report prepared for

The Board of Architects of NSW

Byera Hadley Travelling Scholarship for 2001 (Student)

SEEKING SUSTAINABILITY – Ecologically Sustainable Development In World Architecture

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ABSTRACT

This report is the culmination of a two month educational trip around Europe enabled by the Byera Hadley Travelling Scholarship (Student) awarded by The Board of Architects of NSW. I attended the Sustainable Building 2002 (SB02) International Conference in Oslo, Norway 23-25 September followed by a mostly self directed tour of sustainable building projects in Norway, Sweden, Denmark, Germany, The Netherlands and England.

Ecologically Sustainable Development (ESD), as defined by the U.N. Brundtland Commission in 1987, is:

> "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Edwards 7).

For Norman Foster and Partners, a London based architecture practice world renowned for their sustainable approach to building design, ESD is "creating buildings which are energy-efficient, healthy, comfortable, flexible in use and designed for long life" (Edwards 7). ESD is a complex, wide ranging issue that is changing and developing constantly.

There is sufficient evidence to indicate that global warming is a result of human activity. Trends also show resources depleting and population increasing. Buildings and construction is the most significant of all human activity contributing to climate change and all the associated environmental problems. Therefore, as architects, we have a responsibility to create more sustainable human habitats. (Edwards 4)

This paper will argue that it is not only the techniques of sustainable design that are important but also the process. Therefore there is much we can learn from Europe where the Sustainability agenda has been more prominent in the last few decades than it has in Australia.

This report is based around three central themes, supported with the case studies of buildings I visited during my trip. These themes are:

- Sustainable design and aesthetics - the green aesthetic, does it exist?;
- Sustainability and education – buildings as educational resources on ESD; and

- the integration of sustainable design – is an integrated design process the key to successful sustainable design?

AESTHETICS – THE GREEN AESTHETIC, DOES IT EXIST?

Is ESD the next 'style'? And does ESD create a so called 'green aesthetic'? These questions will be examined with reference to ideas presented at SB02 and through the comparison of BedZed, UK and Houses Without Heating Systems, Sweden. The report suggests a few reasons why there is an aesthetic distaste within the architecture profession, of sustainably designed buildings. The report looks at whether aesthetically pleasing surroundings actually contribute to human sustainability with reference to the Bo01development in Malmö. The role of technology in ESD will be examined, and what impact it has aesthetically. Three so called high tech sustainable projects: the renovated Reichstag, Germany; City Hall, London and the new Swiss Re headquarters, London, will be compared.

EDUCATION – BUILDINGS AS EDUCATIONAL RESOURCES ON ESD

The overriding theme to this chapter is whether education is the key to a more sustainable future. The report examines how buildings can be used to raise people's awareness of the issues of sustainability. A number of case studies from schools to offices to residential developments will be looked at, including Stenurten Kindergarten, Denmark; Peckham Library, U.K and PowerGen Headquarters, U.K. Further to this, the report will consider other ways in which we can actively educate people on ESD. There will be a brief examination of the role of expos and the media. The report looks at how we educate ourselves as architects on the principles of ESD. University education and conferences are the traditional ways but could a pilot project be more beneficial? To answer the question of whether it is necessary to implement legislation requiring ESD, the report will look at what governments are doing, and can do, to encourage the uptake of ESD. Finally, the UIA code of ethics is considered in terms of our responsibility as architects to educate our clients about ESD

INTEGRATION – IS AN INTEGRATED DESIGN PROCESS THE KEY TO SUCCESSFUL SUSTAINABLE DESIGN?

This chapter begins by explaining what an Integrated design process (IDP) involves, and why it is fundamental to sustainable design. The report then examines why there is a resistance to integrated design, by taking a look at how IDP differs from the traditional design process. A number of case studies are considered where an IDP was used: Telenor Headquarters, Norway, PowerGen Headquarters, U.K. and Kvernhuset secondary school, Norway. The report looks at how technology can be used to assist the IDP. An examination is made of many of the rating tools and other types of tools that exist (and are being developed) to assist architects in ESD. In addition to this, the role of context in discussing IDP is considered. A few examples of sustainable renovations and adaptive re-use are studied: Gardsten solar house project, Sweden; the Reichstag, Germany; the Baltic, U.K. and Grunerlokka studenthouse, Norway.

CONCLUSION

The main findings of this report are:

- Sustainable buildings can also be aesthetically pleasing – it is about finding the balance between aesthetics, technology and function.
- Sustainable buildings can serve to educate their users on the issues of sustainability, whether a school an office or a home, educating all on the issues of sustainability is of high importance.
- Successful sustainable design requires an integrated design process - integrating the concepts of ESD and all actors in the project from the beginning of the design process.

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Thank you to Chris Mury for taking a couple of hours late on a Friday afternoon to show me around Tower Place in London. Also, to all the friends and Family in Europe who gave such warm welcomes and hospitality during my trip, thank you very much.

A big thank you to my mother, Kathryn Bennett for her assistance in editing this report.

And finally, thanks to my trusty "Europe, Lonely Planet Guide", that got me around without any hassles.

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1. Beddington Zero Energy Development (BedZED), Surrey, U.K.
   Architect: Bill Dunster
   Building Services Engineers: Arup
   Structural & Civil Engineers: Ellis and Moore
   Quantity Surveyors and Construction Management: Gardiner & Theobald
   Developed by the Peabody Trust and BioRegional Development Group

2. Houses without Heating Systems, Lindas, Sweden
   Architect: EFEM arkitektkontor, Goteborg
   Client: Egnahemsbolaget
   Contractor: PEAB
   Constructional engineer: J&W, Goteborg
   HVAC consultant: Bengt Dahlgren AB, Goteborg
   Electrical services consultant: Probeko, Goteborg
   Site works consultant: Landskapsgruppen, Goteborg

3. Bo01 – City of Tomorrow, Malmö, Sweden
   Key partners: Swedish Government
   City of Malmö, Department of Planning and Building control
   Sydkraft
   HSB
   Telia
   SBAB
   Supported by the EC
   Buildings designed by various architects

4. Reichstag, Berlin, Germany
   Client: Bundesrepulik Deutschland
   Architect: Foster and Partners
   Consultants: Acanthus
   Amstein and Walthert
   Claude and Danielle Engle Lighting
   Davis Langdon and Everest
   Fischer Energie und Haustechnik
   IKP Professor Dr Georg Plenge
   Kaiser Bautechnik
   Kuehn Bauer und Partner
   Leonhardt Andrä und Partner
   Müller BBM GmbH
   Planungsgruppe Karnasch-Hackstein
   Per Arnoldi

5. City Hall, London, U.K.
   Client: CIT Group Ltd
   Architect: Foster and Partners
   Consultants: Arup
   Davis Langdon and Everest
   Montagu Evans
   Mott Green and Wall
   MACE

6. Swiss RE Headquarters, London, U.K.
   Client: Swiss Reinsurance Company
   Architect: Foster and Partners
   Consultants: Gardiner and Theobald
   Hilson Moran Partnership Ltd
   BDSP
   Ove Arup and Partners
   RWG Associates
   Sandy Brown Associates

7. Kvernhuset Secondary School, Fredrikstadt, Norway
   Client: not known
   Architect: not known
   Consultants: not known

8. Stenurten Kindergarten, Copenhagen, Denmark
   Client: not known
   Architect: Arkitektgruppen Aarhus
   Consultants: not known

9. Floriade, The Netherlands
   Fifth world horticultural exhibition

10. Peckham Library, London, U.K.
    Client: Education & Leisure Department, LB Southwark
    Architects: Alsop & Stormer
    Project Manager: Southwark Building Design Services
    QS: Franklin & Andrews
    Structural Engineers: Adams Kara Taylor
    Services Engineers: Battle McCarthy
    Landscape: Jenny Coes, Southwark BDS
    Lighting: Concord
    Acoustics: Applied Acoustic Design
    Contractor: Sunley Turriff Construction

11. Tower Place, London, U.K.
    Client: Tishman Speyer Properties Ltd Marsh and McLennan
    Architect: Foster and Partners
    Consultants: Davis Langdon and Everest
    E C Harris
    Jolyon Drury Consultancy
    Ove Arup and Partners

Stanhope
YRM Engineers

12. PowerGen HQ, Coventry, U.K.
    Client: PowerGen Plc
    Architects: Bennetts Associates
    Structural Engineers: Curtins Consulting Engineers
    Services Engineers: Ernest Griffiths & Son
    Quantity Surveyor: E.C.Harris
    Project Manager: Buro Four Project Services
    Design and Build contractor: Laing Midlands
    Fit-out architect: Fletcher Priest
    Landscape architect: Mark Westacott
    Services QS: Matt Green & Wall
    Environmental modelling: Environmental Design Solutions Ltd

13. Telenor Headquarters, Oslo, Norway
    Client: Telenor AS
    Architect(s): Joint Venture between NBBJ-HUS-PKA
    Consultants: Scandiaconsult AS
    Techno Consult
    Alfacon Nielsen og Borge
    Inter Consult Group ASA
    SCC Bonde & Co.
    SCC Trafikon
    Asplan Viak AS; Hang Kjaerem AS
    PTL Loken AS
    Spor Dark Design AS
    Vesa Honkonen and Julle Oksanen
    DARK Design
    Peakon
    Arbeidsfelleskapet BFP (Bolseth Glass/Flex Fasader/Profilteam)
    Hjellnes Cowi AS
    KWO Arkitecter AS

SCC Trafikon
Storkjokkenutvikling A/S

14. Gardsten Solar House Project, Gothenburg, Sweden
    Owner: Bostads AB Gardsten
    Architect: CNA-Christer Nordstrom Architects
    Builder: SKANSKA Sweden AB
    Monitoring: CIT Energy management AB
    Supported by the EC Thermie program, shine group.

15. Baltic, Newcastle-Upon-Tyne, U.K.
    Architect: Dominic Williams
    Project Manager: Peter Sandell
    Lottery funding.
    Other sponsors were: Gateshead Metropolitan Borough Council
    English Partnerships through One North East
    European Regional Development Fund
    The Regional Arts Board, and Northern Arts.

