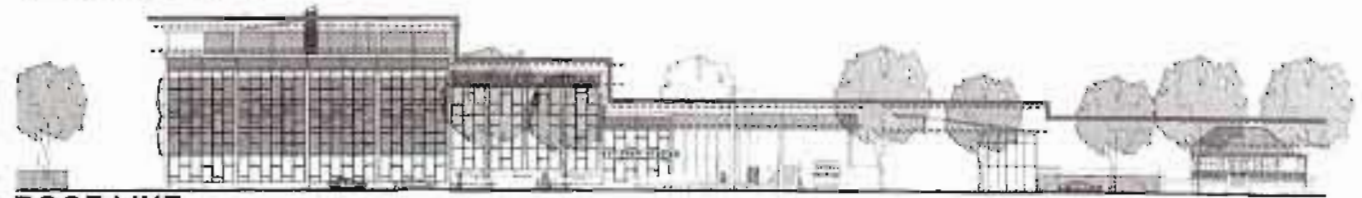
intensity of commercial use decrease away from davenport node



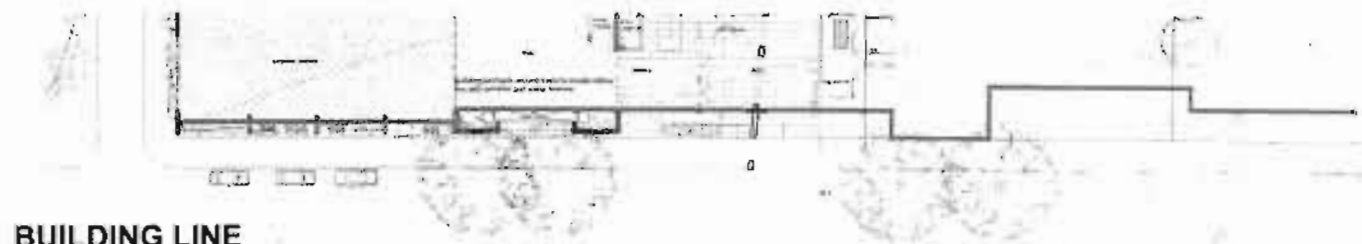
CREATION OF SCIENCE & ART PRECINCT WITH DISTINCT BUS STOPS WITH INTERACTIVE DISPLAYS & DISPLAY SPACE

COVERED PUBLIC PLAZA CONTAINING INTERACTIVE EXHIBITS

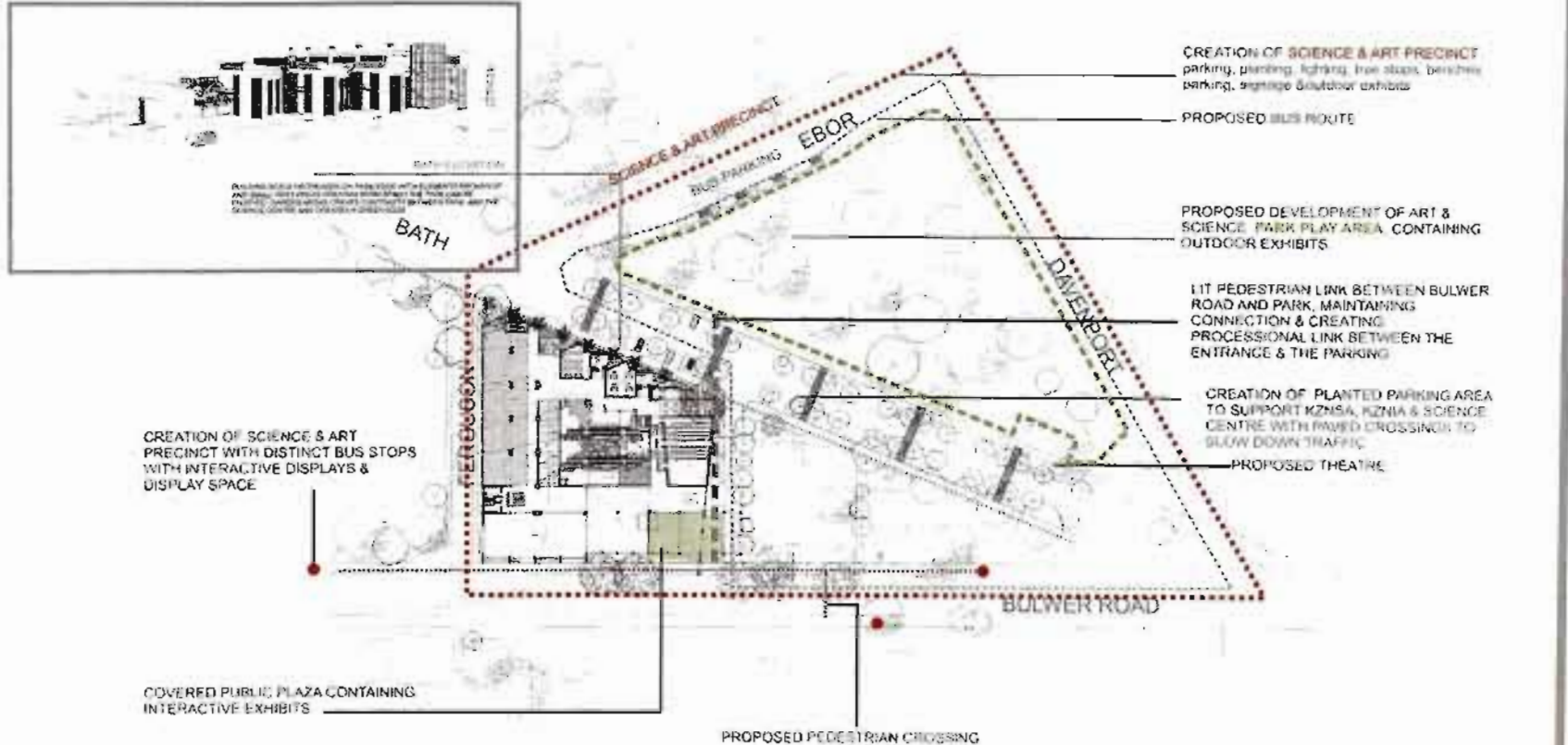
URBAN DESIGN



ROOF LINE



BUILDING LINE



CREATION OF SCIENCE & ART PRECINCT parking, planting, lighting, tree plant, benches, parking, signage & outdoor exhibits

PROPOSED BUS ROUTE

PROPOSED DEVELOPMENT OF ART & SCIENCE PARK PLAY AREA, CONTAINING OUTDOOR EXHIBITS

11T PEDESTRIAN LINK BETWEEN BULWER ROAD AND PARK, MAINTAINING CONNECTION & CREATING PROFESSIONAL LINK BETWEEN THE ENTRANCE & THE PARKING

