2009-11-17

Sustainable Commercial Interior Design

Órla Keane
Technological University Dublin, orla.keane@tudublin.ie

Dublin Institute of Technology

Sustainable Commercial Interior Design

By Órla Keane, BA (Hons.) Interior Design

A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Science in Sustainable Development

Dublin Institute of Technology

Department of Environment and Planning

Supervised by R. O'Sullivan

November 2009

Abstract

Interior design decisions can no longer be made based on aesthetics and functionality. Designers now have a responsibility to create indoor environments that reflect environmental awareness, environmental protection and the sustainability of the building itself.

Very few resources are available that can aid an interior designer to design in an environmentally responsible way. There is a large quantity of information available regarding the specification of environmentally responsible construction materials, in the design and construction of buildings, but very few resources are available that are focused on the interiors of these buildings (Jones, 2008).

In order for commercial interior design to lower the environmental impact of a building, designers must have a broad understanding of sustainable interior design issues, since they are the people who specify the interior components of a building.

The research question to which this dissertation addresses is:

How can commercial interior design lower a building's environmental impact?

Declaration Page

I certify that this thesis which I now submit for examination for the award of _____, is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

This thesis was prepared according to the regulations for postgraduate study by research of the Dublin Institute of Technology and has not been submitted in whole or in part for an award in any other Institute or University.

The work reported on in this thesis conforms to the principles and requirements of the Institute's guidelines for ethics in research.

The Institute has permission to keep, to lend or to copy this thesis in whole or in part, on condition that any such use of the material of the thesis be duly acknowledged.

Signature _____ Date _____
Candidate

Abbreviations

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
Brominated Flame Retardants (BFRs)
Carbon (CO_2)
Chartered Institution of Building Services Engineers (CIBSE)
Commission on Environment and Development (WCED)
Environmental Protection Agency (EPA)
European Environment Agency (EEA)
Chemical Safety Data Sheet (CSDS)
Compact Fluorescent Lamps (CFLs)
Corporate Social Responsibility (CSR)
British Research Establishment Environmental Assessment Method (BREEAM)
Building Energy Rating (BER)
Building Related Illnesses (BRI)
Business and Institutional Furniture Manufacturer's Association (BIFMA)
Environmental Preference Methodology (EPM)
Forest Stewardship Council (FSC)
Global Ecolabelling Network (GEN)
Healthy Flooring Network (HFN)
Indoor Air Quality (IAQ):
Institute of Designers of Ireland (IDI)
Interiors Association (IA)
International Interior Design Association (IIDA)
International Organization for Standardization (ISO)
Leadership in Energy and Environmental Design for Commercial Interiors (LEED CI)
Life Cycle Assessment (LCA)
Light-Emitting Diodes (LED)
Material Safety Data Sheet (MSDS)
McDonough Braungart Design Chemistry (MBDC)
Medium Density Fiberboard (MDF)
Occupational Safety and Health Administration (OSHA)
Sick Building Syndrome (SBS)
Sustainable Energy Ireland (SEI)
Urea- Formaldehyde (UF)
Volatile Organic Compounds (VOCs)

List of Figures (Illustrations)

1. http://www.greengrowth.org/picture_library/Waste-hierarchy.png
2. http://frogandprincess.files.wordpress.com/2009/04/fsc-logo3.jpg
3. Maximizing Ireland's Energy Efficiency- The National Energy Efficiency Action Plan 2009-2020, Department of Communications, Energy and Natural Resources, ROI. October 2007.
4. Danlers (2008) *Controls for Lighting and HVAC,* Product Catalogue July 2008, UK.
5. Bonda, P. and Sosnowchik, K. 2007. *Sustainable Commercial Interiors.*
6. http://naturalinteriors.us/wp-content/gallery/kirei-wheatboard/wheat-board.jpg
7. http://www.julianos.com/imagescat/carpetunderlay.jpg
8. http://blog.ecolect.net/wp-content/uploads/2007/12/fsc-logo.jpg
9. http://www.speaking-up.com/blog/wp-content/bamboo-flooring-2.jpg
10. http://4bars.com.au/web/wp-content/uploads/2009/05/5220_striato_detail-1-2-mbcrop.jpg
11. http://4.bp.blogspot.com/_yRBN4F4O_XE/SgnZNUEjvyI/AAAAAAAAAYs/AFEWj4VQ48A/s320/comfortflr_office4.jpg
12. http://www.buildinggreen.com/cgi-bin/scale.cgi?width=200&src=/productimages/1587_climatex.jpg
13. http://www.metropolismag.com/webimages/2527/Victor_Innov1_t346.jpg
14. http://www.buildinggreen.com/press/topten2005/Carnegie_PLA_panel_fabric.jpg, and, http://i.treehugger.com/interface.gif
15. http://farm1.static.flickr.com/167/407103768_ae9fdae76a.jpg
16. http://farm1.static.flickr.com/177/407103535_47cd85fa49.jpg
17. http://farm2.static.flickr.com/1084/1183324356_a627d578b0.jpg (2009) [Online]. [Accessed: 31October 2009].
18. http://www.archnewsnow.com/features/Feature6.htm (2009) [Online]. [Accessed: 31October 2009].
19. http://www.archnewsnow.com/features/Feature6.htm (2009) [Online]. [Accessed: 31October 2009].

20. http://www.archnewsnow.com/features/Feature6.htm (2009) [Online]. [Accessed: 31October 2009].
21. http://www.hermanmiller.com/MarketFacingTech/hmc/products/Celle_Chairs/EPS_CEL.pdf (2009) [Online]. [Accessed: 31October 2009].
22. http://www.droog.com/contents/products/multibox/chest_of_drawers_xs_04.jpg (2009) [Online]. [Accessed: 31October 2009].
23. http://www.plushpod.com/images/products/preview/1124.jpg (2009) [Online]. [Accessed: 31October 2009].
24. www.apartmenttherapy.com/.../spring-chair-010048 (2009) [Online]. [Accessed: 31October 2009].

List of Tables

Table of Contents

Disclaimer:

The fire combustibility of products has not been taken into consideration throughout the research. This is a subject worthy of independent research in its own right. Reference has been made to the Class Fire Rating of some products, making use of data extracted from Material Data Sheets. This dissertation also solely investigates the non-structural components of commercial interiors: various furnishings, fixtures and finishes. Therefore, the heating and/or thermal and ventilation components have not been assessed.

I N T R O D U C T I O N

Sustainable Development and Interior Design

"Will we be able to face our children and assure them that we did not lack the courage to face these difficult questions, did not lack the stamina to pursue the correct solutions?"