16. Grunerlokka Student House, Oslo, Norway
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    Architect: not known
    Consultants: no known

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INTRODUCTION

BACKGROUND

This report is the culmination of a two month educational trip through Europe enabled by the Byera Hadley Travelling Scholarship (Student) awarded by The Board of Architects of NSW. I had developed a considerable interest in Ecologically Sustainable Development (ESD) during my undergraduate degree in Architecture at the University of Newcastle. I wanted to learn more about this issue, which is becoming increasingly important in the Architectural profession considering that buildings consume 50% of the world's resources. Since Europe (in particular Scandinavia, The Netherlands and England) seemed to be at the forefront of Sustainable development, I decided to use the scholarship to look at ESD in Europe. In particular, I wanted to look at energy conservation in commercial buildings and the design process involved in achieving successful sustainable design, but more generally to educate myself about the many and wide ranging issues associated with sustainable design, and learn from the broader European experience.

The timing of the trip was determined by the Sustainable Building 2002 International Conference in Oslo, Norway 23-25 September. This was the 3rd conference of its kind. The first was held in Vancouver in 1998, the second in Maastrict in 2000 and the next will be in Tokyo in 2005. The Oslo conference attracted over 1000 people from more than 60 countries (a 50% increase on the previous conference). It was a very informative, inspiring and a somewhat intense 3 days and I came away with plenty of literature and several contacts throughout the world with a similar interest in ESD. I followed the conference with a tour of Sustainable Building projects throughout Europe. The entire trip took 2 months and included Norway, Sweden, Denmark, Germany, France, The Netherlands and England. I visited in excess of 30 buildings associated with Sustainable design although not all will be discussed in the report. As a result of ideas and issues expressed at the conference, my focus diversified as I started to think about:

- Sustainable design and aesthetics - the green aesthetic, does it exist?;
- Sustainability and education – buildings as educational resources on ESD; and

- the integration of sustainable design – is an integrated design process the key to successful sustainable design?

These three themes were constant reference points during the trip and will form the basis of the report. The buildings I visited were chosen as a result of a combination of both extensive research prior to the trip, and what would be feasible in a two month visit. It was a fantastic opportunity and I certainly gained a lot from the experience, returning to Australia much better informed about the issues of Sustainability and a renewed enthusiasm for sustainable design. With the benefit of hindsight, the only thing I would have done differently is to establish contacts more rigorously before I went. The projects I visited where I had a pre-arranged contact such as Tower Place in London (Chris Mury) and the Scandinavian excursion (which was organised as an extra with the conference), were certainly more informative and educational.

WHAT IS ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD)?

In 1987, The Brundtland commission defined Sustainable Development as:

> "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Edwards 7).

It is a holistic approach that encompasses not just construction but all human activity. The Brundtland Commission (also known as the UN Environment Commission under Gro Haarlem Brundtland), coined this definition which remains the global standard, if somewhat general and open to interpretation (Edwards 7). We can translate this in relation to the construction industry in a basic way by saying that ESD is about:

- efficient use of resources (energy, water, land, materials);
- minimising waste,
- recycling and reusing;
- using renewable sources of energy (solar power, wind power, hydro power);
- maintaining health (of humans as well as their natural environment).

For Norman Foster and Partners, a London based architecture practice world renowned for their sustainable approach to building design, sustainable design is "creating buildings which are energy-efficient, healthy, comfortable, flexible in use and designed for long life" (Edwards 7).

It is important to make the distinction between being sustainable and being green. Being sustainable is more than just being green. Being green is not necessarily the holistic future oriented approach that sustainability is based on. However, many people use 'green building' and 'sustainable building' interchangeably.

The report associated with the Brundtland definition, went on to argue that successful sustainable development is about balancing the environment with economics and social welfare (Edwards 7). Maria Atkinson (National Environment Manager at Bovis Lend Lease, Chair of the Property Council of Australia's Environment & Regulatory Control Committee and member of the NSW State Government's Sustainability Advisory Council) talks about this concept in terms of "balancing the 'three-legged stool' of economics, society and the physical environment ..... 'when one of those 'legs' falls then

the whole thing falls over" (Atkinson 14). More recently this idea has become known as the "Triple Bottom Line".

The Architect, however, must also consider the way a building looks and works. In addition to environmental, social and economic concerns, Foster includes those of technology and aesthetics: "For me the optimum design solution integrates social, technological, aesthetic, economic and environmental concerns" ("Architecture and Sustainability").

ESD is a complex, wide ranging issue. One that will take us a long time to fully understand and one that is changing and developing constantly. But to make it simple and easy to remember, achieving a lot with a little is the basic premise, as Norman Foster wrote "Sustainable architecture can be simply defined as doing the most with the least means. The Miesian maxim 'Less is more' is, in ecological terms, exactly the same as the proverbial injunction, 'Waste not, want not' " ("Architecture and Sustainability").

WHY IS ESD IMPORTANT TO ARCHITECTS?

Put simply, “Climate Change is a symptom of our activities. We must address these activities” (Hammer SB02). Buildings, in particular, are the major ‘activity’ we need to address, being the world’s biggest consumers of resources. 50% of world material resources go into construction and 45% of energy generated is used to heat, light and ventilate buildings with a further 5% to construct them. Similarly, 40% of the world’s water is used for sanitation in buildings, 60% of agricultural land lost to farming is used for building purposes and 70% of timber products end up in building construction (Edwards 10-11). Meanwhile, resources are dwindling. For example, we have only 40 years left of oil, 60 years left of natural gas and 200 years left of coal (Edwards 23).

Buildings are responsible for 50% of global warming gas emissions (Edwards 21). Global warming, which causes rising sea levels and abnormal weather conditions is leading to loss of land and loss of agriculture on which we rely for human survival. It is particularly critical for Australia when we consider that “Australia is currently the world’s highest per capita emitter of greenhouse gases at 27.6 tonnes of CO_2-e per person per year compared to the USA at 21.1 tonnes and the European Union average of 10.3 tonnes (Turton et al, 2001)” (Clark).

To compound the problem, world population is on the increase. It is estimated that by 2025, world population will increase 50% (from 6 billion to 9 billion), half of that being in the Asia Pacific region (1.5 billion) (Halls SB02). More people will therefore be consuming more resources and requiring more buildings and infrastructure.

It seems a very bleak future when couched in these terms, but it shows the importance for the architectural profession of adopting the principles of sustainable design as a fundamental part of sustaining current and future generations. It makes you think a little differently when you consider this quote made by one of the presenters at SB02:
“We have not inherited the earth from our ancestors, we are borrowing it from our children” (Holm SB02).

This seems like a weighty responsibility to be burdened with. As Edwards and Hyett write: “Architecture alone cannot solve global environmental problems but it can make a significant contribution to the creation of more sustainable human habitats” (4). We, as architects, have “a duty beyond our paying clients, to the present and future users, and to the environment and societal context...” (18).

So what can we do? What constitutes sustainable design? It is not as simple as putting some photovoltaic cells on the roof. In the past few decades, sustainable design evolved by trial and error and thus there is much to learn from precedents, however the basic principles are nothing new. Much has been written and researched on Sustainable design and it has many variables depending on region, site characteristics, resources available, availability of technology etc. Sustainable design can be divided into passive (low tech) and high tech. Elements of passive design such as orientating the building towards the north (southern hemisphere), providing openings that allow for natural cross ventilation and collecting and using rainwater from the roof are things that humans have been doing for centuries. Insulating walls, roofs and floors, recycling building products, recycling greywater, using local materials , encouraging biodiversity and making public transport or cycling a viable option to travelling by car are just some of the elements of passive sustainable design. High-tech sustainable design solutions include elements such as sourcing power to run the building from solar powered photovoltaic cells or wind powered turbines for example, heating via a heat exchanger that uses warmed exhaust air to warm incoming fresh air and cooling with chilled ceilings where the water is sourced from an underground aquifer.

But it’s not just about throwing all these elements together to create a sustainable building. What is sensible in one context, may not necessarily make sense elsewhere. It depends on what is economically viable, socially required/desired and physically possible – as mentioned previously, finding a balance between economics, society and the environment (that three legged stool of Maria Atkinson). The ultimate aim is to close the loop, i.e. not have to rely on others for power, water, food, materials, waste disposal etc.

Obviously, Europe is very different environmentally, socially and economically from Australia. So you may well ask, what relevance does studying sustainable architecture in Europe have here in Australia. In my view it is not only the techniques of sustainable design that are important. We can therefore learn much from Europe in terms of finding the balance between Sustainable architecture and aesthetics, educating about sustainability and integrating sustainability into the design process. These themes, as mentioned earlier, will be my focus.

CHAPTER 1

AESTHETICS – THE GREEN AESTHETIC, DOES IT EXIST?

It has been suggested that ESD is the next 'style'. But can we refer to ESD simply as a 'style'? One of the papers presented at Sustainable Building 2002 International Conference (SB02), addresses "how the architectural profession handles energy efficiency and sustainability in relation to architectonic design" (Ryghaug 1). In her paper, Ryghaug dismisses the notion of ESD as the next style quoting NABU (Norwegian Architects for a Sustainable Development) to explain that it belongs to a different paradigm:

" 'One tends to think about one style after the other, through history, now there is modernism and we wonder what will be the next style because we think linearly. I think ecology belongs to another paradigm and that we therefore should ask a different question, where the point is to say that this is not primarily about form – it is about contents' " (Ryghaug 4).

Norman Foster supports this view saying that "sustainability is not a matter of fashion, but of survival" ("Architecture and Sustainability"). Edwards goes so far as to say that "No architecture has moral validity unless it addresses [global warming] by being environmentally sustainable" (83). It is becoming expected that ESD is inherent to architecture not separated from it and not an option.

Although, as I have just established, ESD exists in a paradigm removed from architectural movements such as Modernism, there does seem to be a general belief among the Architectural profession that Sustainable design creates a certain aesthetic – one that not many architects appreciate. Ryghaug found that "traditional low-tech ecological architecture has an aesthetic expression that most architects find objectionable" (5). Is it in fact the case that ESD creates a so called 'green aesthetic'? And what is it that creates this aesthetic distaste within the profession of sustainably designed buildings? To examine these questions, it would be appropriate to compare two recent European housing projects: Beddington zero energy development (BedZED)

in the U.K. and Houses without Heating Systems in Lindas, Sweden. Both focus on sustainable living but have a very different aesthetic. The latter aims to look 'normal' while the former flaunts it's aspects of sustainable design.