CREATION OF PLANTED PARKING AREA TO SUPPORT KZNISA, KZNIA & SCIENCE CENTRE WITH PAVED CROSSING TO SLOW DOWN TRAFFIC

PROPOSED THEATRE

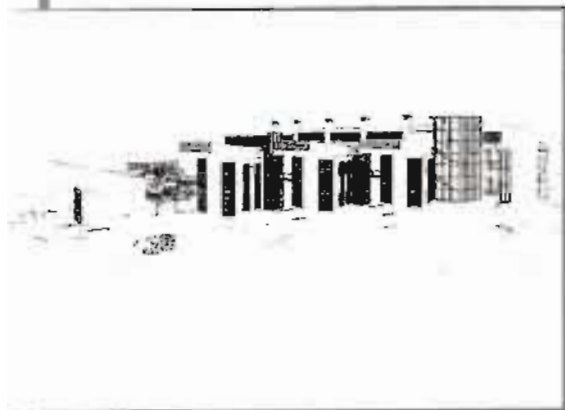
PROPOSED PEDESTRIAN CROSSING

SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE *oaulette barbeau*

urban design

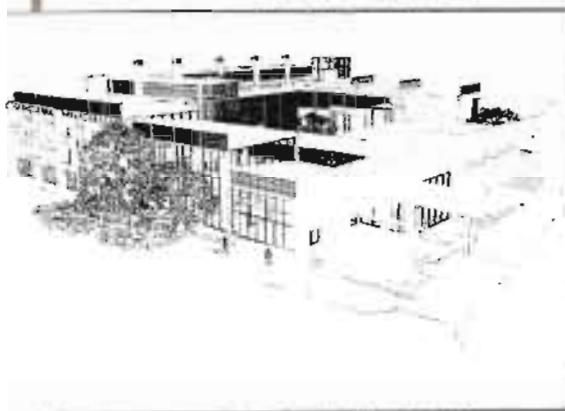
scale 1:200/1:500



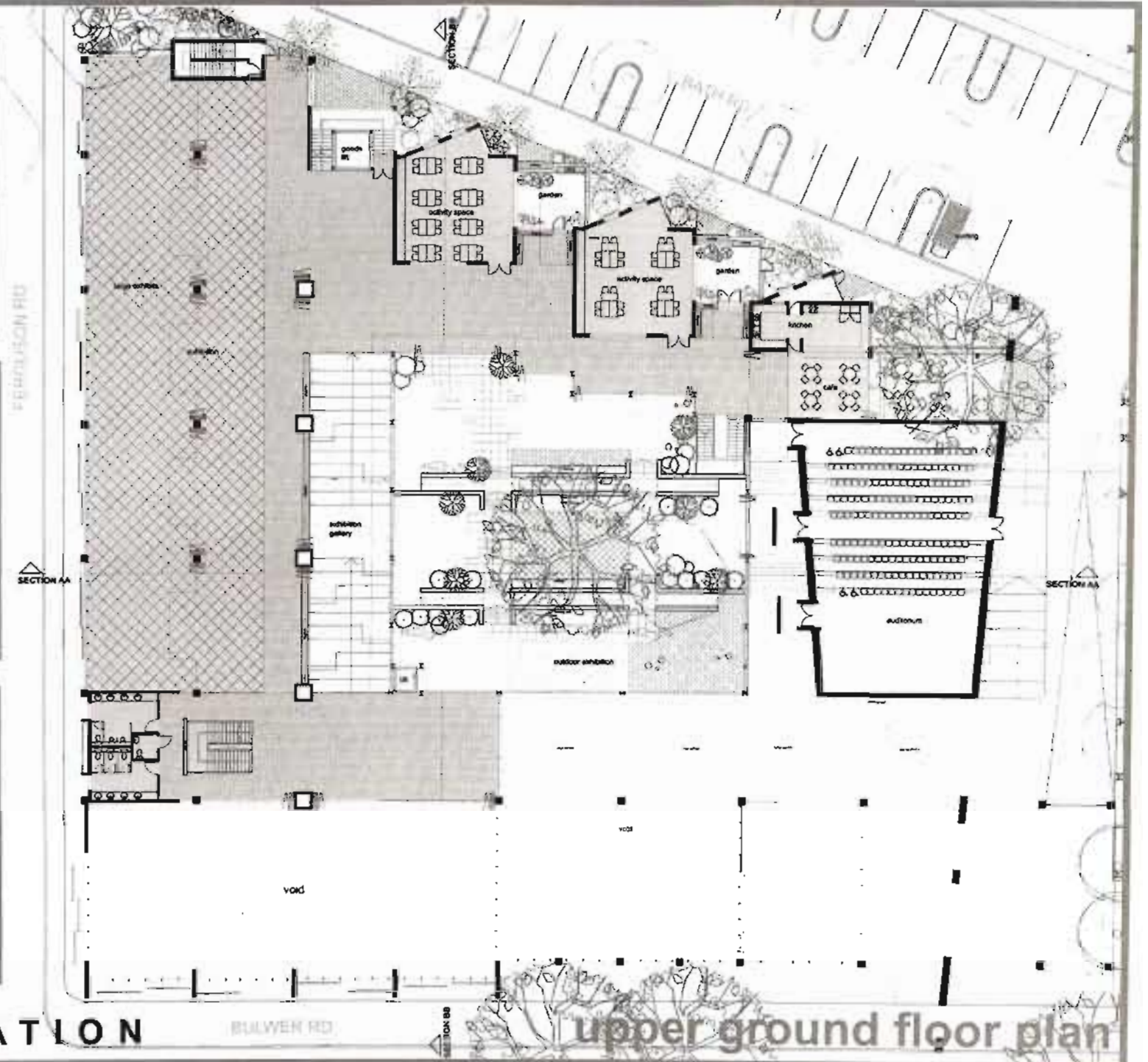
north elevation viewed from park



north elevation viewed from park



south elevation viewed from bulwer road



SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE paulétie barbeau

upper ground floor plan

scale 1:100



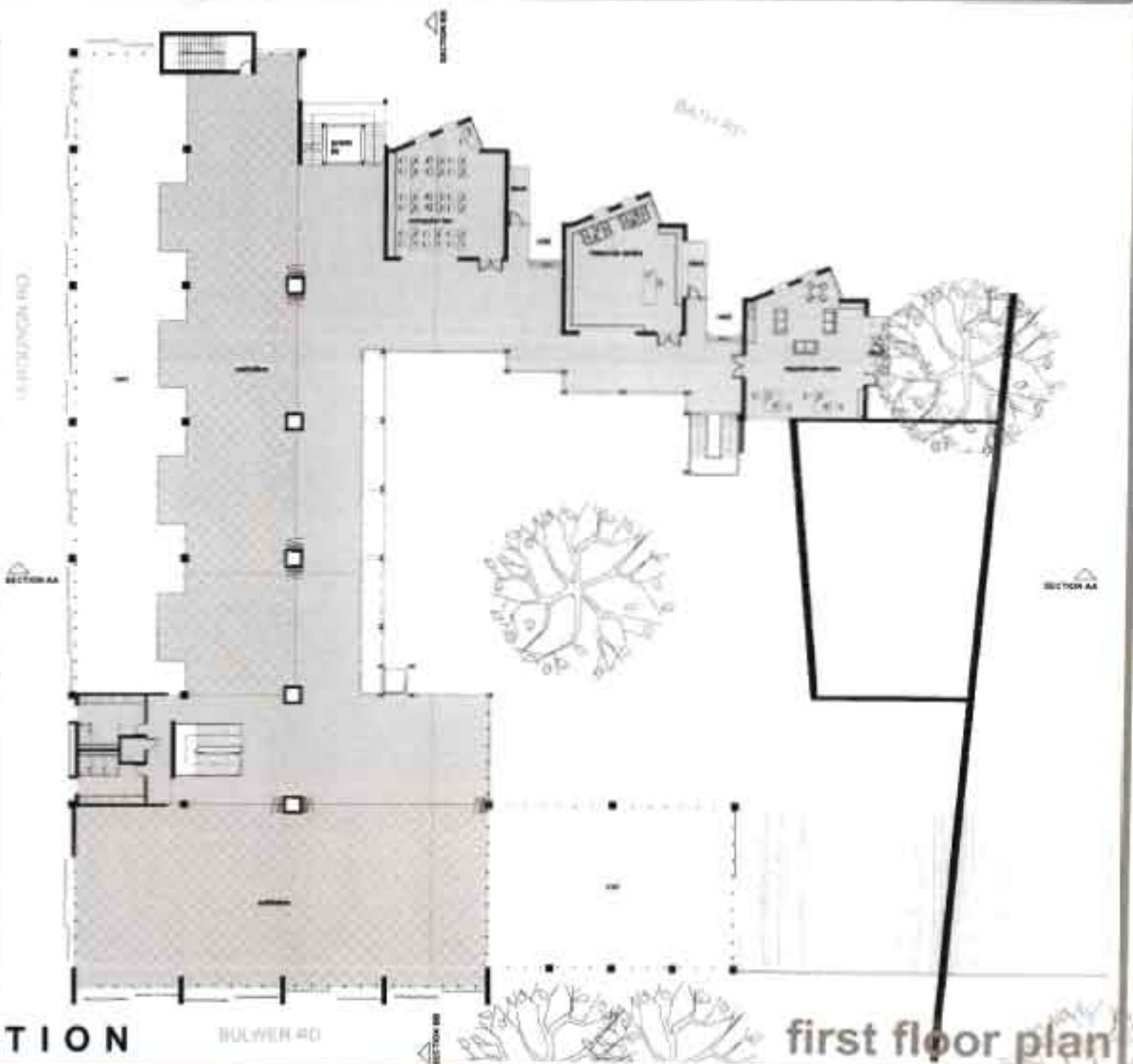
entrance viewed from bus drop off area



view of courtyard and main circulation route from stairs



view of courtyard and circulation route from Bulwer road entrance



SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE public building

first floor plan

scale 1:100



view from bath road



view from corner of Ferguson and bulwer

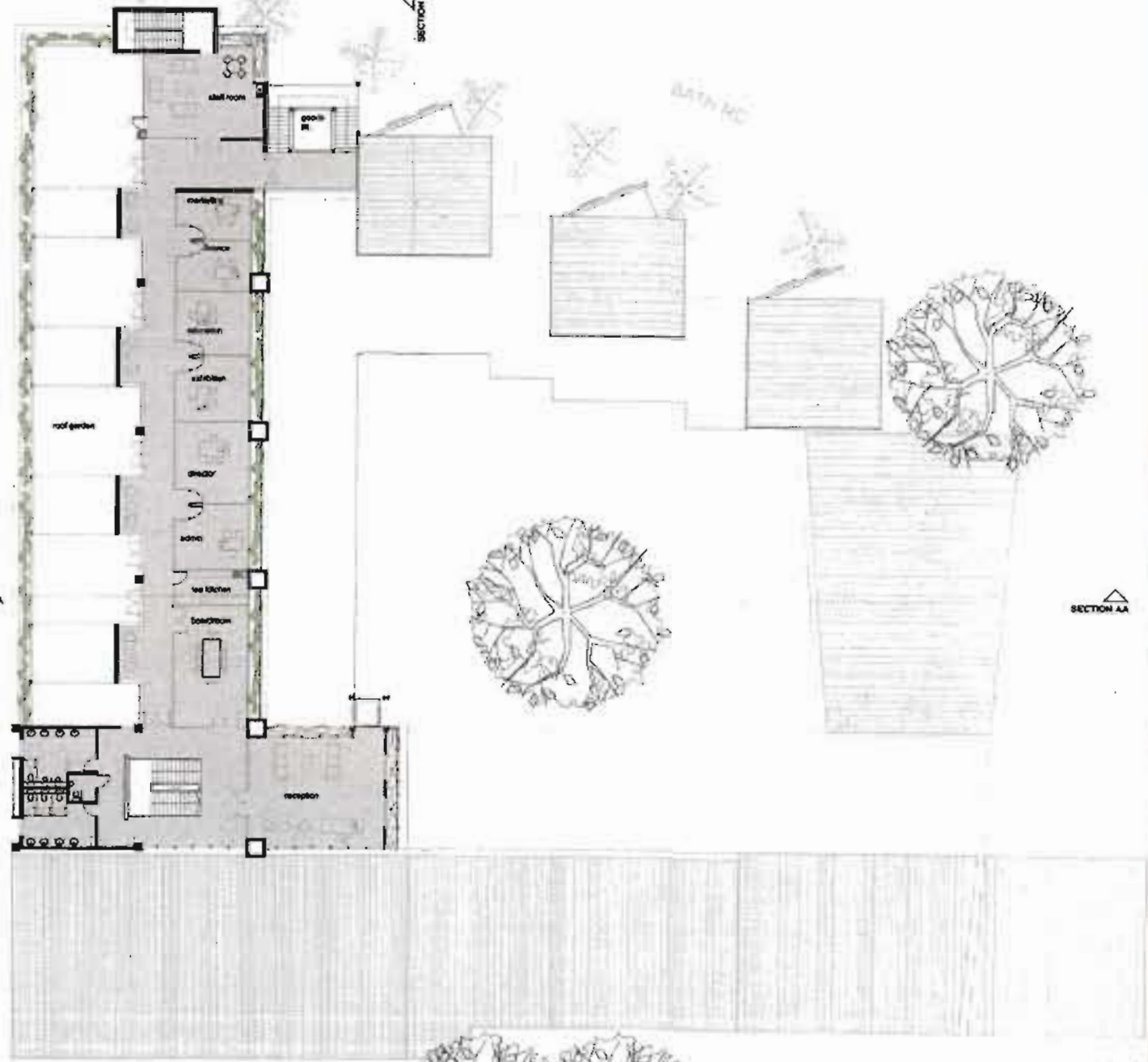


roof view from bulwer road

FERGUSON RD

SECTION AA

SECTION BB



SECTION AA

BULWER RD

SCI-TECH STATION

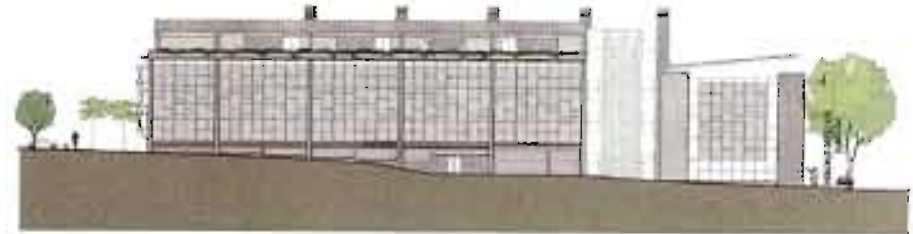
SCIENCE & TECHNOLOGY CENTRE paulette barbeau