-Pierre Elliot Trudeau, Prime Minister of Canada 1968-1984

The ability to design well is the ability to problem solve. There are many difficult environmental issues that designers are attempting to solve, yet there exists only a small amount of technical guidance; the problems that are currently facing the natural environment are moral issues. Every designer is faced with challenges in their work when attempting to implement the right design decisions. A good interior designer is a 'jack of all trades'- they must have the ability to master spatial planning, be familiar with the standard components of interiors such as furniture and fittings, have a creative train of thought for putting together visually stimulating schemes and understand the way that spaces are used, just to name a few. In addition to these traits, interior designers must know the tradesmen of the various fields and have a technical architectural ability to communicate with builders and architects. Moreover, interior design is

utilized in almost every industry. Commercial interior design can include hospitality, recreation, corporate, health, education and retail, amongst others. These are all sectors where each requires specific standards in terms of their construction, health and safety, and special requirements. In addition, these sectors require constant updating and refurbishment, since they are public spaces that may often be developed on an ongoing basis. Buildings must adapt to the times, and the design of the interior of the building is no exception. If anything, interior design can be the voice of the building.

Interior designers are responsible for the design of homes, workplaces and public buildings. The sustainability of interiors is closely linked to environmental construction and building design efficiency. It also includes furniture and fitting industries, and interior designers are in a unique position to implement design solutions that are sustainable, which will help lower the environmental impact of their structures as a whole. It is also an excellent communication tool, since a good part of our day-to-day lives are spent indoors; the psychology of interior design and how a space can affect an individual is important. Economically, the commercial world holds a strong emphasis on brand identity and satisfying their client, and businesses can demonstrate their ability to be up to date though visual communication and interior design.

Material Culture and Image

Interior design can become extremely wasteful in commercial areas like hospitality, retail and office design. These areas may also require retention of corporate image, sending out the message that they are on trend, up to date and ‘ahead of the game’ when compared with competitors. Thus, with updating appearances comes a high turnover of waste.

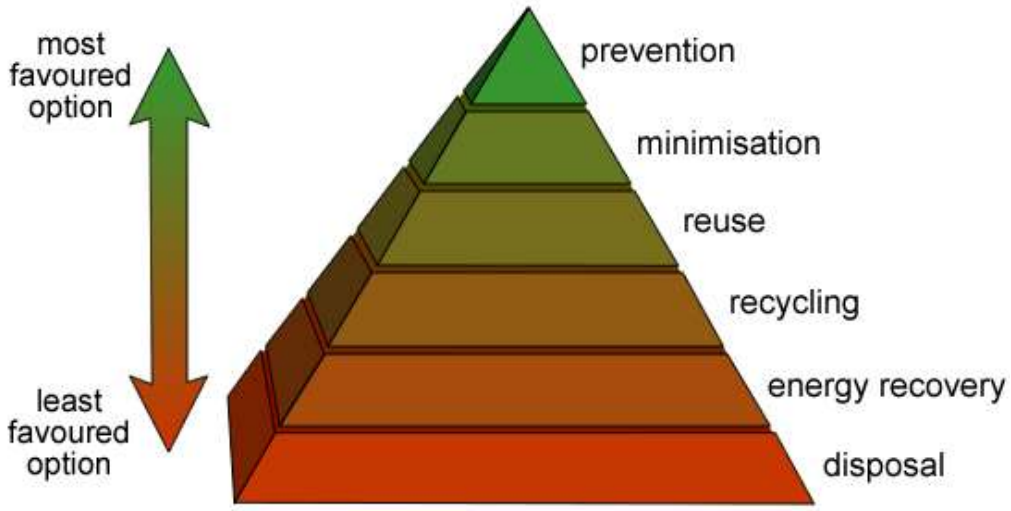


Fig. 1: The Waste Hierarchy

It is important for designers to be familiar with the hierarchy of waste, which begins with prevention (Fig. 1). During refurbishment, it is possible to employ sustainable strategies such as using reclaimed or salvaged furniture, recycled or recyclable flooring, in order to prevent waste. Commercial interior design includes spaces that consumers frequent the most, and attract the most media attention. Therefore, refurbishment can be an essential tool in regard to attracting consumers and media interest, and in turn, aid growth and financial success. Moreover, interior design can also communicate environmentalist values through its design.

However, since the appearances of interiors are regularly updated and reworked, and usually dictated by a trend or specific look (e.g minimal, classical, period, etc.), refurbishment creates new interest and often renders the aesthetics of the previous interior to become obsolete (Walker, 2006). Particularly in commercial interiors, where corporate image is a huge driver of refurbishment. Take for example McDonald's restaurants: in order to take advantage of the mid 90s boom of 'coffee culture', "McCafe" was born, an independent seating area, or 'coffee lounge' that oozed ambiance, decorated in 'coffee and crème' colour schemes. This adherence was to the trends of material culture. Trends have varied life spans, and should they be short-lived,

commercial interior refurbishment can become a cycle based on production and waste.

interior design can also be a powerful tool that can stimulate the market by boosting sales and create competitive advantages. What better tool to use to communicate environmentalism and sustainability? This small step could stimulate interest and progress, in directions that begin to embrace sustainable principles (Walker, 2006). Interior design as a sustainability communication tool is demonstrated in the final chapter devoted to case studies.

A Return to Heritage

At the beginning of the last century, many of our posessions would have been produced locally or regionally, such as furniture, rugs, tools and hardware, or at least in our own country (Walker, 2006). These products were generally built to last, durable and made by locally-sourced materials. Yet at the beginning of the 21st century, very few are made locally, most are imported and the majority are manufactured and assembled in various countries (Walker, 2006).

Architecture in ancient cities was, by its very nature, environmentally responsible (Jones 2008). Construction was based on human labor, raw materials were limited to what was available locally and many hand-built dwellings decomposed back into the natural environment (Jones, 2008). Historically, buildings were built to last, some with exceptional durability. The evidence of this still prevails in Ireland today. From the 17th century thatched cottages to the 18th century Georgian houses that line Dublin's streets, an abundance of historic examples of what life was like in Ireland are still exceptionally preserved. In addition, materials chosen were usually extracted, sourced, and transported with regionally native methods (Jones, 2008).

With the industrial revolution came mass production and accelerated consumerism. Here rose the first appearance of material culture. Before the

industrial revolution, buildings and communities, such as those periods mentioned in Ireland, were built differently. Local resources, both natural and human, dictated what was built and how. Structures were designed based on the understanding of only local materials, local processes, local skills and local traditions, enabling them to become truly integrated within their local environment (Bonda, 2007). These are buildings and communities that are today, often the most desired and envied, for their timeless beauty and quality. Surely these historical principles of sustainable design could be newly embraced and implemented today?