BedZED, designed by U.K. architect Bill Dunster, is situated on the outer edge of London and combines residential with commercial, sport and community spaces in a holistic sustainable living approach. The three storey tiered buildings run parallel to each other on an east west axis. They comprise 1, 2 & 3 bedroom flats and 3 bedroom town houses along the sunny southern sides (NB northern hemisphere) and commercial workspaces on the northern sides. With a combination of passive solar gain, thermal mass and super insulation, there is no need for a central heating system. The homes and offices are powered by a combined heat and power (CHP) unit fuelled by waste from tree surgery (wood chips that would otherwise go to landfill). As a by-product of this system, some heat is produced which is captured to supply hot water across the development via a small district heating system. Rainwater is collected from the roofs for toilet flushing. Waste water is treated on site in a biological sewage treatment plant and once treated, the water is added to the rainwater supply for toilet flushing. To slow the water run off, roofs are planted with sedum, a green/red mossy turf. Photovoltaic cells are made into a feature, incorporated into the glazing of the south facing conservatories. These generate enough electricity to power 40 electric cars which are provided to residents who are members of the ZEDcars car club on a pay-as-you-drive arrangement (Beddington).

1

2

Perhaps the most obvious feature, however, that I first noticed from the street is the wind driven ventilators on the roofs. These were specially designed for this particular project and each one has been painted a different bright colour as if to say 'look at me, I'm a sustainable building!'. It could be argued that aspects of sustainable building need to be obvious to raise the public awareness and form an educational tool in the concepts and issues of sustainability. But what is the cost of this? As Ryghaug writes: "Finding a new architectonic answer to a problem, like for example environmental problems, implies looking for something that may symbolise the environmental aspects. Creating such symbols may create a greater consciousness of the green aspects in buildings, but it could also become so eccentric that it has no transmission value" (Ryghaug 5). This will be covered further in the next chapter. 2.

3

The 20 terrace houses that comprise the 'Houses without Heating Systems' in Lindas, Sweden, 20km south of Goteborg, takes a very different approach in terms of aesthetics. It aims to produce homes that look 'normal' and cost the same as a conventional Swedish home. There are 4 buildings on the site comprising 40 flats. With the combination of exceptionally well insulated construction, greater air tightness, passive solar heating and heat recovery they do not require a heating system. This is quite remarkable when you consider that average winter temperatures in Sweden range between minus 5 and minus 1 C (Lonely Planet 1241)! The walls have 430mm of insulation, the roof 480mm and under the slab is 250mm. Windows are triple glazed with 2 metallic coats and krypton fill between the layers of glass. Like BedZED, the Lindas terrace houses are arranged on an east west axis with large windows to the south to make full use of passive solar gain. The heat recovery system works by heating supply air with the exhaust air in a heat exchanger. This in combination with heat given off by occupants, electrical devices and lighting, creates a comfortable indoor environment. The heat exchanger can be turned off in summer and the house ventilated with only exhaust air and opening the windows ("Explore Scandinavia").

4

The particular house I visited was undergoing a period of monitoring. Freestanding black cylinders gave off heat to simulate the heat given off by a human occupant, and the indoor temperature was being measured and recorded periodically to check whether in fact the conception of houses without heating systems do maintain a comfortable indoor air temperature. Despite the fact that it was a fairly cold autumn day, to counteract the added heat injected into the place by a group of visitors, all the windows and doors had to be opened. Aesthetically the houses look much like typical Swedish homes – they are clad in timber, painted black and are two storey with a pitched roof.

There is no obvious external means of identifying them as sustainably designed dwellings. The intent here is to give the message that to live sustainably, it is not necessary to change your whole lifestyle or pay a lot more money. Neither is it necessary to live in an aesthetically very different house with the perceived social stigma and/or status that may be attached to such a dwelling.

These two examples, one where aesthetics are governed by the elements of sustainable design and the other where the sustainable aspects are hidden and disguised, do not represent exclusively the possible approaches to the aesthetics of sustainable design. For example, the development of Vastra Hamnen or Bo01 in Malmö, Sweden takes the approach that aesthetically beautiful surroundings contribute to human sustainability:

> "There have been high ambitions to combine ecological sustainability with human sustainability in the shape of good architecture, beauty, social interaction and functionality. The large number of contractors and different types of buildings makes it possible for the area to show a great variety of architectural designs and solutions on sustainable building" (Green Guide Bo01).

5

Bo01 – City of tomorrow is the first step in the redevelopment of a former industrial area into an internationally leading example of environmental adaptation of a densely built urban area (Green Guide Bo01). It consists of 140 ha reclaimed from the sea using cleaned landfill from demolished buildings in the city. As a European housing expo it was on exhibition between May and September 2001and is now fully occupied. It consists of 500 dwellings, a mix of rental, tenant ownership, private ownership and student housing. Taller buildings around the edge of the development protect the centre from wind and all

buildings are offset at different angles so as not to create any wind tunnels. Energy for the district is 100% locally produced and renewable, the majority coming from a wind farm 2km away. Waste is disposed into a vacuum shoot system and piped to a recycling plant off site. The site operates on a district heating and district cooling system. The district cooling system is of particular interest in terms of the possibility of its application in Australia. Water is cooled to 4 degrees centigrade and piped through the buildings around the district.


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I found it a very pleasant, visually appealing and uplifting area to walk around. There is much interest to be found in the diversity of architectural styles and while some might say it looks disjointed, it disproves the idea that sustainable design creates a certain aesthetic. Here various architects have been able to design housing across a diverse range of styles and all with the same goal of sustainable living. The architects had to make sustainable living as comfortable and pleasurable as the non-sustainable because "people are governed by their emotions as much as by their intellect . . . [therefore], when environmental technology is shaped with conscious design and when the eco-buildings show examples of stunning architecture, the sustainable alternative becomes a sensory delight" (BO01 – architecture and sustainability).


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Perhaps one reason as to why many architects find sustainable design objectionable is, as Ryghaug points out: "The eco- and energy-friendly architects are not the trend-setters of the

profession. On the other side, those who are trend-setters do not design particularly energy efficient and ecological buildings" (4). Foster and Partners, however, seem to have become 'trend setters' through their approach to sustainable design – their use of technology and innovation. Foster explains their "fascination with inquiry, with going back to first principles to identify whether there is an opportunity to invent, or re-invent, a solution. He goes on to say that,

> ". . . While we frequently explore the newest technologies to find appropriate solutions, we frequently also seek inspiration from forgotten traditions: the use of natural ventilation, or finding ways to reflect natural light into an interior space, for example" ("Architecture and Sustainability").

Edwards writes that "Technology holds the key to architecture's green future" explaining that "The role of technology is to bridge the two worlds of social advancement and ecological harmony" (83).

The Reichstag in Berlin, the City Hall in London and the new headquarters of Swiss Re also in London, are all Fosters' projects and all examples of high-tech sustainable design. While they are not necessarily easy to identify as sustainable buildings at first glance, they are easily identifiable as Foster's projects.

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The original Reichstag of the German parliament was opened in 1894. It was partially destroyed by arson in 1933 when the socialists seized power, was rebuilt after WW2 but not used as a government building, was reinstated as the parliament building when it was decided Berlin was to be the capital once again and finally restored and converted by Foster and Partners, re-opening in 1999 (Bahr 3). The Original building, designed by Paul Wallot, did have a central dome which was demolished in 1954 after heavy war


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damage. Norman Foster basically reinstated this dome in glass thereby fulfilling several functions; it brings natural light into the plenary chamber below, it supplies fresh air and it can be entered by the 'common people' (a symbol of democracy - the voter higher than his servants, the members of parliament). Although the resulting building is a compromise between the many more futuristic versions that Foster designed, and the conservatism of the parliament as client, the outcome is very successful, sensitive and appropriate. Two ramped walkways spiral up the inside of the glass dome, taking visitors to a viewing platform 40m above the ground. Natural light is deflected to the interior via a complex array of mirrors in the centre of the dome. "With its total of 360 individual mirrors, this system provides bright daylight in the plenary chamber ten metres below" (Bahr 11). This cylinder of mirrors also provides ventilation for the debating chamber. "The used air passes upwards via an air extraction nozzle – by thermal updraught – and leaves the building through a central opening in the dome" (Bahr 11)


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By contrast the City Hall in London was purpose built by Foster and Partners for the Greater London Authority (London's government) following a public design competition. The building is 45m high, 10 storeys with 12 000 sq metres of floor space. It stands on

the bank of the river Thames opposite the Tower of London. The concept is a modified sphere "as a sphere has 25% less surface area than a cube of the same volume [therefore] there would be less heat loss from the building during cold weather and less heat gain on sunny days (London Open House). It leans back from the river towards the south, shading itself, and thereby not casting a huge shadow over the open public space of the riverside walkway. "The north facade . . . is fully glazed in order to capture the diffused northern light" (City Hall). Road access is underground for the same reason of preserving uninhibited public open space. Advanced computer modelling techniques were used in the design, each of the glazing panels being unique in shape and size and laser-cut using data from the computer model. It uses one quarter of the energy of a standard office building. Recycled materials are used in many of the fittings and furnishings. The building is cooled using ground water. Two boreholes bring cold ground water up into the building which runs through the ceiling beams and then is used to flush the toilets. In a similar way to the Reichstag dome, a spiral ramp takes visitors through and up the building – the concept of transparency in government being likewise symbolic here.

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While the City Hall building is quite impressive and a unique shape on London's skyline, it looks to me rather like a thumb sticking up out of the river bank. However, perhaps this will diminish with the completion of the developments planned for that South Bank area.