second floor plan

scale 1:100



EAST ELEVATION



WEST ELEVATION



NORTH ELEVATION



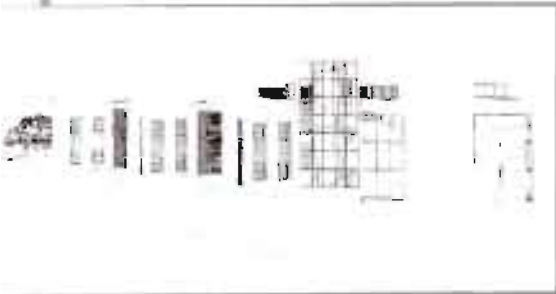
SOUTH ELEVATION



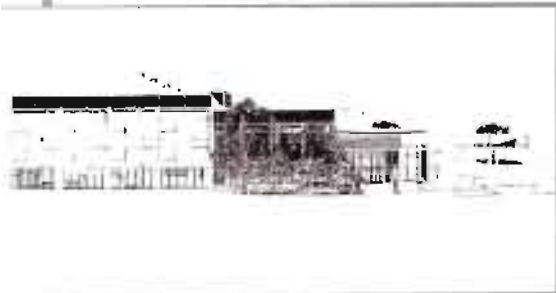
east elevation



west elevation



north elevation



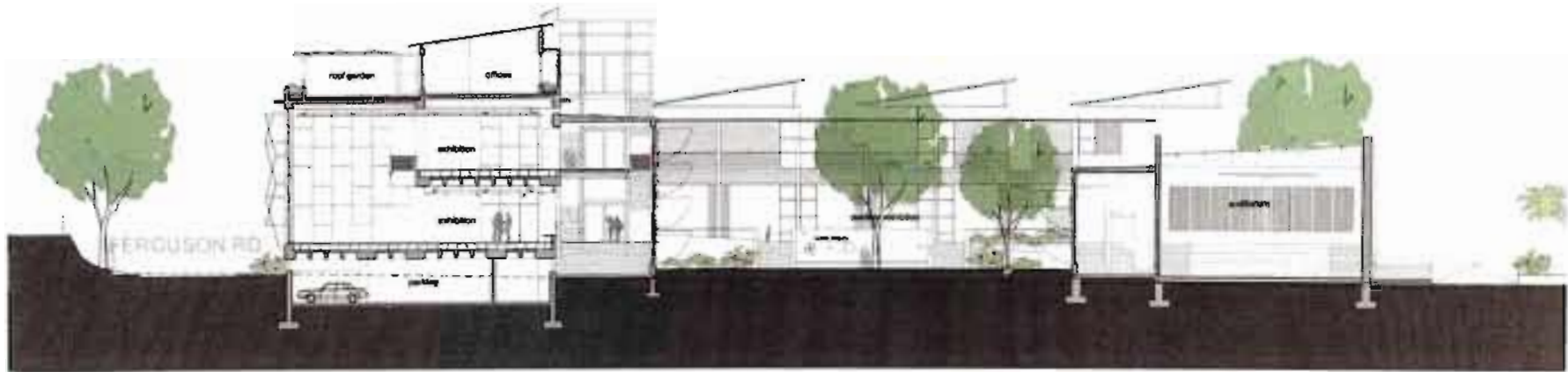
south elevation

SCI-TECH STATION

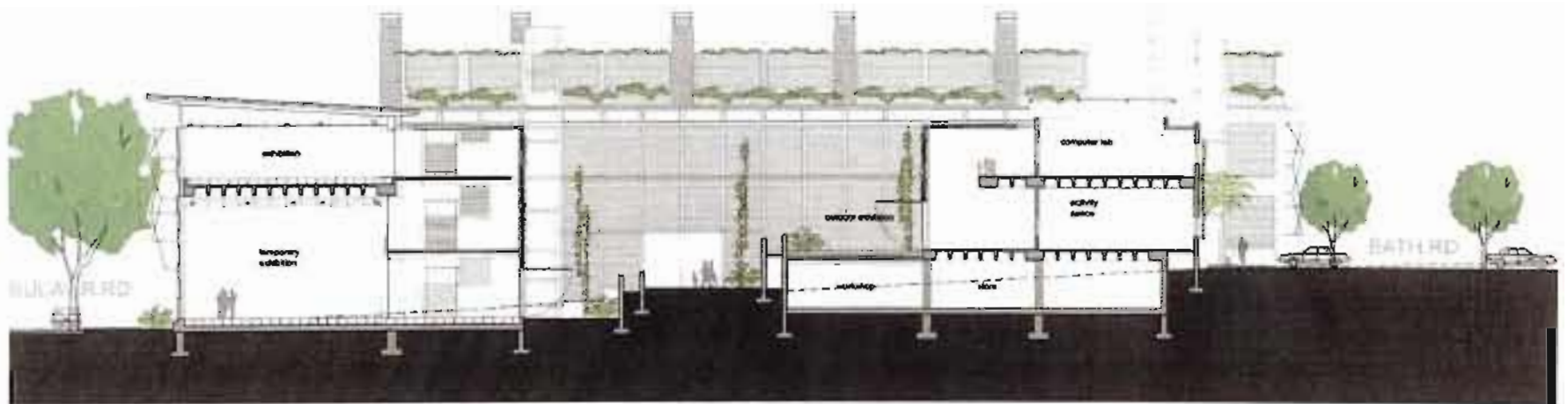
SCIENCE & TECHNOLOGY CENTRE *paulette barbeau*

elevations

scale 1:200



SECTION AA



SECTION BB

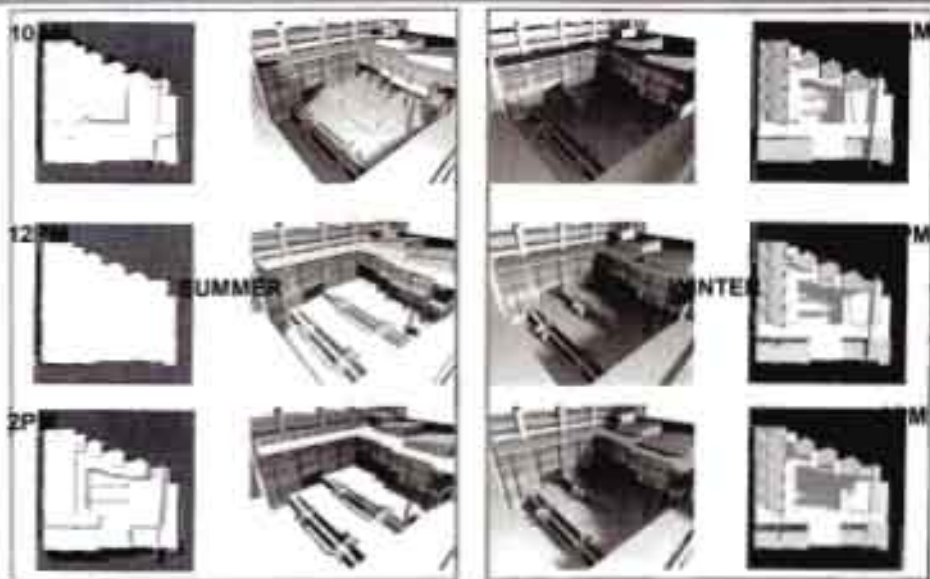
SCI-TECH STATION

SCIENCE & TECHNOLOGY CENTRE paulette barbeau



sections

scale 1:100



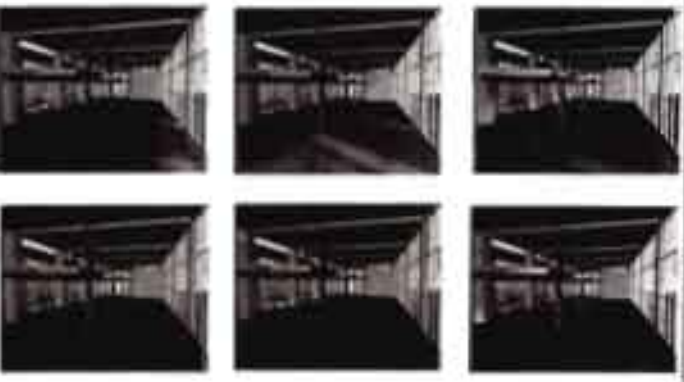
Courtyard

From the beginning of the centre's operational day, the courtyard receives substantial direct sunlight in summer. The screened walkways control the particularly intense insolation especially towards the east and west corners. In winter, the courtyard receives still receive direct sunlight for most of the day, but the surrounding built form casts more of a shadow into the courtyard. Due to their restrained height though, direct sunlight still hits on a significant portion of the courtyard's surface for much of the peak operating hours of 9am to 1pm.