Unfortunately, financial profit is still the dominant influence on designers' decisions, and this is one of the major reasons that change is slow and few decide to stray too far from conventional techniques (Walker, 2006). In addition, cost, aesthetics, availability and durability are all issues that interior designers perceive as obstacles to specifying sustainable products and materials. This dissertation seeks to address these obstacles in order to provide clarity for interior designers. It is the responsibility of interior designers to explore new approaches and new processes that are more integrated, and seek ways in which to implement environmentally-consius decions on a more consistent basis (Walker, 2006).

Sustainable Development

In 1987, the World Commission on Environment and Development (WCED) issued *The Bruntland Report: Our Common Future*, which provided the groundwork for a global sustainability movement (Jones, 2008). *Sustainable Development* was defined as

"Humanity that has the ability to make development sustainable- to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (Bruntland, 1987).

Sustainable Development is development that must not only be environmentally sustainable, but also economically and socially sustainable (Jones, 2008). It is becoming more and more evident in today's world that there is now a 'global ecological debt', where we have used more than our fair share of the Earth's finite natural resources and our behavior is having profound influences on eco-systems and landscapes. Our debt is unevenly distributed, with a higher negative impact being generated by the countries of the north, compared to those of the southern, less-developed countries (Simms, 2005). This creates two crises: ecological debt and foreign financial debt, where the poorer, southern countries lack funding for education and health, and the more industrialized northern countries will feel the greatest effects of climate change (Simms, 2005). If we continue to push ecosystems beyond their ability to renew themselves, the debt will keep mounting (Simms 2005). It appears that our ecological debt in the future will rely on our environmental ethics, when dealing with issues of sustainable development.

Today, there are innumerable pressures on Ireland's environment. Fortunately, the vulnerability of Ireland's natural environment has come under focus more than ever before. Many environmental directives have been brought into Ireland's legislation in the last few decades. They illustrate the actions that need to be taken and they aid in protecting the various different aspects of Ireland's environment. Legislation in Ireland was first introduced to protect the environment when Ireland joined the European Union in 1972 (McWilliams, 2005). Today, pressures such as waste management, water conservation, and energy consumption are some of the most paramount environmental issues on Ireland's national agenda. These pressures on Ireland's environment have developed alongside changes in the Irish lifestyle, where the standards of living have increased with the concept of the 'full-on nation' (Mc Williams 2005), a period which can be perceived as one of excess consumption and materialism. Expectations and needs have risen dramatically in Ireland, and aesthetics and design within the built environment are certainly right at the forefront.

Ethically, Ireland has a responsibility to make sustainable decisions for its future. Ethics are highly based on the individual and each person sees the world through their own filters, their own life experiences. The culture and values of a social scientist for example, differ greatly when analyzing a city's urban generation, compared to those of an architect's. Likewise, what is important to a designer can vary greatly depending on their design ethics. Environmental ethics addressed by designers can demonstrate their capacity to consider the natural environment by specifying more sustainable products and materials. Environmental ethics is not an area for only specialists, but for all. The degradation of our environment poses just as great a threat to life as a nuclear war, and the ultimate challenge of environmental ethics is the conservation of life on earth (Armstrong, 1998).

Yet sustainable interior design is not just about the right specification of furnishings, finishes and fittings. It is also about adaptability and flexibility. According to Sustainable Design International's 2000-2001 Harmonized EU Vocabulary: Useful Terms & Definitions relating to Fire safety & Protection in Buildings, the terms adaptability and flexibility are defined as:

"Adaptability: the extent to which a building component is designed when new, to be capable of being easily modified, at any later stage during its life cycle, to meet the changing life and living/working needs of potential users…"

"Flexibility: the extent to which a building interior is designed when new, to be capable of being easily varied at any later time, with minimal cost and user inconvenience because of changing living/working needs"

Source: Sustainable Design International (2001)

Thus, it is very important that interior designers also consider the entire life cycle of a building. This will result in less energy and materials being consumed for refurbishment, and also result in economic savings if furnishings, finishes and fittings can be re-used. If buildings are designed to allow a greater degree of flexibility, occupants can adapt the space according to their evolving needs,

without reconstruction, thereby addressing adaptation for new use over the building's lifespan (Doran, 2004).

In Conclusion

This dissertation intends to assess the technical guidance that is currently available and applicable to Irish interior designers by which to specify sustainable furnishings, fittings and finishes for commercial interiors. This assessment will address the relative legislation, regulations and building codes that would be of most use to Irish interior designers. In relation to furnishings and fittings, major interior components such as furniture, lighting and water fixtures will be discussed. In terms of finishes, the most environmentally-conscious methods will be suggested based on the most preferred environmental attributes.

Although thermal comfort and ventilation are interior design components that are heavily linked to sustainable design, they will not be included in this study since their specification is not usually the sole decision of an interior designer. This work will focus solely on the non-structural components of commercial interior design.

A lack of awareness of environmental standards, guidelines and regulations for the interiors industry exists in Ireland and is causing designers to continue with their "what they don't know won't hurt them" mindsets. This lack of education and information is a major obstacle for the industry, as illustrated in chapter 5, which discusses the findings of interior design surveys that were conducted in Ireland, in order to ascertain design professionals' perspectives and attitudes towards sustainability. Aesthetics, functionality and budget were also cited as problematic for designers when specifying sustainable products. These myths and misconceptions will be addressed in the same chapter and further dispelled in the section devoted to sustainable interior design case studies.

Finally, the call for sustainable design education and information is also becoming increasingly urgent. The United States is way ahead of Ireland in terms of its national design councils implementing continuing education in sustainable design practice (Bonda, 2007). Their design schools are now preparing interior design graduates as the move forward to sustainable design gains momentum (Bonda, 2007).

This thesis is an attempt to highlight the many issues that interior designers must start considering if they have not yet started. The scope of discussion in each topic is small and merely approached as an introduction to the many facets of sustainable interior design that require Irish designers' attention. Sustainability ***IS*** an issue for interior design. It is of great importance to society and the building sector. Interior design *must* be considered: 50% of material resources that are building-related are taken from nature, 40% of energy consumption in Europe is building-related, and over 50% of national waste production is a result of the building sector (Anink, 1996).