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The new headquarters for Swiss RE is a 40 storey tower under construction in the heart of London's financial centre. It is London's first environmentally progressive tall building. The form (circular floor plates that widen then taper towards the top) is a response to the small site. Parametric modelling (aerospace technology) was used to design the complex curved form. Pedestrian comfort is a benefit of the aerodynamic shape in that wind is not deflected to ground level. Light-wells are formed in the triangular sections of the squared off circular floor plates and they spiral the structure as the floor plates rotate from the ground to the top. The glass of these light wells is tinted, creating a candy stripe effect on the all glass facade. The design combines the use of natural ventilation and air conditioning. For 40% of the year, the mechanical cooling & ventilation supply can be switched off. (Foster and Partners website)

While at face value these three buildings have a similar aesthetic with the curved glass facades, their forms and the range of different technologies they employ are a specific response to their individual locations and functions. Ryghaug suggests that " . . . . dislike of ecological and environmental architecture may be explained by the extensive use of symbols, like solar panels on the roof, discharge water running through reed etc. and the extreme expressions of form that many of these buildings have according to the architects" (5). The danger is of " '. . . technology being used as design criteria, and as trademark'. . . "(Ryghaug 5). In my opinion, these three Foster's projects demonstrate a balance between form and technology and function.

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The danger with technology however is what has been termed the fit and forget principle – the assumption that technology will solve everything so all you have to do is install it and forget about it. An apt analogy given by a speaker at the recent "Green Buildings" Conference in Sydney is that of the intelligent fridge. These fridges beep when the door has been left open for a certain amount of time so now the owner relies on the fridge to tell them when to close the door, whereas before, 9 times out of 10 they would have closed it before the allotted time anyway! (Purdey). So again, in terms of technology versus user control, it's about finding the right balance & educating the user on how to use the building (this will be covered further in chapter 2).

Many architecture firms seem to be jumping on the bandwagon of ESD by adding a few solar panels on the roof of their already designed building and calling it a sustainable building. As society starts to demand more sustainable design, they don't want to be seen as falling behind, however it is often more for show than out of any true sense of ESD. This has been referred to as 'green wash' or light green. Sustainable principles have been explored to some extent but not in a holistic way. As will be discussed in chapter 3, sustainable architecture requires sustainable concepts to be an integrated part of the design process - deep green.

One factor that may deter more architects from designing sustainably is the misconception that pleasing aesthetics and sustainability are mutually exclusive. Ryghaug, in her conference paper, concludes that

> "To make architects more interested in energy efficiency, it is not sufficient to present economic and technological arguments. The arguments should be presented in a way that makes it possible to translate energy efficiency into …… something that is in line with their interest of aesthetics" (6).

CHAPTER 2

EDUCATION – BUILDINGS AS EDUCATIONAL RESOURCES ON ESD

Sustainability affects us all as humans, yet the majority of us don't understand the concept and importance of sustainability. Everybody uses buildings, in fact we spend at least 80% of our lives in buildings (Edwards 51), therefore, buildings themselves can be used as tools to educate their users on the issues of sustainability. This has been recognised already by many architects around the world. Two examples that I observed, and which I will use as case studies, are a secondary school in Norway and a preschool in Denmark which both endeavour to impart the concepts of sustainability to the children who attend the schools.


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Kvernhuset Secondary School in Fredrikstad, Norway is a school in which the building systems form part of the students learning curriculum. It was a Research and Development project supported by the national EcoBuild programme and is part of the municipalities program for Local Agenda 21. It is to accommodate 450-500 students and was due for completion in winter 2002. One of the 4 main objectives in the project was: "The school building and yard should be used as teaching tools to support the Nature

and Environment studies" (Buvik "Kvernhuset"). Buvik explains how this was implemented in the design of the school:

> "Area adaptability, energy saving strategies and ecological cycles are the measures to reduce consumption of resources. The objective is to manifest measures that contribute to sustainability such that the measures have a demonstration and teaching effect" (Buvik LA21).

With this and the economic constraints in mind, three levels were defined. Level one deals with aspects that can be applied to the whole building such as exploitation of natural light, natural ventilation, geothermal heating and natural cleaning of waste water on site (both grey and black). Level two concerns aspects that are not suitable for the whole building (whether for economic or other reasons). In this case, each of the 3 homebase wings emphasise specific issues of sustainability. The yellow wing focuses on solar energy – "active and passive use of solar energy, solar collectors and solar cells, monitoring of energy use" (Buvik LA21). The green wing focuses on growth and recycling of materials – "vegetables and plants, inside and outside, ecological cycles" (Buvik LA21). The Blue wing focuses on water – "collecting water from the roof, water saving armatures in toilets and wash basins" (Buvik LA21). Finally, Level three "deals with devices which facilitate ecology studies (terrarium, aquarium, apparatus), and art decorations to highlight ecological aspects" (Buvik LA21).


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As much as 60% of the external wall is double glazed to maximise the amount of natural light. Half of these are insulated with a semitransparent polycarbonate material called Isoflex, between the layers of glazing. Skylights also contribute to the light airy feel of the building. Parametric modelling was used to find the best ratio between clear glass


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area, isoflex area and skylights that gave high levels of natural light but the lowest possible heat loss from the building. The remaining 40% of external wall is clad in timber from the site itself. Stones from the site are also used in the construction to add thermal mass to the ground level administration areas. These stones are contained loosely in cages – no mortar or cement to bind them together, so at the end of the building's life, the walls can be easily deconstructed, returning the stones to their former state on the site. This concept of "Think globally, Act locally" is the mantra of Local Agenda 21. To achieve successful sustainable design and the objectives that were set at the beginning of the project, it was seen as essential that the teachers were included in the design process. This theme of integration of ESD principles from the beginning of the design process and the involvement of stakeholders will be expanded in chapter 3.

The Stenurten Kindergarten in Copenhagen, Denmark addresses the role of ESD education at a different level. It is situated on a narrow site in a city context. Like Kvernhuset, education on sustainable building systems was one of the initial aims of the design.

> "In the building, low-tech' solutions are emphasised enabling children and adults to participate if the air needs refreshing, heating needs adjusting, lights need switching on or if the combustion heating needs to be lit. There is a display where children and adults can read the energy consumption of the building"


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The building is angled towards the sun to maximise warmth and natural light from the sun. The single loaded 'corridor' which runs the length of the long southern facade doubles as an atrium. It collects the warmth from the sun in winter and the warm air passively warms the classrooms that are accessed off the corridor (and less so the service zone situated at the rear (north) side of the building). In summer, warm air that builds up in the atrium/corridor can be exhausted through openings in the top before it reaches the classrooms. The sedum roof serves to regulate temperature (acts like thermal mass on the roof) and also reduces the hard surface area of the building. Mechanical ventilation assists the passive measures during months of extreme cold. The heating ducts are integrated into timber benches that run the length of the glazed side of each classroom. Therefore the heat is dispersed where it is needed – at people level, and can be exhausted by the same system as the passive ventilation. The added advantage of the system being at people level and integrated into something they sit on, is that it is obvious and therefore of educational value to the users of the building.


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It is my belief that there is anurgency to implement sustainable practices such that we cannot rely on educating only the younger generations, whose knowledge and enthusiasm will take years to become influential. General knowledge of

sustainability is required now across all levels of society. To this end, Expos provide a method of presenting information and education to the masses. Bo01 in Malmö, Sweden and Floriade in Amsterdam, The Netherlands attracted millions of visitors and both had a sustainable angle in presenting their respective exhibitions.


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As discussed in chapter 1, Bo01, the European housing expo in Malmö, Sweden was on exhibition between May and September 2001. During that period of time, visitors could participate in study tours, obtain advice and information, look at exhibitions and attend seminars on sustainable living. Now that the district is occupied, the educational aspect continues with residents in a number of houses being able to monitor and regulate their use of water, energy and ventilation via their home PC. A special web-tv channel will then give them access to the overall statistics of the district plus information on what else they can do, with the aim of generating debate and discussion between residents.

Floriade is the world horticultural exhibition held every 10 years. In 2002, The Netherlands was the host of the 5th Floriadewhich I was fortunate enough to be able to visit during my study tour. On a 65 hectare park, a short distance from Amsterdam, every aspect of Dutch horticulture was showcased, from fruit and vegetables to flowers, shrubs and trees. Sustainability was a theme that ran throughout the displays – in particular, 'The Green City' area. Here there were educational exhibits


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on various aspects of the environment and the future e.g. Wonderwaterland – a multimedia journey through the history of Dutch water management.

The roof of the exhibition building was covered with more than 19 000 solar panels – the largest solar energy installation in the world to be integrated into one roof (which is bigger than 4 football pitches)! It had the capacity of generating 2.3 MW, enough for all the park's energy needs during Floriade (6 April – 20 October).

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Public buildings are also being used to educate the public on sustainability. Peckham Library is a 5 storey building in a suburb of London that was part of an urban regeneration project. It takes the shape of an inverted L in section. The brief called for

> ". . . a thoroughly modern building that is ahead of its time but does not alienate local people by giving an appearance of elitism, strangeness or exclusivity. Local people must be able to relate to the architecture and design as well as the service provided and they should feel pride in, affection for and ownership of the building" and called for "flexibility of use, adaptability to the ideas of future generations and accessibility for all" ("Peckham's fun palace").

One enters the building under the 12m high overhang into the foyer and community information facility at ground level. A glazed lift and staircase provide access to the upper floors where the Library is located. Within the library space, there are three pod

shapes supported on tripods. The central one is open and houses the Afro-Caribbean literature section. The other two are enclosed and puncture through the roof– one being a children's space and the other a meeting room. Both are clad in airplane ply which is stapled on.

The place where most people spend the majority of their time is the workplace. This is therefore a major opportunity for education in action about sustainable practices. Frequently office buildings are inefficient, relying heavily on air-conditioning and artificial lighting. Often they are speculatively built by developers where short-term economies outweigh long-term building efficiency. Having said that, as Edwards points out in Rough Guide to Sustainability, "Sustainability has altered the design of offices arguably more than any other building type" (89). Tower Place, an office building in London by Foster and Partners and the PowerGen headquarters in Coventry are both unique examples of sustainable office buildings.