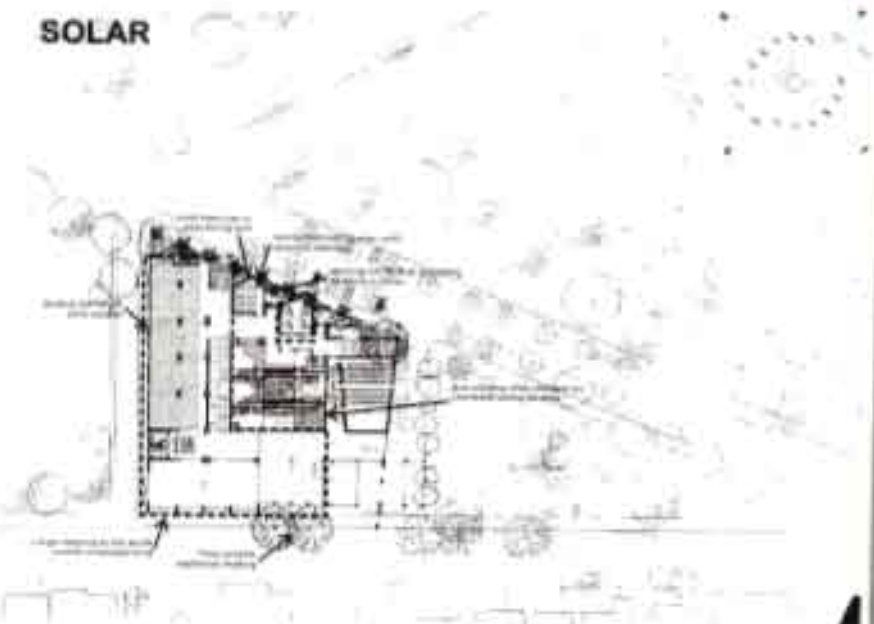
Ferguson Rd Exhibition Space

In the Ferguson Road facing exhibition space, summer insolation penetrates from 1pm onwards. In the late afternoon, the sun is low and penetrates considerably into the space. Full height screens are required to shade the space appropriately. In the winter, due to the building being aligned 42 degrees off of true north, the exhibition space receives early morning, deeply penetrating, insolation from the courtyard facing facade. This reduces towards midday, but later in the afternoon, after 3pm, insolation penetrates from the east wall glazing mainly, but this is less intensive.

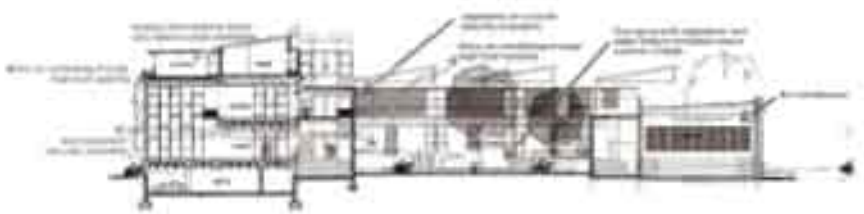
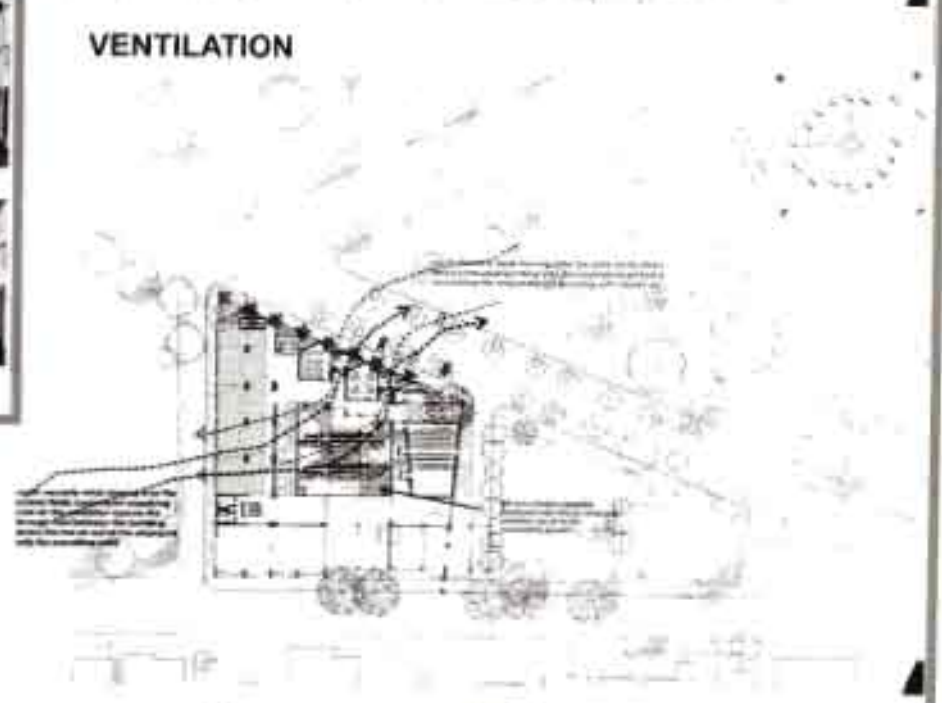
Overall Conclusions: The 1st exhibition allows for considerable amounts of direct insolation to penetrate deeply into the space. Therefore exterior screens are essential to reduce heat build up and glare in the spaces. The offset orientation of the building results in extensive screening being required on all facades, as opposed to an even overhang or the occasional fin wall. The courtyard is adequately used for appropriate direct sunlight exposure during peak operating hours, especially in winter.