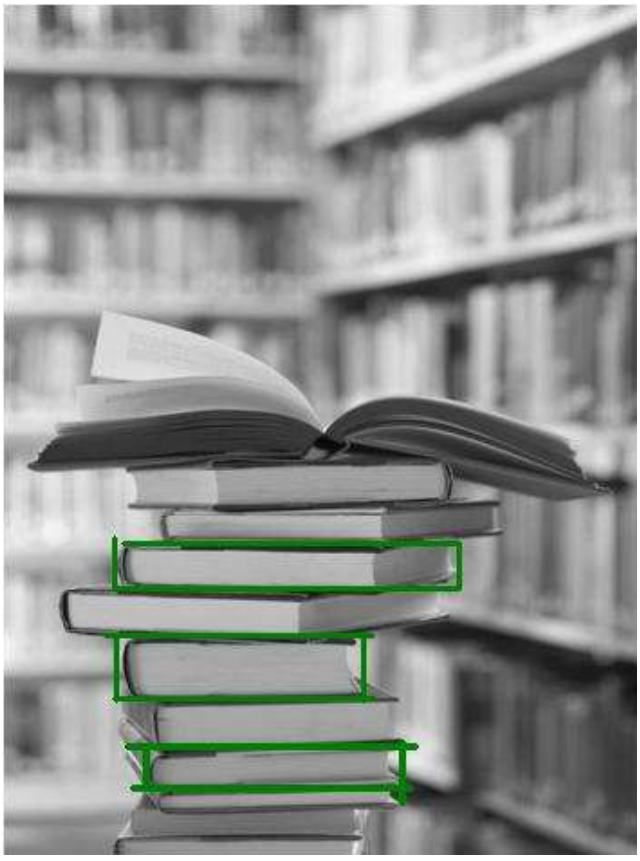
Interior designers play a key role in sustainability. Consciously or not, they have the power to choose alternatives that have lower environmental impacts. Therefore, it is essential that interior designers are aware of the environmental options that are available to them.

CHAPTER ONE

Interior Design and Environmental Policy: Laws, Regulations and Building Codes

"The most important thing to know about a material's green certification is the source of that rating. It's the designer's responsibility to go beyond the buzzwords, beyond the surface. They must know how products are made and used, and they must become educated in knowing what questions to ask."

- Penny Bonda, FASID, LEED AP, coauthor of Sustainable Commercial Interiors.



Implementing innovative design solutions whilst complying with building regulations and legislation is an integral part of the design process. In addition, regardless of the project type, interior designers must always consider the health, safety and welfare of the public. To add to this difficult task, governments, organizations and agencies have been developing new environmental certifications, policies, laws, regulations and building codes all

over the world, in order to protect the natural environment. It is crucial that interior designers remain up to date with the environmental laws and regulations that apply in their country, in order to practice sustainable interior design (Winchip, 2007). However, there are currently very few resources that exist that can aid an interior designer to design in an environmentally responsible way (Jones, 2008). There is a large quantity of information available regarding the use of sustainable design practices and the specification of environmentally responsible construction materials, in the design and construction of buildings, but very few resources are available that are focused on the interiors of these buildings (Jones, 2008). Are not all professionals involved in the construction and design industry morally obligated to contribute to lowering the environmental impact of their work?

In 1999, the International Interior Design Association (IIDA) conducted a study regarding environmentally responsible interior design, and discovered major differences between designers and their actions (Jones, 2008). They found that 83% of the designers surveyed felt they had a moral responsibility to offer clients sustainable options, yet only 37% actually did so (Jones, 2008). A lack of credible and consistent information was cited as a key obstacle by 75% of the designers surveyed, for implementing sustainable design concepts (Jones, 2008). Thankfully, the building industry in the US has been slowly -but consistently- developing and piloting protocols for environmentally responsible design (Jones, 2008). Interior designers are now being asked to create spaces that protect the health, safety and well being of the people who work, live and play in their interior environments (Jones 2008). At the same time, by doing this, they will be creating spaces that also protect the health, safety and well being of nature itself. Yet what is the current understanding of sustainable interior design in Ireland, and how much guidance is available to Irish designers?

In Ireland, there are several pieces of environmental policy that interior designers should be familiar with. There are also certain aspects of the Irish Building Regulations, such as the Technical Guidance Document Part L-

Conservation of Fuel and Energy, which directly apply to the energy efficiency of non-structural interior components such as lighting. In addition, there are also UK-based building codes such as the British Research Establishment Environmental Assessment Method (BREEAM) and the British Standards that can be used as sustainable guides for certain aspects of interiors. Finally, it's important for Irish interior designers to be aware of leading international sustainable guidelines that have a focus on interiors, such as Leadership in Energy and Environmental Design for Commercial Interiors (LEED CI). This chapter intends to focus on the various laws, regulations and building codes that are the most applicable to Irish interior designers, and that would benefit their environmental awareness by acting as informative resources for designing sustainable commercial interiors.

1.1 Irish Environmental Policy

IN 1997, the Kyoto Protocol was negotiated as an amendment to the United Nations Framework Convention on Climate Change and by ratifying this, Ireland committed to reducing its carbon dioxide emissions and greenhouse gases (http://unfccc.int/kyoto_protocol/items/2830.php, 2009). The European Commission then put forward a far-reaching plan that would deliver on the European Union's commitments to fight climate change and promote renewable energy up to 2020 and beyond (http://ec.europa.eu/environment/climat/climate_action.htm, 2009). Under this agreement, Ireland must reduce its greenhouse gas emissions by 20% relative to 2005 levels, by 2020, and one of the greatest CO_2 abatement potentials lies in Ireland's energy sector (Siemens, 2009).

This year, Siemens Limited commissioned a team to carry out research, which, for the first time for the Dublin region, offers a comprehensive analysis of costs and infrastructural CO_2 abatement potentials (Siemens, 2009). Technological levers from the sectors of buildings and energy, amongst others, were examined for their potential to reduce greenhouse gases and help to meet the

emission targets (Siemens, 2009). Many of the identified technologies, such as solar power and energy efficient technologies make economic sense as most of them pay back their investment costs through energy savings (Siemens, 2009). The report found that cities account for approximately 75% of global energy consumption. Therefore, the energy efficiency of buildings plays a huge part in reducing greenhouse gas emissions, and the design and components of their interiors that consume energy also play a vital role.

The National Energy Efficiency Action Plan for Ireland 2009-2020 also identified that there are significant potential energy savings to be found through the development of energy efficient lighting. The Irish government has committed to using fluorescent bulbs wherever possible, and to the replacement of incandescent bulbs with Compact Fluorescent Lamps (CFLs),going as far as implementing legislation to eliminate inefficient lighting products from the Irish market altogether (National Energy Efficiency Action Plan for Ireland, 2009). The Irish Building Regulations 2010 will also demand a 30% improvement on energy performance of non-residential buildings relative to the 2005 building regulations (National Energy Efficiency Action Plan for Ireland, 2009).