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Tower Place, located next to the Tower of London, is unique in that it is a speculative office building where sustainable design was a criterion put in place by the developer! The process has been protracted (started in 1992) and not always smooth. I visited the building 3 weeks out from being occupied. In plan it consists of 2 rounded triangular shaped buildings. The huge glass atrium in the space between the buildings will accommodate two trees, each three storeys in height. The design was heavily constrained by planning conditions such as maintaining existing pedestrian rights of way through the site, which determined the plan, and maintaining view corridors between St. Pauls Cathedral and the river Thames, which determined the

roof shape. It has a sophisticated mechanical ventilation system where air is pumped into floor plenum and extracted through the light fittings into a void above the suspended ceiling. There is no duct work under the floor, relying instead on air pressure and convection to move the air. The temperature is controlled by computer – controlled in zones. For example, the strip around the windows is separately zoned from the main space so that any fogging up of the windows can be avoided without affecting the overall temperature of the space. To keep a consistent facade treatment on all sides of the towers, sun shading blades are used throughout. They are deeper on the south and narrower on the north so as to maximise floor space and provide effective sun shading.


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The headquarters of PowerGen is unique. It is the offices of one of the 3 major electricity generating companies in England and Wales. The building, which was completed in 1994 and now accommodates 600 employees, aims to minimise the use of the product is sells! It has a long narrow floor plan on an East-West axis. Each floor consists of two parallel floor plates, 12m deep, separated by a central atrium. The offices are open plan along these floor plates with centralised facilities at the ends. There is a combination of user control and a sophisticated building management system. Each floor has


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3 parallel rows of windows – the lower two can be opened by staff, the third one is controlled by the building management system (BMS). The BMS also controls the lights. A certain amount of user control of the internal environment was recognised as contributing to employee satisfaction and therefore productivity. In this situation it may be necessary to provide training to the employees on the operation of the building systems. At PowerGen, they have a hybrid system – a BMS with manual override. A full time Facilities Manager is on site. One of the roles of the Facilities Manager is to decide when to switch from user control to BMS (notifying employees to close their windows via email) and vice versa.

In a residential situation, however, it is more usual for low tech passive solutions to be employed, relying on user control to operate efficiently. As a result it could be argued that the elements of ESD need to be more obvious to allow users to understand and thereby control their environments. Or, in fact, that they should be provided with a user manual on how to operate the building, much like an appliance. As suggested at the "Green Buildings" Conference we shouldn't assume that because someone occupies a building that they know how to use it (Purdey). The example of Torvetua in Bergen, Norway shows that the inhabitants of this ESD housing community have been educated by the experience of living in these residences and in some cases actually altered their lifestyles to be 'greener'. This is not a project I visited but the paper presented at SB02 by Eli Stoa deals with the question: "How have the environmental goals affected the experienced housing quality and the inhabitants' attitudes and behaviour towards the environmental aspects?"(Stoa). Torvetua is designed by Architect Bjørn Eik and the main elements of ESD are:

- "Preservation of existing vegetation and landscape;
- Cycle based sewage purification plant (e.g. treatment of wastewater by soil infiltration);
- Use of healthy and environmentally friendly building materials (e.g. heartwood outdoor cladding with no need for surface treatment);

- Car-free neighbourhoods (common parking areas in the outskirts of the housing area)
- Source segregation and composting of household waste" (Stoa).

A survey of residents was conducted and the result was as follows:

> "Many inhabitants answer that they have changed their attitudes after moving to Torvetua. In particular they have become more conscious of the significance of establishing satisfactory common solutions, of the use of building materials and of their own consumption of resources"(Stoa).

In this case, the buildings have proven to be an effective educational tool on the principles of sustainability.

I was impressed, when visiting BedZed, with the extensive educational display that forms part of the complex. It was the architect, Bill Dunster in conjunction with BioRegional who established the BedZed Centre which houses an exhibition, show home and seminar space as a resource for anyone who wants to find out more about the development. Also, like Torvetua, the sustainable ideals of BedZed extends beyond the building itself to the overall way of life. A 'farm shop' in the village square at the heart of the development allows residents to order organic produce, there is a community composting scheme which complements the on-site recycling facilities and as mentioned in chapter one, the residents are encouraged to use the Zedcars electric cars in preference to fossil fuelled cars.

As society starts to demand sustainable design, we as architects need the expertise. Architecture schools are embracing the subject. Hyett in Rough Guide to Sustainability points out that " . . .the institute [RIBA] recently introduced *ecological sustainability* as a topic to be incorporated into the new criteria for validation documentation that is issued to schools seeking to gain and retain validation" (17).

Some institutions are creating an entire degree based around Sustainability. In Norway, in recognition of the vast number of issues involved in ESD, they are developing the idea of an Sustainability Engineer, as a profession in it's own right to guide society in becoming more sustainable: This is "a new 3-year study programme at Oslo University College, Faculty of Engineering. "We have seen the need for a new kind of engineer to help society reach its goals regarding sustainability in buildings. This educational

program is a direct consequence of the external demand for sustainable buildings" (Berre). Engaging ESD consultants is becoming the norm in Architecture practices now. A couple of reasons for this is the complex nature of ESD which requires specialised knowledge and secondly, that architects cannot hope to acquire that specialised knowledge in the time frame necessary, considering the fast pace of change in the area of ESD. ESD consultants in many cases come from a mechanical engineering background.

Beyond university education the traditional ways of reaching the architectural profession is through conferences and seminars etc. The problem tends to be that architects who attend ESD conferences and seminars are those who are already interested and have some experience in ESD. Ryghaug quotes an employee of the EcoBuild programme "it has been particularly difficult to reach the realm of architects and that one only reaches those who are already interested" (3). This is evidenced by the recent "Green Buildings" conference held in Sydney where I was one of few, if any, other architects among only 41 delegates (25 of whom were presenters/chair people/panel participants).

Assuming that the information from conferences and seminars is taken back to the practice situation, it is another thing altogether turning that research into action.
"It is well-known that many findings from ongoing research are not used in practice although they are available" (Eden & Jonsson)

Many architecture firms have found that Pilot ESD projects are a good way of increasing knowledge of ESD principles – the idea of learning through doing, or problem based learning(PBL) that many university architecture courses now utilise. Anna Lindstad of Sinclair Knight Merz (SKM) in Melbourne presented a paper at SB02 on their recent Pilot Green School:

> "Increasingly expertise in ESD is perceived to be important as a marketing edge. Sinclair Knight Merz, originally an Engineering Consulting firm established over 30 years ago, has recognised the importance of ESD for the future and decided to document a pilot Green School as internal 'research and development' in a parallel process to the standard brief from DE&T, one of our major clients" (Lindstad).

As was the case with Kvernhuset secondary school in Norway, SKM realised the importance of school children learning *from* the buildings they learn *in*:

> "Providing models of environmental responsibility in school buildings is vital to set a good example for future generations. Students can experience and monitor the benefits of ecologically sustainable development (ESD) through the buildings and environment in which they learn. This paper explores the 'Green' design and development of a new school in Melbourne by Sinclair Knight Merz for the Department for Education and Training (DE&T)."

Does the answer lie in legislation requiring ESD? The danger is that it is seen as just another bureaucratic hoop to jump through and that it becomes an impediment to innovation. However, there seems to be a general consensus that government has a responsibility to drive the uptake of sustainability whether that is formally (through building codes and council regulations) or informally (through procurement policy and appropriate cost signals i.e. appropriate pricing for fossil fuel based energy and rebates for renewable energy initiatives). But is legislation a failure of education? According to Delwyn Jones, Department of Public works, Queensland, legislation in Australia these days is introduced as a last resort (Jones). So although the days of the big stick might be gone, the days of the big carrot are not!

The government can encourage ESD through policies which give incentives to design sustainably. For example, in Canada, it is the building owner who is eligible for a financial incentive for an energy efficient building therefore it is the client who is driving the architect to design sustainably:

> "The Commercial Building Incentive Program (CBIP) was one of many programs that was initiated in 1998 as a direct response to the Kyoto Protocol. . . . The objective of CBIP is to encourage the incorporation of energy efficient measures into the design and construction of new commercial, institutional and multi-unit residential buildings in order to contribute to the reduction of GHG emissions in the commercial sector. Building owners are eligible for a financial incentive if their building design is at least 25% more energy efficient than a similar building built to the level of the MNECB, which specifies minimum energy performance standards for the construction of new buildings in Canada" (Cinquino).

Other examples include France where they actually have a law called the "Land management and sustainable development act" and in the Netherlands, there is a law against dumping of re-usable building waste (passed April 1997)

In Australia this year, minimum energy performance standards for all new and refurbished buildings will be introduced into the Building Code of Australia (BCA) (Reardon 1). In Europe all buildings are designed by an architect whereas only 2% of Australian houses are architect designed. Most Australian houses are designed by Building Designers, and professional rivalry exists between them and Architects. However to date, the Building Designers, not architects, have taken most initiative in promoting sustainable design in a practical and accessible way. They have developed the *Your Home* publication and in conjunction with the Green Building Council of Australia (GBCA) have been running a series of seminars around the country, now in it's 3rd year.

> "*Your Home* . . . . is intended to break down the complexity of sustainable theory and ease it into mainstream home building practices allowing industry to absorb it at an achievable pace. Whilst Your Home identifies and recommends best practice in every case, it also encourages partial implementation of all principles at every opportunity and encourages participation over perfection." (Reardon 3)

In doing the research for this publication, it was observed that:

> "Many consumers had little knowledge of environmental sustainability or why it was important to the local or global community. Others had substantial awareness but believed that sustainable features were too expensive or unavailable to them." (Reardon 3)

Meanwhile, for the commercial building sector,

> "The Green Building Council of Australia (GBCA) is currently producing an internationally recognised rating tool for commercial buildings in Australia. It will provide both a common language for sustainable development and a tool to recognise best practice achievement. A pilot version for new and existing commercial buildings will be launched in July 2003" (Lindstad "Environmental Weighting").

More will be said about this and other tools in chapter 3.

The role of architects in educating their clients on issues of sustainability is clearly stated in the Union of International Architects code. Clause 2.1 in the Union of International Architects (UIA) code states that

"Architects shall . . . . .strive to improve the environment and the quality of the life and habitat within it in a sustainable manner, being fully mindful of the effect of their work on the widest interest of all those who may reasonably be expected to use or enjoy the product of their work" (Edwards 16)
Unfortunately this is a voluntary code of ethics, it is not enforceable.