SOLAR

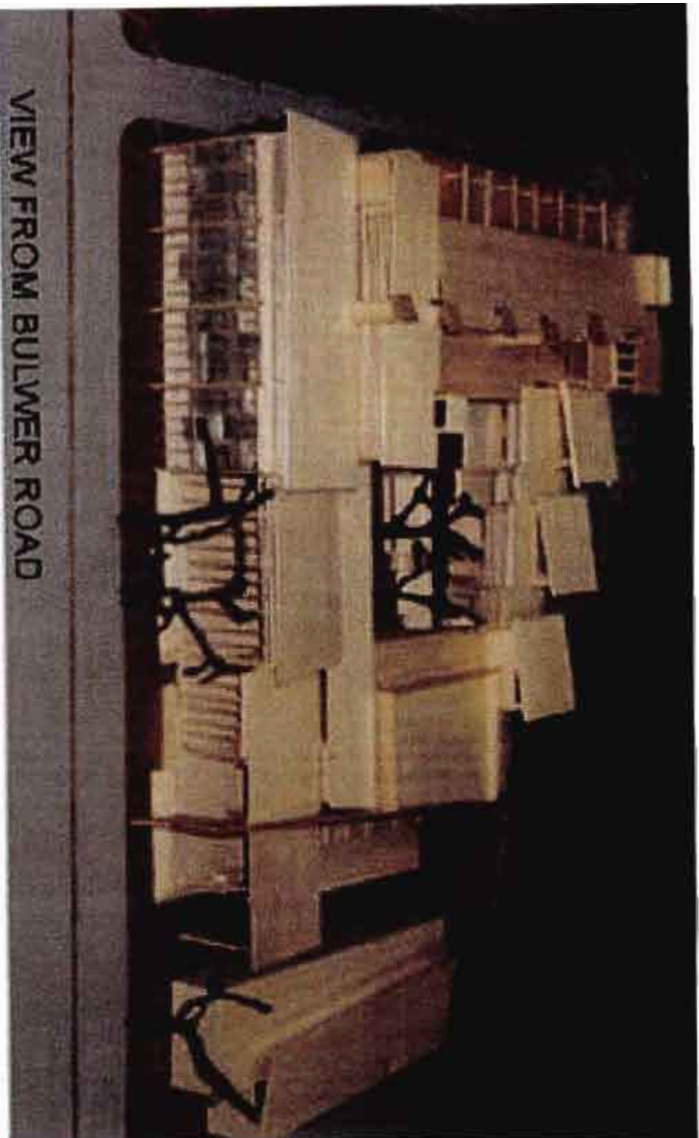


VENTILATION



SCI-TECH STATION

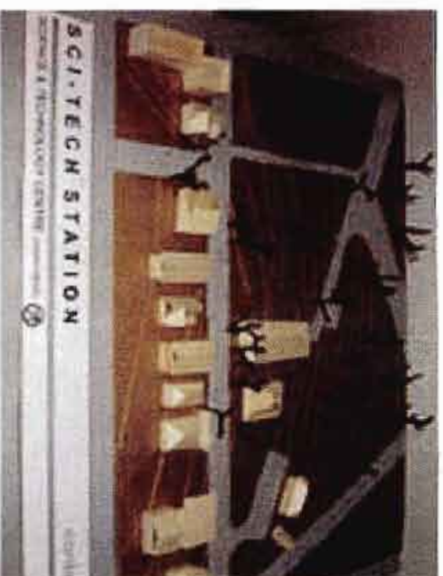
environmental response



VIEW FROM BULWER ROAD



VIEW FROM BULWER PARK/ BATH ROAD



CONTEXTUAL MODEL

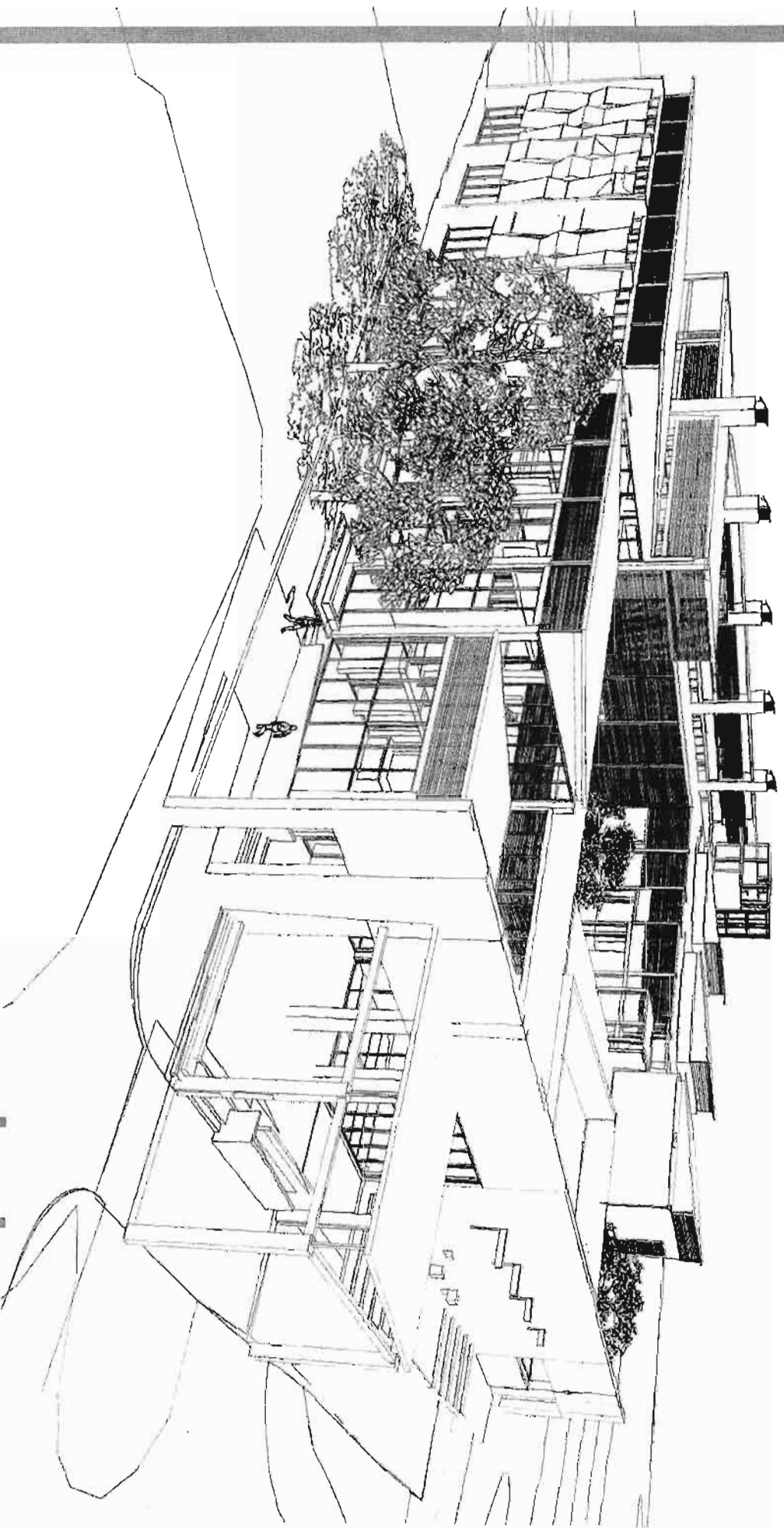


VIEW OF COURTYARD



VIEW FROM FERGUSON ROAD

PHOTOGRAPHS OF FINAL MODEL



SCIENCE & TECHNOLOGY CENTRE palette barbeau

design report

INTRODUCTION

In South Africa, a large portion of our society has been denied access to science education. This has led to a generally low public understanding of science and a poor scientific skills level, which has the impact of negatively effecting our countries economic growth. The Department of Science and Technology (DST) has proposed a network of science centres across South Africa. This network consists of flagship science centres in all the major cities, which support smaller science centres in outlying areas. The aim is to increase people's access to science and technology in a non-threatening environment that appeals to all ages.

This aim off this design is to provide a science centre for Durban. A science centre can be defined as “an educational facility that offers an informal educational experience in science, technology, engineering and mathematics (STEM) by providing interactive exhibits and displays; and interactive programmes” (DST, 2005:10).

The aims of science centre are to demonstrate a scientific theories, principles and phenomenon through interactive exhibits, to demystify science and to create a free choice, interactive learning environment

THE CLIENT

The DST has identified Full Service Science Centres to be run by Public Private Partnerships (PPP) (DST, 2006:15). This involves a partnership between a public sector institution and a private party. The science centre will be run as a private entity with some government, municipal and private funding.

FUNDING

The DST has proposed to subsidise 30% of the running cost of the science centres. The Full Service Science Centres, which will be run by PPP, will be funded by the private sector. This includes naming rights and sponsorship of various exhibits. The science centre will also be partially funded by the municipality. The aim is for the science centre to be self-sufficient. It is therefore important that the science centre has some ability to generate income apart from entrance fees. Primarily construction will be funded by a combination of the DST, eThekweni municipality and the private sector, which is an international norm.

SITE SELECTION

As seen in the precedent studies science centres are generally located in public areas relating to other public buildings such as well as public open space. Science centres are destination attractions and are not dependent upon their neighbours however, it is ideal that it relates to its neighbours. The site should be attractive, accessible and safe. It should also be highly visible and therefore on a busy route. People should know where it is and how to get there. It needs access for both cars and buses. It should be accessible by public transport. As the aim of the science centre is to provide facilities for all, it is important that it is easily accessible. The site or surrounds should allow for parking and service access and ideally bus parking, if not on the site, then parking should be available nearby. The site should be secure and should be perceived as safe; else, this will hamper evening programmes. It should be centrally located.

Ideally, the science centre should link into an existing network of schools, which acts as a support base for the science centre, and is readily accessible to students. The support of these schools helps to keep the science centre financially viable and supports outreach programs into rural areas. Close proximity to tertiary institutions is ideal as they provide lecturers and demonstrators as well as the explainers on the floor who explain to people how the exhibits work. A link to a park is advantageous as exhibits can filter into the park. The site also needs to be on municipal land.

SITE SELECTION CRITERIA

As a result of the above requirements, the site selection criteria can be defined as:

visibility: how visible the site is

accessibility: easily accessible by public transport

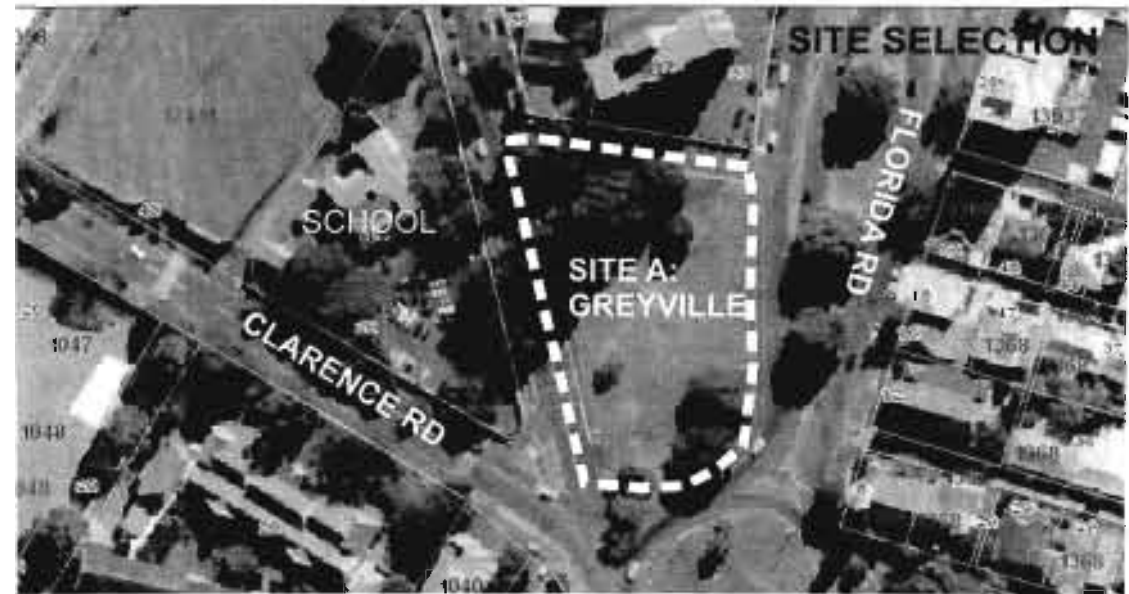
connectivity: link to an existing network of schools and tertiary facilities
linkage to open space & public buildings

Three sites were considered, a site in Greyville, a site near Durban Botanical Gardens and a site near Bulwer Park. These were analyzed and rated according to their ability to meet the above requirements with 5 being the highest score.



SITE A: GREYVILLE

Being on a corner site the Greyville site has fair visibility however; this is not a very busy road and therefore does not have the passerby traffic, which would increase its visibility. It is easily accessible from main roads and to the CBD. It is located close to a few schools but there is not a strong network of existing schools. It is also not well located in terms of its linkage to public open space and public buildings.



SITE B: BOTANICAL GARDENS

This site is located off a busy road, which makes it easily accessible and is within a close distance of the CBD. As a result of being on a quiet road off a busy road, it does not have the passerby traffic desired and lacks visibility. Its



connection to schools and public buildings is weak. The strength of this site lies in it being adjacent to the Botanic Gardens, one of Durban's great assets.

SITE C: BULWER PARK

This site is located on a busy road with high visibility. It is located near a national freeway. It is close to the CBD and is in the epicenter of a network of schools and tertiary institutions. The site neighbours on the KwaZulu-Natal Society for Arts and the KwaZulu Natal Institute of Architects. It also borders on a large public park.