Thus, the challenge of conserving energy in Ireland's building and energy sectors has begun, thanks to various government initiatives. Also introduced have been national campaigns such as the Power of One, and new tax incentives and awards that encourage/award companies who purchase the most energy-efficient equipment, such as:

Accelerated Capital Allowances for energy efficient equipment
Companies may claim 100% of the capital cost of certain energy efficient equipment against corporation tax in year of purchase. By encouraging businesses to purchase equipment that is highly energy efficient, they can benefit by significant savings on energy costs and reduce carbon emissions (http://www.dcenr.gov.ie/Energy/Energy+Efficiency+and+Affordability+Division/Programmes.htm, 2009).

The Sustainable Energy Awards

Held annually by Sustainable Energy Ireland (SEI), the awards recognize and publicly acknowledge the best achievements in energy efficiency and renewable energy. The awards are open to all businesses and organizations, private and public sector.

IS393, the Irish Standard for Energy Management

Support by the Irish government for businesses in maximizing their energy efficiency through the adoption of IS393

SEI's Energy MAP (Energy Management Action Plan)

Assistance for smaller businesses with limited resources to improve their energy management through the Energy MAP initiative.

(Source: National Energy Efficiency Action Plan for Ireland, 2009)

Although awareness in regard to energy efficiency has been raised and progress has been made as a result of these initiatives, there is still very little awareness being promoted on the use of recycled products, water efficient fixtures, carbon neutral materials or environmentally healthy interior finishes within the Irish building sector. This dissertation will argue for the importance of generating a greater awareness of the environmental benefits of implementing these types of sustainable strategies.

1.2 Building Research Establishment (BRE)

breeam

The term 'cradle to cradle' is often used to describe the entire life of a component or product, based on its Life Cycle Assessment (LCA), which covers

the sourcing of raw materials to the recycling into raw materials at the end of its defined life (Jones, 2008). This concept of ‘no waste”, modeled after nature, was first introduced by architect William McDonough, leading to the Cradle To Cradle certification from McDonough Braungart Design Chemistry (MBDC) (Jones 2008). The UK-based Building Research Establishment (BRE) uses a variety of Life Cycle Assessment (LCA) methodologies to help companies understand how their products, materials and systems will perform and how they might improve the environmental performance of their buildings (http://www.bre.co.uk/page.jsp?id=1578, 2009).

BREEAM (Building Research Establishment Environmental Assessment Method) is one of the leading and most widely used environmental assessment methods for buildings in the UK. It sets the standard for best practice in sustainable design and is used to measure a building's environmental performance (http://www.breeam.org/page.jsp?id=66, 2009). BREEAM addresses a wide range of environmental and sustainability issues and enables developers and designers to prove the environmental credentials of their buildings to planners and clients, by using a straightforward scoring system that is transparent, easy to understand and supported by evidence-based research (http://www.breeam.org/page.jsp?id=66, 2009). The standard covers ten categories of sustainability including:

- Management
- Health & Wellbeing
- Energy
- Transport
- Water
- Materials
- Waste
- Land Use and Ecology
- Pollution
- Innovation

BREEAM is then dissected into building types, or ‘schemes’, such as Prisons,

Courts, Healthcare, Office, Retail, Industrial, etc. and within these schemes there is a medium sized scope that applies to interior design, in terms of refurbishment and fit-out (BREEAM Offices, 2008). The schemes that most apply to commercial interior design are Courts, Healthcare, Office and Retail. Stages that apply to interior design work are: major refurbishment, tenant fit-out, initial design stage, post construction stage and in- use. In regard to the schemes that are the most applicable to the field of interior design, BREEAM Retail and BREEAM Offices have the most information on common commercial interior design issues that are related to sustainability.

The BREEAM Office scheme is not designed to assess a minor refurbishment of an existing building, i.e. works that do not result in the provision, extension or alteration of thermal elements and/or building, or a change of use (BREEAM Offices, 2008). Therefore, this system may have little value to interior designers for sustainable office refurbishment or designing for change of use. However, the extent that BREEAM can be applied to interior design is through its assessment of a fit out of an existing building. Replacement by durability or fashion (fit out assessments only) is also addressed in BREEAM Retail.

Table 1 summarizes the BREEAM fit- out related issues that apply to sustainable interior design:

Table 1: Interior Fit-Out Issues According to BREEAM

Glare Control: To give building users sufficient access to daylight. To reduce problems associated with glare in occupied areas through the provision of adequate controls, for example an occupant-controlled shading system on all windows, glazed doors and roof lights in all relevant building areas.
High Frequency Lighting: To reduce the risk of health problems related to the flicker of fluorescent lighting.
Internal Lighting Levels: To ensure lighting has been designed in line with best practice for visual performance and comfort.
Lighting zones and controls: To ensure occupants have easy and accessible control over lighting within each relevant building area.
Indoor Air Quality: To reduce the risk to health associated with poor indoor air quality, with a focus on natural and artificial ventilation to dilute pollutants as compliance criteria.
Volatile Organic Compounds: To recognize and encourage a healthy internal environment through the specification of internal finishes and fittings with low emissions of volatile organic compounds (VOCs).
Reduction of CO2 emissions: To recognize and encourage buildings that are designed to minimize the CO2 emissions associated with their operational energy consumption (e.g. lighting).
Water Consumption: To minimize the consumption of potable water in sanitary applications by encouraging the use of low water use fittings.

Source: BREEAM Offices, 2008

These issues are taken into account at both the initial design stage and post-construction stage, and are included in both the 2008 BREAAM Offices and Retail Assessor manuals.

BREEAM also publishes a Green Guide to Specification, which is an easy-to-use comprehensive reference website and electronic tool, providing guidance for specifiers, designers and their clients on the relative environmental impacts for a range of different building elemental specifications (BREEAM Retail, 2008). The ratings within the guide are based on Life Cycle Assessment, using the Environmental Profile Methodology- EPM (BREEAM Retail, 2008). In

relation to interior design, this includes elements, for example, such as floors, which are expected to last for the entire life of the building, and carpets, which may be changed regularly through the life of the building (http://www.thegreenguide.org.uk/page.jsp?id=15, 2009).

Finally, the BREEAM manuals include the British Standards' required Volatile Organic Compound (VOC) emission levels from various interior products and finishes. BREEAM Offices also supports the responsible sourcing of materials. However, the scope of BREEAM does not extend to furnishings e.g. desks, shelving, etc. It only focuses on the key internal finishes and fittings integral to the building (BREEAM Offices, 2008).