The media also plays a significant role in the promotion of, and education in, ESD. A lot can be learned from case studies of green buildings. This not only promotes ESD but is also a marketing tool for the practice. The Gardsten solar house project in Gothenburg, Sweden have taken this a step further and actually produced a children's fairytale based on the real events of the project, from community consultation and the building process to minimising waste on site and providing jobs and training opportunities. Following is an extract from this booklet that can be enjoyed by adults just as much as children!:

> " . . .Small wonder that the Enchanted Forest had got a bad reputation, the Witch thought. In actual fact it was becoming depopulated. But there was going to be some changes, if she had anything to do with it. Let's see now ... What could persuade people to move into the area?
>
> The answer came to her suddenly. Build gingerbread houses! It couldn't be more ecological. All the materials were recyclable. And the houses would be irresistible, as she knew from experience. It would need dough, of course. Lots of dough. But no doubt the gnomes on the board could see to that " (Fransson, chapter 1).

To conclude this chapter, it can be seen that buildings themselves, whether schools, public buildings, offices or houses, can be effective tools to educate people on the principles of sustainability. While universities, conferences, pilot projects, legislation, architects and the media can all have some influence, as Hyett writes in Rough Guide to Sustainability "Ultimately, only society can require sustainable design; architects cannot impose it and the professions cannot regulate it" (17).

CHAPTER 3

INTEGRATION – IS AN INTEGRATED DESIGN PROCESS THE KEY TO SUCESSFUL SUSTAINABLE DESIGN?

An 'Integrated design process' (IDP) is one where the principles of good environmental design are fundamental to the design process, not tacked on at the end. In a broader sense, integrated design also refers to the involvement of all actors or stakeholders (owners, users, building managers, developers, contractors, designers, manufacturers etc) in the design process from the beginning and also the integration of the building within its wider planning context. I want to discuss these three aspects of integrated design and its application to some of the projects I visited.

The linear nature of the traditional design process is at odds with the concept of the integrated design process. In the conference paper entitled "IEA Task 23: Integrated Design Process (IDP) Guideline and Navigator" Lohnert et al acknowledge that "The traditional [design] process is related to the setting of task performances, generally in connection with corresponding fee structures ……. essentially linear in nature" (2). And also that

> "Unfortunately, procedures and/or decisions frequently take place during the crucial transition phases from design to construction and from construction to operation, that are at complete variance with integrated and sustainable design goals"

Similarly, Addis, in his paper entitled "Delivering sustainable construction" points out that "Environmental and sustainability advice to projects is often made at the design stage, rather than earlier". He sites two disadvantages of this scenario:

- "The project team and management structure may have already been set up in ways that make it difficult to achieve the client's sustainability aims.
- Sustainable technologies and design advice can often be removed from a project when it moves into the construction phase because of the considerable influence of contractors, project managers and others who are keen to reduce costs". (1)


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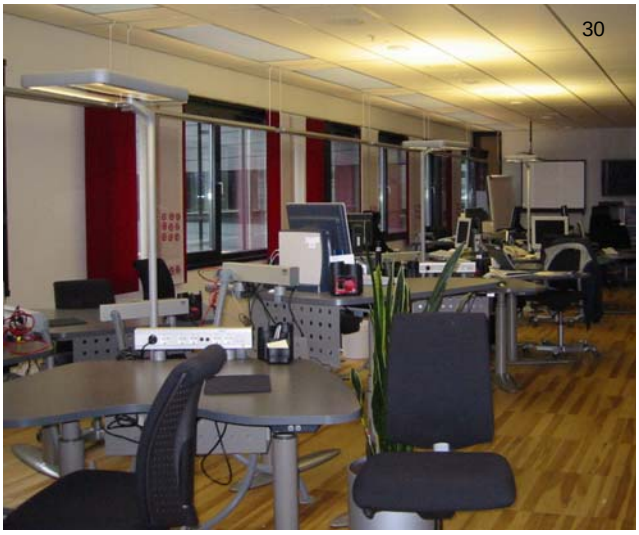
The Headquarters for the Norwegian telecom, Telenor, is an example of a project where principles of ESD were integrated into the design process from the beginning. Like Bo01 in Malmö, Telenor is part of a new urbanisation development based on sustainability. The site at Fornebu was previously the Oslo International airport, which was relocated in 1998. The Telenor offices will accommodate 7500 employees, however only two thirds of them at any one time. The idea here was that "more efficient area utilization leads to reduced consumption of energy and material savings in operation and maintenance" (Sund). With current work trends such that more employees are working partly from home and/or spending large amounts of time out of the office on work tasks elsewhere, the architects of Telenor saw the opportunity to have maximum flexibility designing *all* workspaces as 'hot desks'. Employees have their own 'zone' but nobody has a permanent desk. Lockers at the entrance to each zone are provided for employees' personal items and they have the opportunity to sit at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a different desk each day if they so choose. The idea is that each employee will have their own laptop and mobile phone which they connect up to the multi-function power board incorporated into each workstation. Ultimately, a reduction in space means reduced consumption of resources.

To promote an integrated design process at Telenor, strict regulations were set for both contractors and suppliers at the beginning in order to achieve the ESD goals. These formed 5 main environmental issues/targets as follows:

> "1. Environmental considerations will be central to the choice of materials
> 2. Today's area consumption to be reduced by 40%
> 3. More than 50% of the total energy consumption will be covered by a local renewable source, i.e. the use of sea-water
> 4. 90% of all waste must be separated at source during the operating phase, during the construction phase the corresponding figure is 70%. The total amount of waste must not exceed 25kg/m^2 during the construction phase.
> 5. All managers from enterprises that perform construction work for Telenor Eiendom Fornebu AS must go through a half-day course of HSE and external environment, held at the construction site" (Sund)

IDP also relies on the involvement of all actors in the development throughout the design process. Ornth, in his conference paper entitled "German Guidelines for Sustainable Building", explains that :

> "the design team should consist of experts from the various disciplines under the leadership of the planner responsible for the overall coordination, and they should work closely together towards the aims of sustainability. . . . to a large extent, the cost-effective decisions will have been made during the definition of the programme and the initial concept phase. The same is also true for the impact to the environment" (Ornth, abstract).

Another paper presented at SB02 entitled "Mainstreaming integrated Design: A Real-World Energy Performance Analysis Approach" by Ehret & Hepting, suggests a couple of reasons to explain why there has been such a slow uptake of integrated design: "the industry's reluctance to deviate from the 'way designs have always been done' [and] the perception that the approach is too expensive and that it will slow the design process"

(Ehret & Hepting 1) as it "typically involves a staged analysis with several meetings of the design team". (Ehret & Hepting 1)

"Negotiating a Green Mindset" a conference paper by Batshalom and Cohen support this view: "…the primary barrier to integration or implementation is . . . the mindset of the many stakeholders who drive the decisions during the design process" (1). Misconceptions about cost and the perceived challenge to 'business as usual' are also cited as barriers, as well as "short term thinking, assumed liability risks, externalities, valuation, the threat of new or different processes. . ."(1). ESD needs to be seen as an opportunity rather than a threat. We are starting to see quantitative evidence that ESD makes good business sense. The question now is, from a business point of view, can we afford not to pursue ESD? An example that would suggest a negative answer to this question is the new Police HQ in Parramatta. It is aiming for a 4.5 star ABGR energy rating. Once the tenant has moved in, if the rating shows that the tenancy is operating at the required 4.5 stars but the base building is performing at less than that, they have the contractual right to negotiate the rent!

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Both Kvernhuset secondary school in Norway and the PowerGen Headquarters in England are examples of projects where the majority of stakeholders were involved in the design process. For example, Buvik says of Kvernhuset that:

"The planning and building process for Kvernhuset secondary school has involved not only skilled workers, craftsmen, engineers and architects, but also the pupils of today and tomorrow, teachers, parents and politicians. Through influence everyone has been able to contribute to the shaping of this school. (Buvik "Kvernhuset")

In fact, some of the teachers themselves were involved in giving our group the guided tour of the building. The understanding of how the building works and a sense of pride

in and ownership of the project was evident among the teachers which will be invaluable in the classroom situation.

O'Niell et al on the PowerGen Headquarters claim that:

> "This building is a good example of the blending of architectural and engineering design solutions. This was achieved through a committed team effort which concentrated on providing an integrated design solution" (O'Niell 7).

The building struck me as a very simple design solution. For example, the integration of lighting, acoustic insulation, smoke and fire detectors and PA system within the ceiling coffers. These coffers are elliptical in section, 2.4m wide and span from atrium to external window. Housing the services in this way allows the concrete soffit to remain exposed, providing effective thermal mass to the office space. An added benefit is that they also provide some sculptural interest to the ceiling, emphasised by the uplighting. (O'Niell 4). In my opinion, this is a perfect example of finding a balance between function, form and technology.