BULWER PARK SITE

The Bulwer Park site scored the highest and met with all the site selection criteria and was therefore selected. It is located on a busy road with a fair number of passersbys, so the site is visible. It is easily accessed by public transport; there are three bus stops in close proximity. Its close proximity to the N3 makes it easily accessible by road and is within a 10-minute walk from central town. The site is located in a dense network of schools and is strategically located between the University of Kwa-Zulu Natal and the Durban University of Technology .The site is opposite a large well-established park, which is currently underused. This park offers an opportunity to create an outdoor exhibition space that could feed into the science centre. It was therefore decided that his would make an ideal site for a science centre

criteria	site A: Greyville	site B: Botanical Gardens	site C: Bulwer Park
visibility	3	1	5
accessibility	3	2	4
connectivity	3	3	5
linkage	1	4	5

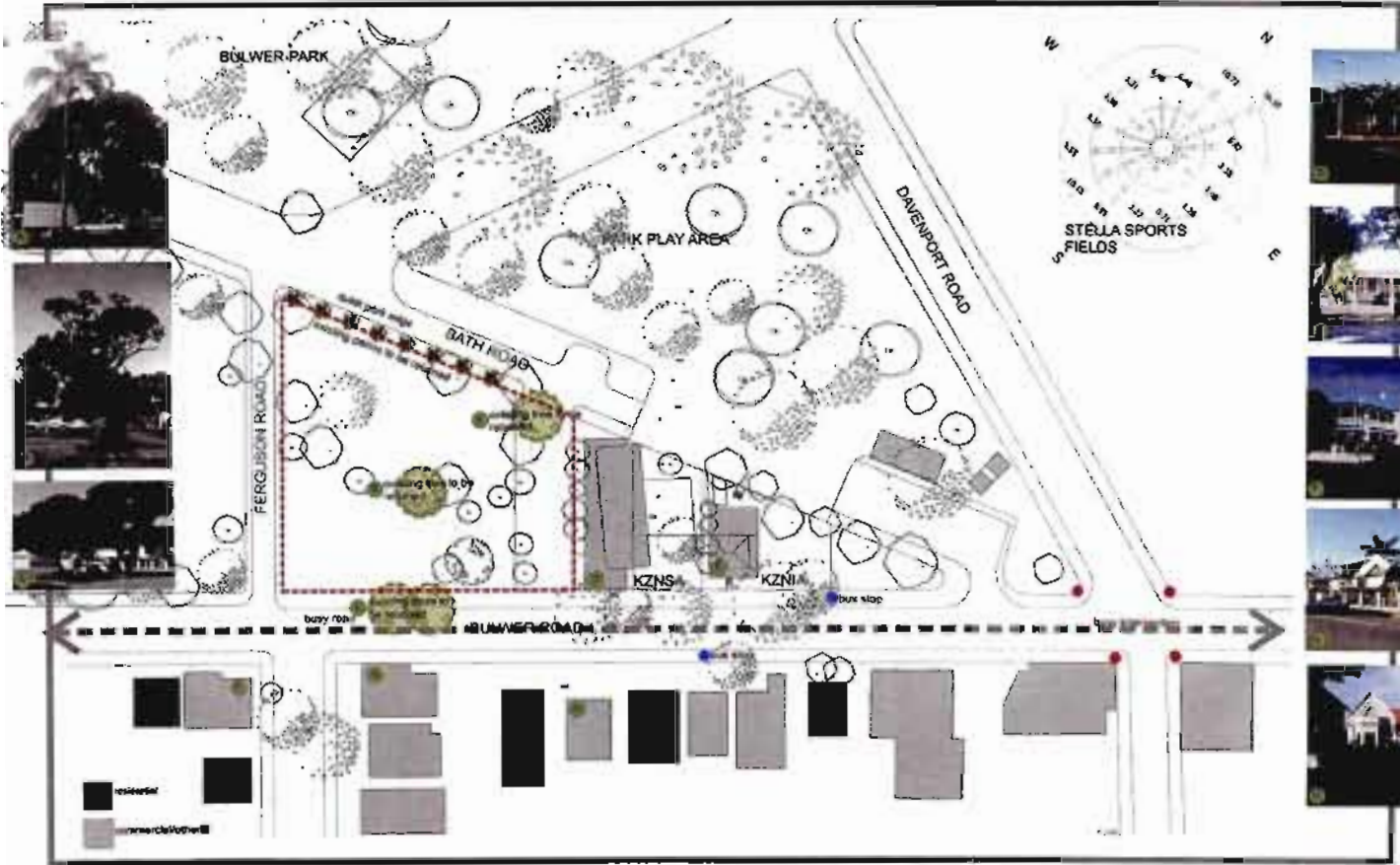
ACCOMMODATION SCHEDULE:

In order to meet the aims of the science centre there are four main components of a science centre, the general exhibition spaces, an auditorium for demonstrations, activity spaces for making projects and various activities and support facilities including offices and store rooms.

Entrance		Sqm
public plaza		
entrance portico		
foyer		100
info desk/tickets/security		20
lockers		20
washrooms		
Cafe		
kitchen		20
store		8
seating area		80
Exhibition		
Temporary exhibition		500
Exhibition		1500
storage		500
Exhibition maintenance		
workshop		80
store		20
theatre		
auditorium		150

storage		15
ablutions		
education		
activity zone	2	120
computer zone	1	60
science resource centre		100
administration		
reception		15
boardroom		30
director		15
PR/marketing		12
Finance		15
Educational program director		15
Exhibits co-ordinator		15
admin officers	2	24
tea kitchen		10
staff room		24
explainers room		24
services		
control room-security		12
electricity		12
generator		12
delivery area		40
cleaning		12
bin area		15
TOTAL		4015

SITE ANALYSIS & RESPONSE



SITE & CONTEXT ANALYSIS



MASSING/ORIENTATION

large exhibition spaces to south of site smaller units on north elevation to avoid overshadowing south light in exhibition spaces



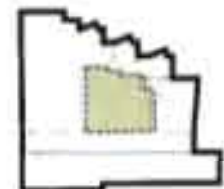
CIRCULATION

single clear circulation routes around courtyard



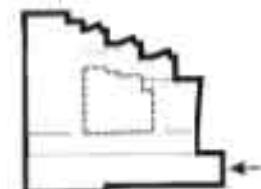
EXISTING TREES

building pulled back around existing trees



COURTYARD

built to edges hard external edge soft perforated interior green courtyard



SAFETY

hard exterior single entrance



VISIBILITY

ground floor transparent on bulwer road to allow glimpses into the science centre and exhibits



PLACES TO PAUSE

small spaces to retreat to to assimilate information to avoid museum fatigue



PARK

smaller elements on park edge to reduce the scale, gardens and planting to create a soft edge along the park



FLEXIBILITY

large exhibition spaces to allow for flexibility



The site is bounded by roads on three sides. The busiest and therefore most visible is Bulwer Road. Ferguson road is quieter and Bath Road divides the site and the park. The forth side is bounded by the KZNSA, which provides a harsh solid edge wall softened only by some planting.

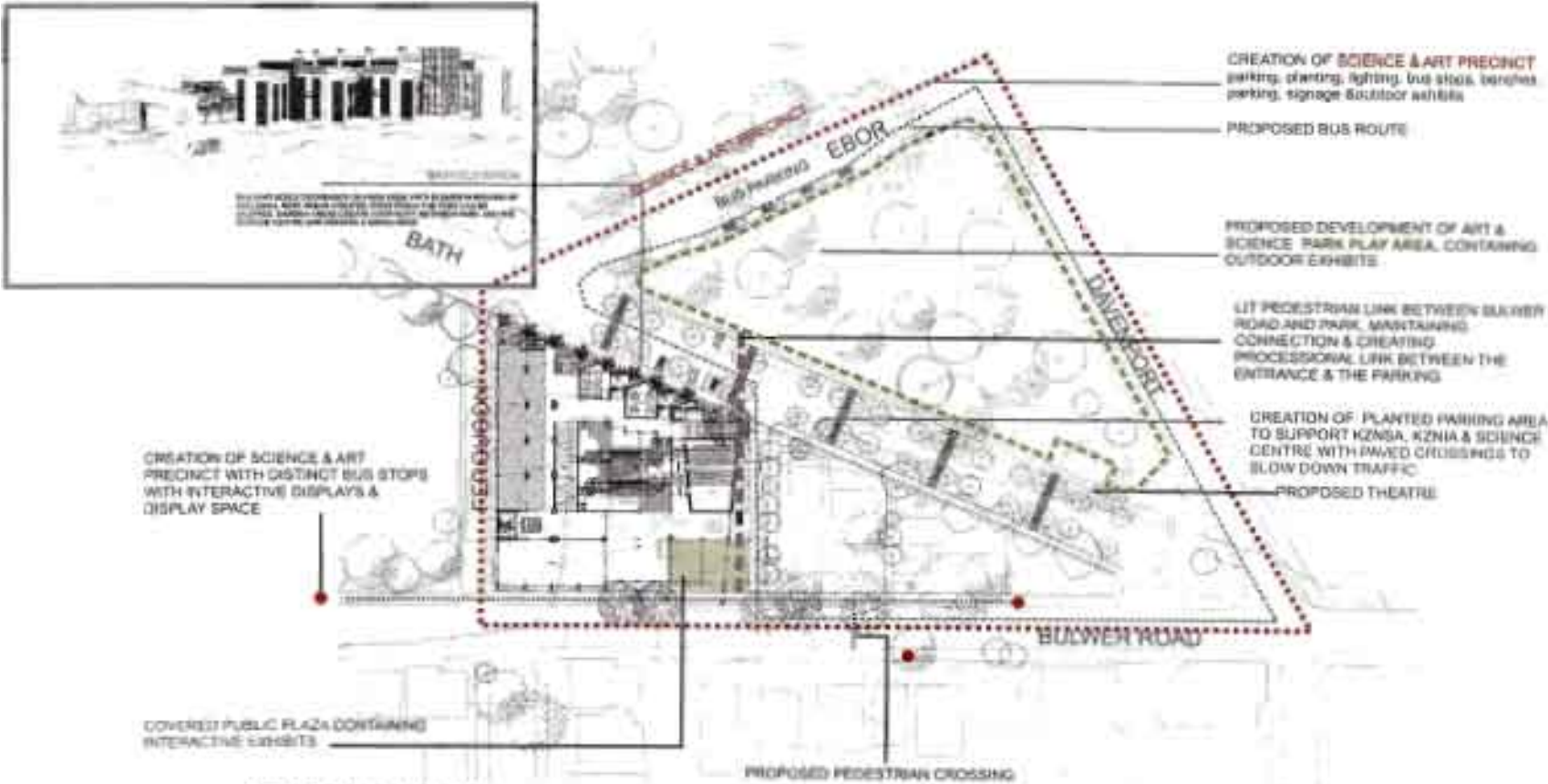
The largest volumes in the science centre are the exhibition areas and it was therefore decided to locate these on the southern edges to prevent overshadowing. This placed the bulk of the building on Bulwer and Ferguson Road. This is allowed the passerby views into the science centre. The smaller scale buildings containing more focused activity was located on the north on the quieter park edge bringing a more human scale to this edge.