BREEAM lacks an in-depth guide that solely focuses on the interiors of commercial buildings. The guide applies t interior design only for that it addresses refurbishments, the use of artificial and energy efficient lighting and the emission levels of VOCs in various finishes(Volatile Organic Compounds), which can impinge on indoor air quality (BREEAM Offices, 2008).

Assessments using UK BREEAM schemes can be carried out in the Republic of Ireland. BREEAM is tailored to the UK's construction sector, but it has been used extensively in Northern Ireland and many times in the Republic (Gallagher, 2009). This is due to Ireland's strong similarities with the UK in terms of climate, construction techniques, technologies, standards, culture and society (Gallagher, 2009). BRE are in the process of developing BREEAM for Ireland. BRE Ireland plan to develop an Environmental Assessment Method specific to Ireland (Gallagher, 2009). BREEAM When asked if their plans for Ireland will include a focus on commercial interior design, a representative for BRE Ireland responded:

"The first BREEAM Ireland scheme will be Offices and we expect a pilot version to be available in the next few months. This is largely due to a recent increase in its use in Ireland. It will not be that different (at least initially) from the UK and European versions – minor changes to account for differences between the UK and Ireland… things like standards, policies etc will be updated for Ireland. As you know the BREEAM schemes

were originally for new build only but they can now be used during major refurbishments and fit out. At this moment in time BREEAM Offices and BREEAM Retail can be used in Ireland by just using the UK BREEAM standards."

Their current activity in Ireland includes:

• 25 buildings registered
• 8 buildings assessed
• In excess of 10 Assessor organizations
• Development of BREEAM Prisons
• OPW specifying BREEAM

Source: Gallagher, A. (2009) BREEAM in Ireland

Assessments in Ireland are hoped to be made using a combination of existing BREEAM methodologies, European and international examples, the final result also including an Irish based assessor network and an Irish based certification scheme (Gallagher, 2009).

1.3 BSI British Standards and BREEAM

The British Standards is the UK's National Standards Body (NSB). BSI British Standards works with manufacturing and service industries, businesses, governments and consumers to facilitate the production of British, European and international standards. (http://www.bsi-global.com/en/Standards-and-Publications/About-BSI-British-Standards/, 2009). BREEAM refers to a selection of British Standards which it uses as evaluation criteria of VOC emissions from various product types:

BS EN 14342:2005 Wood flooring – Characteristics, evaluation of conformity and marking.
BS EN 14041:2004 Resilient, textile and laminate floor coverings. Essential characteristics.
BS EN 717-1:2004 Wood-based panels- determination of formaldehyde release.
BS EN 13999-1:2007. Part 1: Adhesives – Short term method for measuring the

emission properties of low-solvent or solvent-free adhesives after application
BS EN 13999-2:2007. Part 2: Determination of volatile organic compounds.
BS EN 233:1999. Wall coverings in roll form – Specification for finished wallpapers, wall vinyls and plastics
BS EN 234: Specification for wall coverings for subsequent decoration.
BS EN 266:1992 Specification for Textile wall coverings.
BS 3046:1981 Specification for Adhesives for hanging flexible wall coverings.
BS EN 13300:2001 Paints and varnishes – water-borne coating materials and coating systems for interior walls and ceilings – Classification.
BS EN ISO 11890-2:2006 Paints and varnishes- Determination of volatile organic compound (VOC) content.

Source: BREEAM Offices, 2008

These standards can be useful guides for interior designers when specifying materials, because they are directly assessed with the main consideration being indoor air quality (IAQ).

1.4 LEED: Leadership in Energy and Environmental Design

LEED is an internationally recognized green building certification system, developed by the U.S. Green Building Council (USGBC). It provides verification that a building is designed and built using strategies aimed at improving environmental performance (http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988, 2009). LEED also has a rating system that is specifically focused on commercial interiors, defined by the USGBC as follows:

"LEED for Commercial Interiors is the green benchmark for the tenant improvement market. It is the recognized system for certifying high-performance green interiors that are healthy, productive places to work; are less costly to operate and maintain; and have a reduced environmental footprint. LEED for Commercial Interiors gives the power to make sustainable choices to tenants and designers, who do not always have control over whole building operations."

(Source: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=145, 2009).

This demonstrates the importance of sustainability within the interiors industry in the United States. LEED CI credits within each of the key LEED areas also cover a wide range of interior-focused environmental aims:

Water Efficiency: minimum water use reductions of 20-30%;

Energy & Atmosphere: Optimizing energy performance of lighting power, lighting controls, equipment and appliances;

Materials & Resources: the storage and collection of recyclables, for building reuse maintaining minimum of 40% of interior non-structural components (adaptation/change of use), to reuse a minimum of 30% furniture and furnishings, rapidly renewable materials and certified wood;

Indoor Environmental Quality: Low-emitting materials, sealants, adhesives, paints, coatings, carpet materials, composite wood and laminate adhesives, incorporating daylight into a minimum of 75% of spaces;

Innovation & Design Process: innovation in Design.

Source: U.S Green Building Council, (2006).

LEED CI is one of the few systems available in the construction sector that has a rating system specifically geared towards commercial interior design. Moreover, LEED CI includes a section devoted to Indoor Air Quality in commercial interiors- an area which, at the time of this writing, is lacking comprehensive guidelines in Ireland, other than the Decorative Paints Directive, which limits volatile organic compound (VOC) emissions.

Clients seeking LEED certification in North America-especially institutional clients- is now the norm, with design firms integrating sustainable practices into their work, paying for staff LEED exam fees, and rewarding them by sending them to green building conferences (Jones, 2008). Sustainable design is not considered an 'add-on' service in the US, but is becoming an integral part of the design process (Jones, 2008). Although the comparison between Ireland and the US may be unrealistic in terms of size, population, demographics and industrialization, LEED CI is becoming increasingly successful and is an insightful guide for interior designers in Ireland.

1.5 International Organization for Standardization (ISO)

The ISO contains a global set of standards that can be applied and understood in every country. ISO 14000: Environmental Management holds the majority of their sustainability-related standards which focus on minimizing environmental impact (http://www.iso.org/iso/iso_14000_essentials, 2009). The standards also address specific environmental aspects, including: labeling, performance evaluation, and life cycle analysis (http://www.iso.org/iso/iso_14000_essentials, 2009). By being familiar with the ISO 14000 standards, interior designers will be able to identify and control the environmental impact of their company's activities, products or services, improve its environmental performance

continually, and implement a systematic approach to setting environmental objectives and targets, all essential steps for forming a sustainable design practice (http://www.iso.org/iso/iso_14000_essentials, 2009). It is within this context that the ISO 14000 standards can benefit interior designers, helping them to progress the development of their companies to become more integrated in the sustainable design process.