My impression, however, is that many architects see the IDP as 'designing by committee', which can often result is a series of compromises, and therefore there is a lot of resistance to it. As with any new way of approaching things, a high degree of scepticism is inevitable, and proof is required to justify it. The result is that often the architect is forced to justify every individual element of the design which goes against the principle of IDP. Paul Sloman of Arups in his presentation at the "Green Buildings" conference stressed the importance of the whole building approach. "Avoid death by one thousand cuts" he warned, "the whole is greater than the sum of its parts". (Sloman)

IDP requires a fundamental change in the way architects and the construction industry operate and technology is being used to facilitate this change. Computer technology has not only had an impact on building techniques and building design but now on the process of design itself. There are numerous environmental management tools and building assessment tools that have been (and are being) developed around the world. There are the generic environmental management tools such as Life Cycle Analysis (LCA) and Environmental Management Audit Scheme (EMAS) (which will be covered later) and then there are the specific ones designed for particular building types in particular countries such as BREEAM for office buildings in the UK and LEED™ in the

USA. According to Liu & Prasad in the conference paper entitled "Explorations of a Generic Vs Regional Specific Indicator Framework for Green Building Assessment: Including example from N. China":

> "Green building assessment has been acknowledged as one of the most effective ways to encourage green building development. Different assessment tools and methods have been developed since 1990. From 1998, methods of establishing an international generic framework that can be used to compare the different assessments and to produce regionally specific styles have been explored internationally". (Liu & Prasad, 1)

Edwards, in Rough Guide to Sustainability cites four of numerous benefits to the construction industry as a whole in utilising these tools:

- "developers can promote the high environmental performance of their buildings and thus increase sales;
- designers can quantifiably demonstrate the environmental achievements of their work;
- landlords can audit the property from an environmental point of view with the aim of making cost savings; and
- employers can reassure employees that their working environment is healthy and of high quality" (57)

Some of the common and reputable tools include:

- BREEAM (Building Research Establishment Environmental Assessment Method) is the tool most commonly used by architects and designers in the UK for office buildings. It allows different design strategies to be compared before construction begins, based on a scoring system. Edwards describes it as "comprehensive yet simple to use" (56).
- LEED™ (Leadership in Energy and Environmental Design), is the U.S. based rating tool. Assessment is made based on six categories: "Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, and Innovation & Design Process" (Lewis & Miranda 1).
- CASBEE-J in Japan (Comprehensive Assessment System of Building Environmental Efficiency) considers the environment as a closed system and is quite scientific in its approach. It is based around an equation: BEE=Q/(6-L)

where Q is building environmental quality and performance and L is reduction of building environmental loading. (Murakami et al 1)

- MEDIA (Modelling Environment for Design Impact Assessment) is a computer based model developed in The Netherlands.
- Green Globes - a Canadian based online methodology designed "to provide a report that building owners and managers would find useful" (Skopek 1).
- GBTool (Green Building Tool) was developed jointly by 18 countries and has been evolving since 1996. It is managed by iiSBE (International Initiative for a Sustainable Built Environment).

It has been suggested that an IDP is necessary in order to achieve the rating desired on a building. The Lewis & Miranda paper entitled "Impacts of a Green Building Rating System on the Design and Construction Process: A Summary of Ten Projects Using LEED™" was that:

"unless the design team *integrates* the various sustainable design measures, the cost of achieving the desired level of LEED™ will be higher than otherwise. However, the required types and degrees of integration of "whole building" issues are foreign to standard design practice in the US, and require substantial attention to be successfully achieved" (Lewis & Miranda 2).

In Australia, in terms of rating tools, there is NatHERS (National Housing Energy Rating Scheme) which as the name suggests, is specific to housing and energy consumption. It gives a star rating of between 1 and 5 stars. The ABGR (Australian Building Greenhouse Rating) scheme is a similar tool but for commercial office buildings only at this stage and concentrates exclusively on energy consumption. "It is based on the measured energy consumption of a building or tenancy over a 12 month period" (Clark, 5). NABERS (National Australian Building Environmental Rating Scheme), is in the process of being developed by Environment Australia and is also based on a star rating out of 5 in nine environmental performance categories. The development of this tool began two years ago with a review of around 60 tools worldwide and NABERS will be formally launched in September 2003. The ABGR forms one section (the energy component) of this new tool. In addition, Sinclair Knight Merz, in conjunction with the Green Building Council of Australia is currently developing an Australian version of BREEAM. It will be:

". . . an internationally recognised rating tool for commercial buildings in Australia. It will provide both a common language for sustainable development and a tool to recognise best practice achievement. A pilot version for new and existing commercial buildings will be launched in July 2003" (Lindstad. GBCA).

Despite the fact that there are so many of these environmental rating tools that have been developed, one criticism has been that they "do not typically use Life Cycle Analysis (LCA) as a tool for credit accounting" (Trusty & Horst 1). In their paper "Integrating LCA Tools in Green Building Rating Systems", Trusty and Horst state that :

> "there is too often a confusion of means and ends, with the means becoming objectives in their own right to the detriment of environmental performance" (1)

For example, points may be given for the use of recycled material in isolation without considering the energy use or green house gas emissions that were generated to create that recycled component. (Trusty & Horst 1).

There is now a trend to develop environmental assessment tools that integrate LCA such as BSLCA-tool in Finland. It does a quick Life Cycle Inventory (LCI), which draws on information that can be taken from other design tools, and produces a Life Cycle Analysis (LCA). The advantage is that it is a staged process:

> "In the conceptual phase the energy use and environmental impacts of different building shapes and structural solutions may be compared. In the following design phase different technical systems are compared using more detailed energy simulations and life cycle calculations. In the detailed design phase it is possible to compare the environmental impacts of system components" (Reinikainen & Laine 1).

Life Cycle Analysis (LCA) is the most well known generic environmental management tool. Edwards in Rough Guide to Sustainability provides a working definition of (LCA):

> "LCA identifies the material, energy and waste flows associated with a building over its entire life in such a fashion that the environmental impacts can be determined in advance" (53).

It is a concept that predates the many building assessment tools and helps in looking at the building in terms of its total lifetime cost – from construction through use to decommissioning. Edwards points out that: "Too often, buildings are measured against

the initial, capital cost, not its operational costs over the 50 or more years of its life, and, more rarely still, the cost which is carried by others (pollution, waste, ecological damage)" (52).

The Environmental Management Audit Scheme (EMAS) is the preferred model in the EU. It has the same basis as LCA but it requires that the environmental performance be made public as well as externally audited (Edwards, 55).

There are also tools for selecting sustainable building products – what has become known as eco-labelling. The Australian online database, Eco-specifier was developed in 2000 with a dataset of 100 products rated in terms of environmental performance. Eco-specifier 2 is due for release onto the market in October 2003 which will have over 1000 products in the dataset and a more detailed and user friendly product information. Material selection forms 10% of ABGR but as the developer of Eco-specifier said at the recent "Green Buildings" conference in Sydney "it shouldn't be about ticking the materials box but about making informed decisions during the design process". (Walker-Morison).

Thermal modelling is a tool that is now quite familiar to projects in Australia and Europe where the whole building or part thereof incorporates passive ventilation. With this technology, thermal performance of the building can be determined from the design drawings. The results can be used to adjust the design to achieve better thermal comfort in the building.

Further, there are the Environmental Indicators and Benchmarks. Environmental Indicators are measurable properties that can be used to determine environmental performance quantitatively and allow comparisons between buildings of the same type. Sigurjónsson et al explain in their conference paper entitled "Environmental indicators for the construction and property sector":

> "Companies and property owners, which are interested in showing their progress in environmental activities and responsibilities, can use indicators to follow up their efforts. . . . Benchmarking is one way to compare progress and results within a company over a period of time, and to compare one company to another" (Sigurjónsson et al 1).

The advantage of indicator analysis, as one conference paper suggests, is that "it acts like a sieve sorting out relevant information which makes it possible to follow changes over time more closely and consequently address the causes for these changes" (Zinkernagel 1). However, it can also be misleading. As another conference paper points out, they don't tell you anything about the quality. The paper entitled "Key factors and indicators – how do we use them?" by Eva Dalmmann uses Malmö Bo01 as an example and illustrates how misleading the use of indicators can be. One indicator is the Green space factor, which measures the ratio of land used for foliage. Dalmmann points out that "This hardly gives you the information needed to grade or evaluate the quality of the yards . . . "(Dalmmann, abstract). Another indicator is the one of energy efficiency which measures used energy per square metre per year. The weakness here, as Dalmmann states, is "A big apartment uses less energy per square metre, since the kitchen and bathroom units are the high consumers. Also, a single person in a huge apartment would result in low use of energy per square metre, even though this would be a person who would set a huge ecological footprint". Thirdly, solar gain is measured by window area per square metre of floor area. Dalmmann's criticism here is that "it doesn't say much about the solar gain at all. Is the building exposed to sun or in constant shadow? Which direction does the apartment face? and is the light in the apartment beautiful?" (Dalmmann, abstract).

Integrated Design, I would suggest, also includes the integration of a building into it's wider context. As Norman Foster states:
"As architects we are rarely given the opportunity to influence the urban environment on the broadest scale through planning an entire city or neighbourhood, but we can improve the environment at a local level by insisting on the need for mixed-use developments." (Norman Foster *Architecture and Sustainability*). The advantage of mixed use developments, as evidenced by BedZed, is that people live, work and shop in the same community, reducing the need for extensive travel – a saving in time, cost and energy.

In The Netherlands, a district assessment tool is being developed to assess a district as a whole in conjunction with the tools that apply to individual buildings. Through the joint cooperation of the Dutch Ministry of Housing, Spacial Planning and the Environment, TNO (Building and Construction Research) and IVAM (Environmental Research), a

"Sustainability-Profile for Districts" (DPL) group has been formed and is developing the DPL tool for "assessing sustainability at district level" (Kortman 1)

True Sustainability relies on cooperation at a regional level, however"...an individual project, linked to an enlightened political initiative, can regenerate the wider fabric of a city." (Norman Foster *Architecture and Sustainability*). I believe this should be the architect's goal.

On the topic of integration within environmental context, it is appropriate to discuss sustainable renovations and adaptive re-use. Sustainable renovation refers to bringing a building up to date in terms of energy and environmental performance as an essential part in any renovation project. This is explained in the conference paper entitled "Environmental assessment of renovation projects", presented by Hansen and Petersen:

> "There is a growing demand for taking environmental impacts into consideration in renovation projects, both because the environmental impact from the life cycle of buildings is considerable, and because the long service life for buildings implies that the existing building stock for many years will dominate the total building stock" (Hansen 1).