The entrance was located near the KZNSA to create a hub of activity along Bulwer Road and to maintain the existing street language with more activity occurring closer to the KZNSA and usage becoming more residential further away.

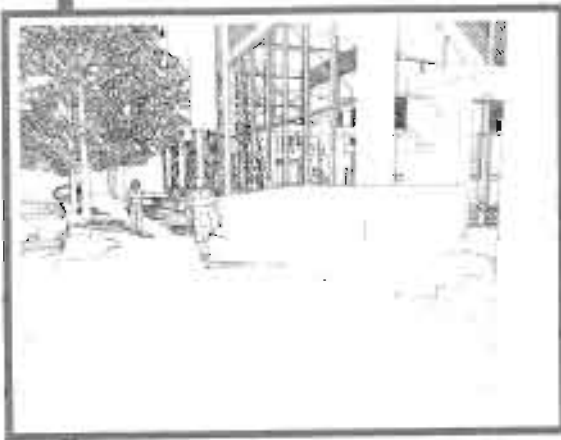
Due to the busyness of the roads surrounding the site and the nature of the users, it was decided that a courtyard strategy would be most effective providing a safe and secure centre.

The existing trees were maintained with the building stepping around them.

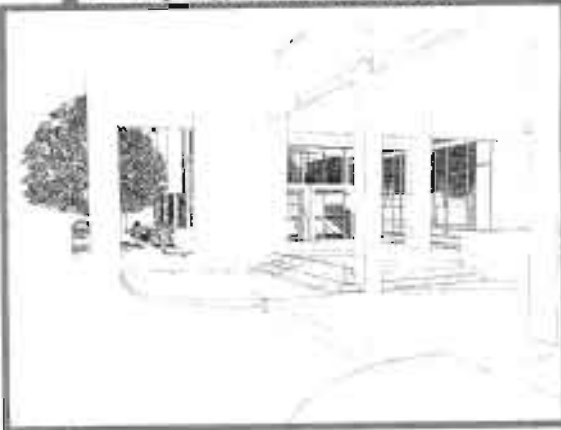
URBAN DESIGN



URBAN DESIGN



perspective of bulwer road viewed from kznsa:
building stepped back around trees



perspective of bulwer road entrance
viewed from kznsa

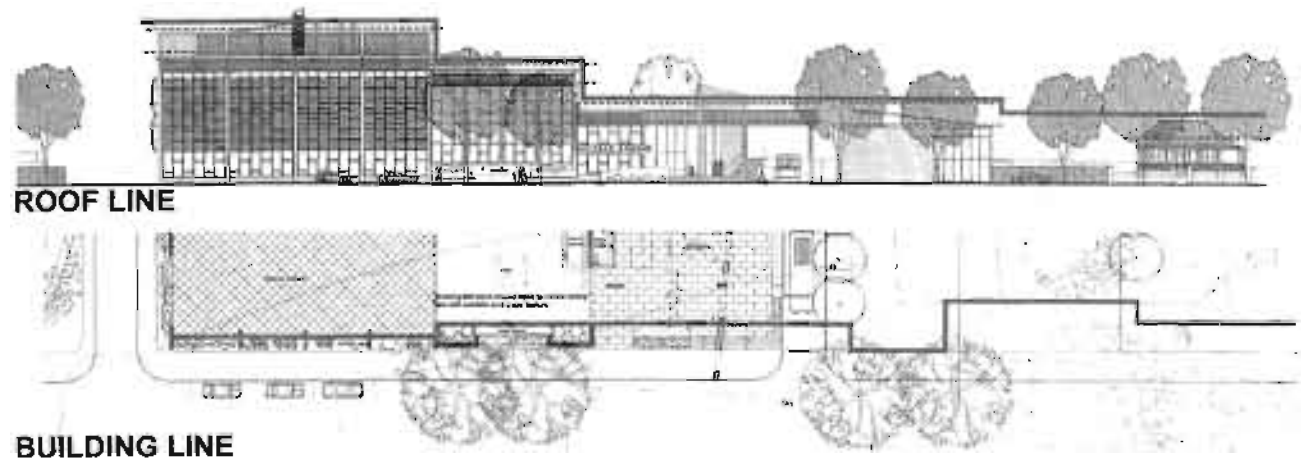


view of seating area below trees looking
towards kznsa

The proximity of the science centre to the KZNSA and the KZNSA encourage the development of a science and art precinct, which can be developed with street furniture, lighting and bus stops. The park can be developed with interactive exhibits and art work, bring activity and life to the park.

The creation of parking along Bath Road will make use of a currently unused portion of tar. Interspersing trees and planting between parking bays will create an avenue of tree and provide shade. Built up paved pedestrian crossings will help to divide the parking and slow traffic movement down as well as creating a strong visual as well as an actual link between the science centre and park. This strong link helps to define the precinct and indicates to user that they have crossed over into an area. It also seeks to direct them to the entrance and to maintain a link between the park and Bulwer road in a similar manner in which KZNSA attempted to.

The outline of the science centre steps back along Bulwer road to create space for the trees and follows a similar response to KZNSA. The roofline drops towards KZNSA following the existing pattern created between KZNSA and the KZNSA. Similarly, a gap has been left between the science centre and KZNSA to maintain the existing language



ROOF LINE

BUILDING LINE



timber screens



green screens



metal screens



concrete wall



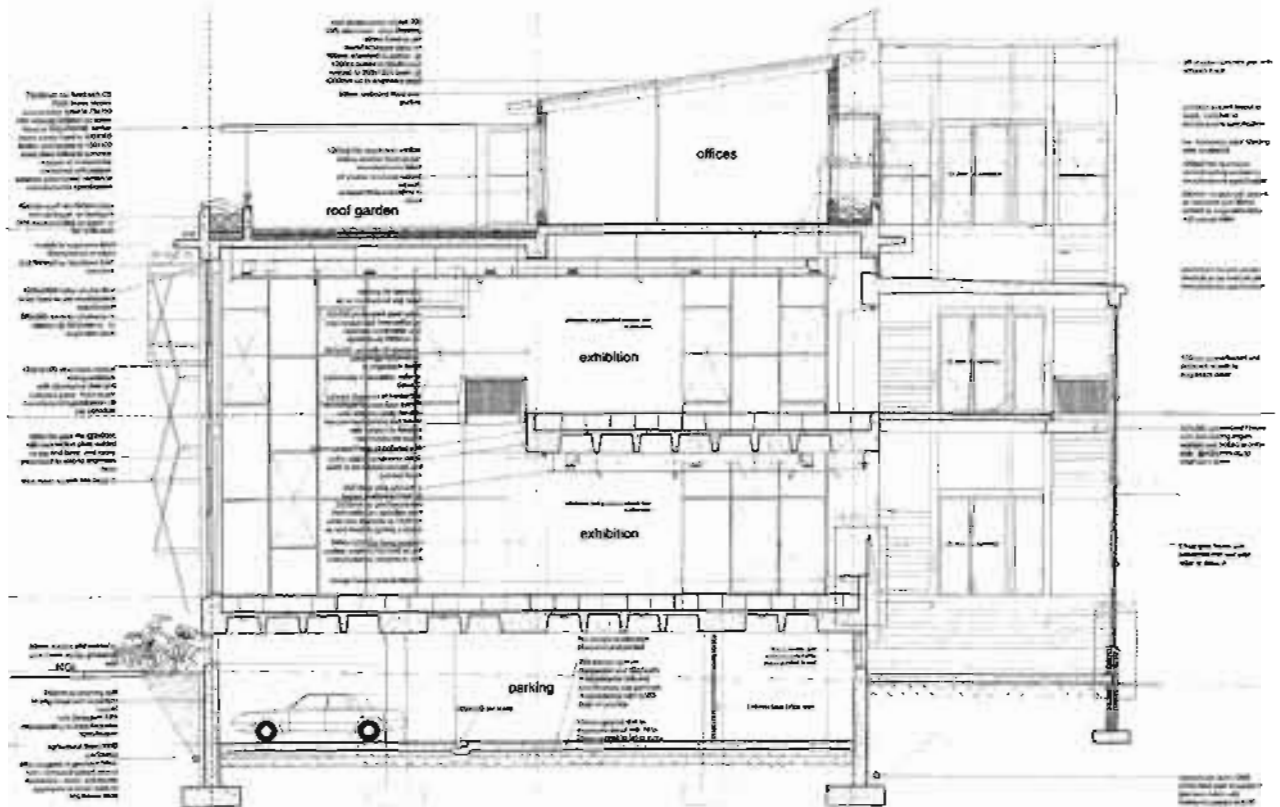
circulation tower

ARCHITECTURAL LANGUAGE

The architectural language varies on the different elevations of the building. The precedent examined used a fair amount of glass with relative success to allow the passerby to experience some of the exhibits and be aware of what occurred inside. The precedent example I felt was most successful was Techniquest which used a technical architectural language, simply without distracting from the exhibits. It conveyed the content of the science centre whereas the other precedent examples could easily have been art galleries. A fair portion of glass has therefore been used on the southern sides to allow views in, with bent metal screens occurring 3m above to capture a sense of movement and to protect the exhibits from early morning and late afternoon sun. Ensuring the light is indirect light. The metal screens do not hamper the connection with the outside world allowing one to easily orientate within the greater context. These screens convey a technical feel. Behind them are glass panels in varying colour creating a sense of fun that should be associated with a science centre.