1.6 The Environmental Preference Methodology (EPM)

The EPM was developed by Woon / Energie (now E/E) in 1991 for selecting building components and materials (Anink, 1996). Various building projects at the time highlighted the increasing demand for accessible, up to date information on the environmental impact of building components and materials, so a ranking system for the selection of building materials -according to environmental preference- was developed (Anink, 1996). Cost or aesthetics are not taken into account in the EPM assessment, and the ranking preferences are based on environmental impact and environmental preference (O'Sullivan, 2009).

The EPM ranks materials according to their environmental impact, not based on financial cost but on the following criteria:

-raw material availability
-ecological damage from extraction
-energy consumption including transport
-water consumption
-environmental pollution including waste
-health
-repair, reuse, recycle

Source: Haslam, M. (2009)

Consideration is also given to the environmental effects of different materials, with more sustainable options suggested, based on available information, which can consist of Life Cycle Assessments (LCA) that have already been carried out, or data provided by manufacturers or other surveys (O'Sullivan, 2009).

1.7 The Decorative Paints Directive (Directive 2004/42/EC)

Volatile Organic Compounds (VOCs) are compounds that vaporize (become a gas) at room temperature and common sources that can emit VOCs into indoor air include various building and furnishing materials (Irish Public Health Institute, 2006). Some examples include: paints and lacquers, paint strippers, building materials and furnishings, glues and adhesives, urea-formaldehyde foam insulation (UFFI), pressed wood products (hardwood, plywood, wall paneling, particleboard, fiberboard) and other furniture made with these pressed wood products (BREEAM Offices, 2008). The Decorative Paints Directive addresses the need to reduce the risk to the user and the environment due to exposure to volatile organic compounds (VOC), by limiting their VOC content (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009). The Directive was enacted into Irish law by the Limitation of Emissions of Volatile Organic Compounds due to the use of certain Paints, Varnishes and Vehicle Refinishing Products Regulations 2007 (External link Statutory Instrument 199 of 2007) (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009).

The environmental impact of paint is based on its embodied energy, the VOCs emitted during its lifetime, and waste disposal (Hartman, 2009). Manufacturers are currently working hard to comply with the second phase of the directive, which will go into effect in 2010, moving towards more water-based paints as opposed to solvents (Hartman, 2009). Since VOCs pose a risk to human health and the environment, interior designers *must* consider the VOC limits of paints and finishes. By specifying finishes that have a low or 'zero' VOC content, a designer is implementing a sustainable strategy that will improve indoor air quality. Reading the content labels of interior products and having an

awareness of this current environmental legislation is crucial for the specification of interior finishes.

1.8 Material Certifications

The Forest Stewardship Council (FSC) is an independent, non-governmental, non-profit organization that promotes the responsible management of the world's forests http://www.fsc.org/about-fsc.html, 2009). This certification system is unique because it provides an internationally recognized, standard-setting accreditation to companies, organizations, and communities who are interested in responsible forestry (http://www.fsc.org/about-fsc.html, 2009). The FSC label enables consumers and businesses to make purchasing decisions that they know will benefit people and the environment, and it is nationally represented in more than 50 countries around the world (http://www.fsc.org/about-fsc.html, 2009).

Fig. 2: The Forest Stewardship Council's global trademark

It is important for interior designers to be familiar with the three versions of certification: first-, second- and third-party, and third-party certification- which is the most credible (Whitemyer, 2007). When a dealer or manufacturer is making direct claims about its product's attributes it is first-party certification, or self-certification (Whitemyer, 2007). Second-party certification may be done by a trade association or vendor, and finally, for third-party certification, credible

testing and labeling agencies must be nonprofit and have no direct connection with the material or its manufacturer (Whitemyer, 2007).

Other notable certification schemes include, but are not limited to:

Green Spec Directory from Building Green, inc. (UK): A directory of sustainable materials available in the UK (http://www.greenspec.co.uk/, 2009). Amongst the materials assessed are interior wall paints, varnishes and flooring.

Sustainable Textile Standard, from the Institute for Market Transformation to Sustainability (MTS) (US): developed with manufacturers and other interested parties, this standard measures a product's performance based on a variety of environmental issues (http://mts.sustainableproducts.com/standards.htm, 2009).

The Global Organic Textile Standard: The aim of this standard is to define requirements to ensure the organic status of textiles, from the harvesting of raw materials, through environmentally and socially responsible manufacturing, up to labeling, in order to provide a credible assurance for the end consumer (http://www.imo.ch/imo_services_textile_gots_en.html, 2009).

The Global Ecolabelling Network (GEN): a non-profit association made up of third-party, environmental performance recognition, certification and

labeling organizations founded in 1994 to improve, promote, and develop the "ecolabeling" of products and services (http://www.globalecolabelling.net/, 2009). The GEN defines 'ecolabeling' as:

"...a method of environmental performance certification and labeling that is practiced all around the world. A label identifies the overall environmental preference of a product or service within a specific product/service category, based on life cycle considerations. In contrast to "green" symbols or claim statements developed by manufacturers and service providers, an ecolabel is awarded by an impartial third-party in relation to certain products or services that are independently determined to meet environmental leadership criteria."

(Source: http://www.globalecolabelling.net/whatis.html, 2009)

Above: Examples of global eco labels that make up the GEN, comprised of national and multinational third-party environmental performance-labeling organizations. Clockwise from the top left: The Global Ecolabelling Network, Germany, Canada, Australia, Croatia, EU (also for Luxembourg, Greece and UK), Hong Kong, United States, Korea, Nordic % countries, Philippines, Spain, Sweden, Thailand, Hungary. *(Source: Winchip, 2007)*

The Business and Institutional Furniture Manufacturer's Association (BIFMA): provides guidance for office furniture manufacturers and suppliers of all sizes to establish and/or expand their environmental management systems and include sustainable business practices (BIFMA, 2005). They insist that manufacturers and suppliers should implement and publicly announce the following:

- An Environmental Policy;
- The environmental aspects of the company – for example, their energy or water conservation, recycling, etc.
- Legal and other requirements –for example to subscribe to at least one national or internationally recognized sustainable business code or practice;
- Objectives and Targets – for example to increase the use of renewable raw materials within a certain timeframe.

Source: BIFMA Sustainability Guidelines 2005

These schemes are just a small sample of the numerous certification schemes which represent the products and materials used within the interior design industry. Each scheme listed here is a reliable representative of the environmental certification industry itself, and many set extremely high standards in terms of lowering environmental impact, product quality and performance.