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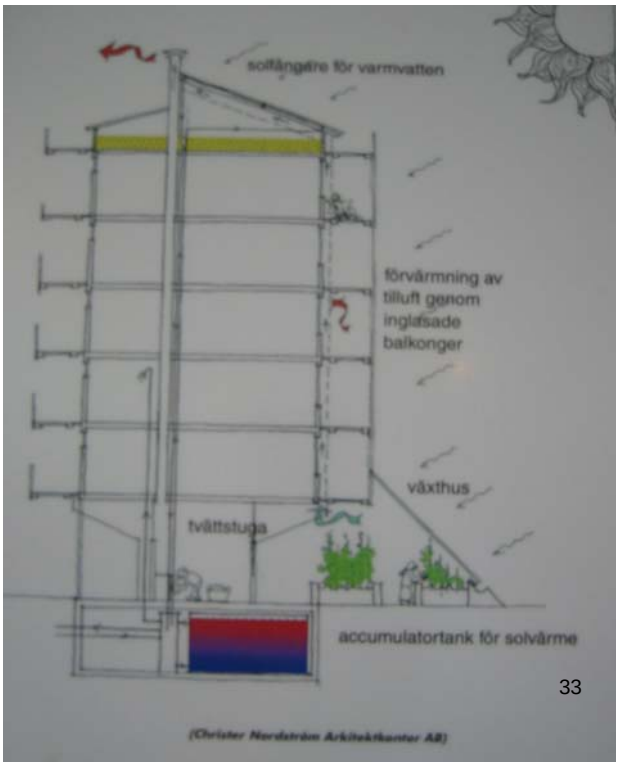
The Reichstag is an example of sustainable renovation – proving that with the aid of modern technology, a historic building can be converted from an energy guzzling building into an energy saving one. Foster writes that:

> "Before the installation of new services the building consumed enough energy annually to heat 5000 modern homes; and raising the internal temperature by just one degree on a typical mid-winter's day

required a burst of energy sufficient to heat ten houses for a year" (Architecture and Sustainability). Now ". . . rather than burning fossil fuels, [The Reichstag] runs on renewable 'biodiesel' – refined vegetable oil made from rape or sunflower seeds. Together with the increased use of daylight and natural ventilation, this has led to a 94 per cent reduction in the building's carbon-dioxide emissions. The building is also able to store and recycle surplus energy, using underground seasonal energy reservoirs. The Reichstag now creates more energy than it consumes, allowing it to act as a local power station supplying heat to other buildings in the government quarter" (Architecture and Sustainability).

This is a remarkable transition and Foster goes on to make the comment that "If a nineteenth-century building can be transformed from an energy-guzzler into a building so efficient that it is now a net provider of energy how much easier is it to design new buildings that make responsible use of precious resources? "(Architecture and Sustainability).



Gardsten solar house project is located in Gothenburg, Sweden and is undergoing renovation of 255 apartments (10 buildings) built in the late 1960's. The fist stage was completed in 2000 and supported by the EC Thermie program. As a result of the renovation, they achieved a 40% decrease in heating demand. The concept for the six storey blocks was to enclose the ground level (previously open as in Le Corbusier's Unité) in order to create a community glazed green house, which in turn heats the balconies by the convection of the warm air produced. The flat roofs were replaced with skillion roofs and extra insulation placed in the cavity thus created. Solar collectors for preheating of domestic hot water were placed on the new skillion roofs which were angled at the optimum for solar collection. A new laundry at

ground level and compost and recycling facility were installed. In the three storey blocks, like the six storey blocks, a skillion roof replaced the former flat roof and extra insulation installed. Extra insulation was also installed on walls exposed to wind. In the extra height gained on the southern side of the building as a result of the new skillion roofs, solar air collectors were installed which then heats the internal spaces by storing the heat in the old thermal mass walls and released into the building. (Nordstrom)

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As the project is being completed in stages, the benefit of visiting Gardsten at this time was the opportunity to compare the renovated buildings with the not-yet-renovated buildings of stage two. In my opinion, it is an excellent transformation both in terms of ESD and visual appearance. Many of the principles, such as replacing the flat roofs with skillion roofs angled towards the sun for solar gain to the rooftop solar hot water system and filling the roof space with insulation, are quite simple but very effective.

Adaptive re-use is a term that has become very common in the architecture and construction industry. Rather than demolishing an obsolete building, a new use is found for it and all or part of the building fabric re-used, saving the financial and environmental costs of demolition. There is often also a heritage or novelty aspect to such projects.

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The Baltic Flour Mill in Newcastle-Upon-Tyne, U.K, now a Gallery of contemporary art and the Grunerlokka student house in Oslo, Norway which was previously a grain silo, are two examples of innovative adaptive re-use both of which I visited.

The Baltic Flour Mill has been a Tyneside landmark for over 50 years. Its structure of four towers and curtain wall in polychrome brickwork has been preserved. The central space, which originally contained a honeycomb of vertical grain storage bins, was gutted and divided into six floors of gallery spaces. (Baltic)

Grunerlokka functioned as a grain silo until 1992. The conversion was completed in 2001 and accommodates 340 students. Prior to the conversion, it consisted of 21 cylindrical silos, arranged in a grid three by seven and rising 40m high on the inside. 16 floors were put in with a corridor down the central row of 'cells'. The 226 housing units are distributed as follows: 22 bedsits (2 rooms each with communal facilities); 165 one room flats (75 furnished for couples and 90 for single students) and 39 two room flats.

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While this project cost in excess of what it would have cost to build a new building, it can be argued that it saves in other ways. Cutting openings in the very thick concrete walls of the silo is both costly and difficult but the alternative, being demolition, would also have been costly with the added problem of finding a new use or way of disposing the thousands of tonnes of concrete. This solution both finds a new use for an iconic structure in Oslo while providing appealing student accommodation (it is now the most popular student accommodation building in the city!).

To conclude this chapter, I want to reiterate Norman Foster's words "For me the optimum design solution integrates social, technological, aesthetic, economic and environmental concerns." (Norman Foster *Architecture and Sustainability*)

CONCLUSION

Sustainability is a holistic approach to human activity which is about minimising use of resources and generation of waste while maximising health, comfort and flexibility with present and future generations in mind. It has the triple bottom line of social, economic and environmental considerations. Since buildings are responsible for 50% of greenhouse gas emissions and use 50% of the world's resources, as architects we have a responsibility to embrace Ecologically Sustainable Development.

ESD is not the next 'style' but a matter of survival. The notion that ESD creates a certain aesthetic is a misconception as has been evidenced by the comparison between the colourful, organic shaped development of BedZed with its sedum roof contrasting with the more traditional form of the timber clad Houses without Heating Systems in Lindas, Sweden. Neither of these projects rely on external sources for energy to heat or cool the dwellings.

In commercial architecture, high-tech ESD solutions offer opportunity for more aesthetic variations. Innovation is an important aspect of improved ESD solutions – finding the balance between aesthetics, technology and function rather than allowing the technology to dictate form. This can be seen in three of Foster and Partners projects, City Hall, London; Swiss Re HQ, London and the Reichstag, Berlin.

To take the notion of aesthetics and ESD further, Malmö Bo01 is developed on the idea that pleasing aesthetics actually contributes to human sustainability through a heightened sense of well being.

It is important, however, to distinguish between sustainable buildings and green wash. Putting a few photovoltaic panels on a building at the end of the design process is not ESD.

For Architects, to whom aesthetics is of high importance, ESD needs to be couched in aesthetic terms, in order to appeal.

Buildings themselves can be used to educate people on the issues of sustainability. The examples of Kvernhuset secondary school in Norway, where the building systems form part of the students curriculum and Stenurten kindergarten in Denmark, where the children play an active role in adjusting the heating and lighting need, are two cases in point.

The time imperative however is such that there is a need to educate all on sustainability not just the younger generation. Expos such as Bo01, Sweden and Floriade, The Netherlands; public buildings for example, Peckham Library, U.K.; offices such as Tower Place and PowerGen HQ; residential developments like Torvetua and BedZed are all great examples of how people can learn about the issues of sustainability through the buildings themselves.

Architecture courses at most Universities have an ESD requirement and some Universities have developed specific degrees in Sustainability in recognition of the complex nature of ESD.

While conferences and seminars on ESD can be very useful and informative, they tend to attract only those who already have an interest, and the information gained is rarely implemented back in the work situation.

Pilot projects seem to be the most effective way of increasing knowledge of the principles of ESD, as evidenced by the Pilot Green School initiated by Sinclair Knight Merz in Melbourne.

While the general consensus is that the government has a responsibility to encourage the uptake of ESD, legislation should be a last resort for fear of impeding innovation however, government incentives can be very effective as has been proven overseas.

Architects themselves have a responsibility to educate their clients on sustainability according to the UIA code of ethics.

The media also has a role in promoting ESD. Much can be learned from case studies of green buildings.

An Integrated Design Process (IDP) is the key to successful sustainable design. IDP involves integrating the principles of ESD into the design process from the beginning. The Telenor HQ building in Norway is an example of a project where quantifiable and reachable sustainability goals were set at the beginning of the project.

IDP also relies on the involvement of all actors in the project throughout the design process. This occurred during the design of Kvernhuset secondary school, Norway and that of the PowerGen HQ, U.K. culminating in a functional sustainable result where people have a sense of pride in, and ownership of, the projects.

The IDP requires a fundamental change in the traditional design process which is essentially linear in nature. To assist this change, there have been many tools developed worldwide. Rating tools such a BREEAM, LEED™, NatHERS and NABERS help to identify and quantify energy consumption among other factors. Life Cycle Analysis (LCA) considers the whole life cycle of the building. For sourcing sustainable building materials there are online databases such as EcoSpecifier. Thermal modeling assists in determining the thermal dynamics of a design and finally Indicators and Benchmarks provide quantitative measures to allow comparisons between buildings. Theses tools can be beneficial but are not without their anomalies.

IDP also extends to integration of a building within its context. Sustainable renovations such as the Reichstag, Berlin and Gardsten solar house project, Sweden show that building renovations provide the perfect opportunity to bring the building up to date in terms of energy and environmental performance. Adaptive re-use is the term given to finding a new use for an obsolete building and converting it rather than demolishing it. The Baltic, U.K. and Grunerlokka student house, Norway are both successful examples of adaptive re-use.

So, in summary, sustainable buildings can also be aesthetically pleasing – it is about finding the balance between aesthetics, technology and function. Sustainable buildings can serve to educate their users on the issues of sustainability, whether a school an office or a home, educating all on the issues of sustainability is of high priority.

Successful sustainable design requires an integrated design process - integrating the concepts of ESD and all actors in the project from the beginning of the design process.

Eventually, “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Edwards 7), will become the norm.

Finally, to conclude, another quote from Norman Foster:
“There are no technological barriers to a sustainable architecture, only ones of political will. The architecture of the future could be the architecture of today.” (Norman Foster *Architecture of the future*)

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