As softer edge has been created on the park edge and internal courtyard using wooden screens and tilting screen to prevent the ingress of summer rays but also to create a strong indoor-outdoor connection linking with the park. This language responds to the park and acts as a trellis for climbing plants, which help to provide shade and cool the inflowing air. This creates a green park edge and a green interior. The wall, which forms the link between the park and Bulwer Road, echoes the hard wall of KZNSA and acts as a directional element linking with the park. It is an off shutter concrete wall with element and peep holes cast into it. This explores different aspects of science and acts as an art installation connecting the arts and the sciences. The glass and steel lift and circulation towers act as beacons indicating circulation nodes and are light up at night as circulation beacons.

CONSTRUCTION



In order to provide the flexibility required for a range of exhibits and heights a large uninterrupted span was required with as few columns as possible. In order to achieve this coffer slabs with a reinforced concrete frame structure were used, as this was the most economical means to achieve this. In the courtyard, lighter steel sections are used to create a feeling of lightness.

Brick infill has been used. A mixture of glass and brick infill were used. Glass was used on the south for indirect light and the solid mass on the north.

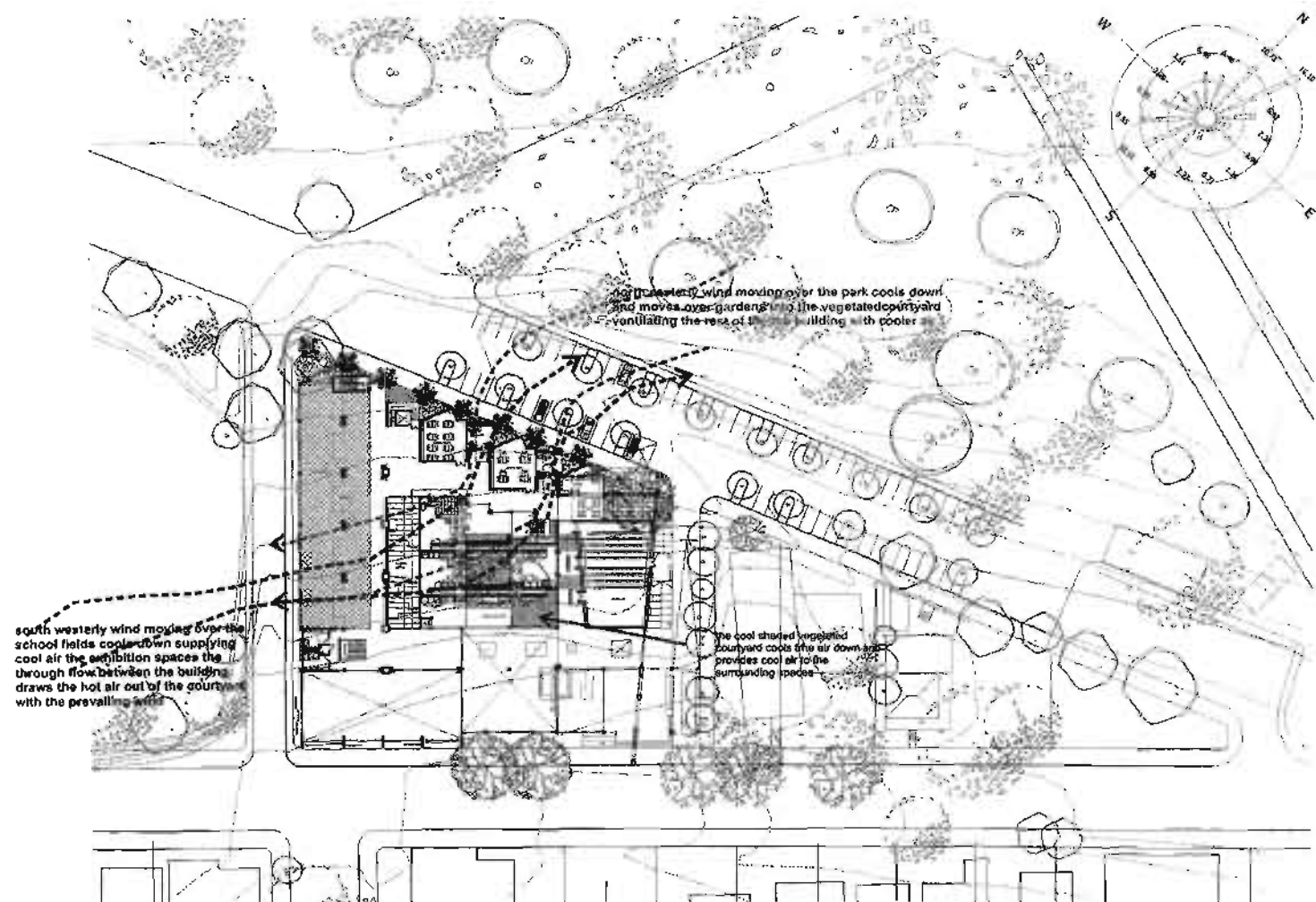
MATERIALS

A neutral expression has been selected for the science centre to provide a neutral backdrop to the bright colourful varying exhibits. Durable materials have been selected. In high traffic areas, a power floated screed has been used. The surface is easy to clean. In the exhibition area carpet tiles have been used as some exhibits require being on the ground and carpet tiles are more appropriate for this. They also act as a sound absorber. The structure and concrete have been left off shutter. Balustrades are made from steel mesh to allow children of varying heights to see over. Glass, concrete and steel have been used on the urban edge of Bulwer Road and softer wooden sun shading on the Bath elevation. The metal screens have a technological association, which is appropriate as an architectural image for a science and technology centre,



VENTILATION

A dual ventilation strategy has been used, using air-conditioning when demanded when there are no breezes and when the building is at peak use. Air flows over the park or school fields and loses heat to the vegetation.



LIGHTING

As much diffused light as possible has been allowed into the exhibition areas however, this needs to be assisted by artificial lighting. General lighting is available as well as lighting grids to allow for specific lighting of exhibits.

10			M	Courtyard
2	SUMMER	WINTER	M	
2P			M	

From the beginning of the centre's operational day, the courtyard receives substantial direct sunlight in summer. The screened walkways control the particularly excessive insolation, especially towards the east and west corners. In winter, the courtyard facades still receive direct sunlight for most of the day, but the surrounding built form casts more of a shadow into the courtyard. Due to their retained height though, direct sunlight still falls on a significant portion of the courtyard's surface for much of the peak operating hours of 9am to 3pm.

Ferguson Rd Exhibition Space

In the Ferguson Road facing exhibition space, summer insolation penetrates from 7am onwards. In the late afternoon, the sun is low and penetrates considerably into the space. Full-height screens are required to shade the space appropriately. In the winter, due to the building being aligned 43 degrees off of true north, the exhibition space receives early morning, deeply penetrating, insolation from the courtyard facing facade. This reduces towards midday, but later in the afternoon, after 2pm, insolation penetrates from the end wall going mainly, but this is less insulative.

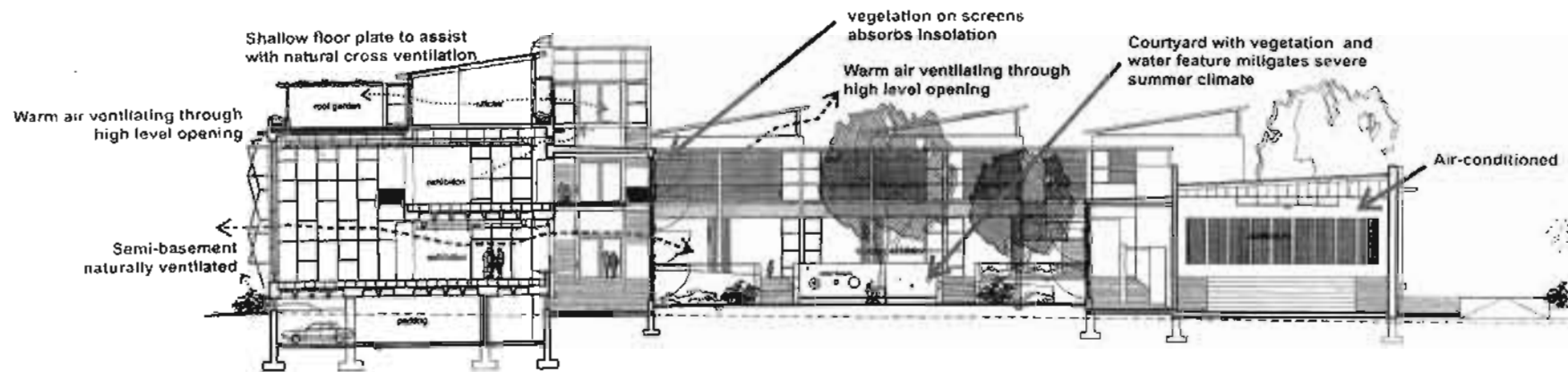
Overall Conclusions: The lot exhibition area for considerable amounts of direct insolation to penetrate deeply into the space. Therefore exterior screens are essential to reduce heat build up and glare in the spaces. The efficient operation of the building results in extensive screening being required on all facades, as opposed to an awning overhang or the occasional fin wall. The courtyard is adequately sized for appropriate direct sunlight exposure during peak operating hours, especially in winter.

FLEXIBILITY

To create the flexible space that is required for the ever-changing needs of a science centre, access flooring has been used so power or other surfaces can be accessed at any point. This is augmented with an overhead cable tray system to deliver power from above.

The exhibition spaces have large clear spans and range in height to allow for a variety of exhibits. Sliding folding doors allow areas of the science centre to be closed off and to block out light if required. On the West façade, roller-screens have been included to allow for total darkness to be achieved.

ENVIRONMENTAL RESPONSE & SUSTAINABILITY



The building is orientated 43 degrees off North. These results in most of the facades needing to be shaded, the greater mass has been located on the south so as not to overshadow the rest of the site. Smaller scale buildings are located on the north. Vertical sun shading is used on the west façade and horizontal on the north. Shading is used on all surfaces of the courtyard due to the sun's movement.

Rainwater is collected off the roofs and is used to water the courtyard and supply water to the water feature, which acts as a purification system and exhibit. Photovoltaic are incorporated on the north-facing roof of the Bulwer road exhibition to supply some of the energy needs of the building. Solar hot water heaters are included above the bathrooms to supply hot water.