However, It can be very easy to announce an environmental policy or certification for a product or material. Today, designers are often confused as to how to get past all the 'green washing' that is coming onto the market. Not all environmental certifications are equal and it is crucial that interior designers understand *how* companies are testing, and *exactly what* they are validating (Bonda, 2007). Only then will designers become truly aware of which certifications are best to follow.

There is an endless amount of sustainability guidance available for building and construction materials. This chapter has only assessed a selection of guidelines that appear to have the most relevance to interior design within Ireland. However, in conjunction with the environmental laws, regulations and building codes discussed in this chapter, it is imperative that designers continue to ask questions when specifying materials in a project: where is it from? How is it made? What are the possibilities for reuse afterwards? It is also up to designers

to inquire about the environmental issues of products, such as energy efficiency, disposal, durability, toxins, transportation, regulations and recyclables (Whitemyer, 2007). It is not enough for designers to only follow guidelines without making inquiries into the many different environmental issues associated with a product or material. No sustainability guide or certification scheme should take precedence over a designer thoroughly knowing about the materials and products they are specifying.

By enhancing environmental awareness, interior designers will be able to make more environmentally responsible decisions in the design process. Ireland has begun its focus on energy consumption within its built environment , yet there still remains a void where critical information on sustainable materials, furnishings and fixtures for interiors should be available. Perhaps if designers' awareness was addressed and the design guidelines that apply to Ireland were expanded to incorporate sustainable interior design, there would be a rise in the implementation of sustainable solutions within the Irish interiors sector. Ultimately, unless an interior designer has an understanding of the relevant environmental regulations, legislation and policies in Ireland, the right choices will not be made. Morally, designers may not feel obligated to commit their professional practice to practicing sustainable design.

It is unlikely that there is going to be an abrupt shift in the way interior designers work and implement sustainable solutions in Ireland. It will happen gradually-but steadily- and any changes that occur will hopefully encourage more widespread sustainable thinking within the interior design sector.

CHAPTER TWO

Literature Review

"True education is concerned not only with practical goals but also with values. Our aims assure of us of our material life, our values make possible our spiritual life."

- Ludwig Mies van der Rohe

Designers of all types are continually questioning their values and what is important to them, in terms of what their professional and personal goals are. Within the sector of commercial interior design, sustainability is receiving more attention now than ever before. This may be due to the fact that on a global level, governments are responding to the detrimental environmental impacts that are associated with the construction industry. There is now a need to change behavior and how interior designers consider the environmental impact of their work on a moral level. Yet to what extent is assistance and guidance provided in order to do so?

There are various environmental regulations and guides that can assist interior designers, as discussed in the last chapter. However, much of the focus and comprehensive literature on the subject of sustainable interior design that has emerged in the last five years is U.S-based. In addition, sustainable interior design requires continuous education, and it is a subject whose presence is not very evident in Ireland's interior design programs. There is no doubt that sustainability is going to become more of an issue for this

sector in Ireland because it is directly related to the built environment. Therefore, by raising awareness, interior designers can become more equipped to implement sustainable solutions in their projects.

For example, the emerging potentials of energy and water conservation, renewable technologies and materials, and sustainable manufacturing processes are just a few of the areas that if familiar with, could broaden a designer's way of thinking, and benefit Ireland's construction industry. The topic of sustainability can be incredibly overwhelming, and this obstacle of confusion, combined with a lack of guidelines in Ireland that are focused on interiors, demonstrates the need to create more awareness on the topic. This dissertation aims to highlight that if the awareness of sustainable interior design is not improved in Ireland, a change in behavior where designers consider the environmental impacts of their work will be less likely, and slower to occur. This lack of awareness and lack of guidance is also addressed by some of the authors reviewed in this chapter, some of whom are now considered to be heading the movement of sustainable interior design in the U.S.

***Environmentally Responsible Design: Green and Sustainable Design for Interior Designers*, by Dr. Louise Jones (2008)**

In this recent book, Dr. Louise Jones amalgamates a collection of her writings on sustainable interior design alongside contributions from other design professionals, on various environmentally responsible design issues. The book addresses global sustainability, sustainable development, and provides an interesting timeline of human and environmental interactions, within the context of the built environment. In this discussion on human behavior, Jones explains that a paradigm shift is needed from *environmental irresponsibility* to *environmental responsibility*, which will challenge the range of professionals responsible for the design and construction of the built environment. Jones also explains that the paradigm shift from *unsustainable* to *sustainable* design and construction is also challenging those responsible for the built environment (Jones 2008). Ultimately, Jones defines environmentally responsible design as

an integrated process: a joint effort from government, planners, developers, financiers, architects, engineers, interior designers, construction managers, code officials, landscape architects and facility managers, as well as trades people (Jones 2008).

According to Jones (2008), environmentally responsible design, or sustainable interior design, as it is referred to in this dissertation, should encompass the following principles:

- Respect for nature and natural systems
- Respect for people and the goal of creating healthy habitats
- Respect for the cycle of life, which includes that in nature all waste products are useful, and
- respect for the conservation of natural resources

By introducing the concept of using nature as a model for sustainable design, the book proceeds to present in depth discussions by various experts on some of the topic's most critical areas, such as indoor air quality, sustainable lighting design, and efficient energy and water use.

Another key issue that Jones highlights is the lack of information available relating to sustainable interior design:

"The specification of furnishings, finishes and equipment (FF&E) that are green (i.e. protect people's health and well being) and sustainable (i.e. protect the earth's health and well being) demonstrates environmental responsibility. Although there are currently several groups who are producing information regarding green and sustainable building construction methods and materials, (e.g. the US Green Building Council), no one is concentrating on a comprehensive understanding of environmentally responsible FF&E. This lack of focus on interiors has created an information void for architects, interior designers and facility managers who want to specify environmentally responsible FF&E for interior environments."(Jones, 2008)

the fact that the current green building standards are encouraging the industry to look at buildings as long-term investments is encouraging, and has the

potential to encourage interior designers to follow the same principles. The economics of sustainable building is addressed, stressing the importance of how small decisions implemented at initial construction stages can end up being financially rewarding over the lifetime of the building, for example, by reducing energy or water costs. Jones states that a life-cycle approach to interior design involves analyzing interior finishes and furnishings: from their specification of raw materials to the end of their use. In addition to their raw materials, the manufacturing methods, transport, installation, maintenance and disposal of these items must also be considered (Jones, 2008).

Predominantly focusing on the United States, the collaboration of authors then delve into evaluating interior finishes and furnishings, assessing various environmental building certifications, evaluation instruments, specifications for products, concluding with a selection of sustainable interior design case studies.

Jones expertly highlights the entire process for sustainable design, from specification, to use, to re-use, to end-of life issues. End of life of course addresses the concept of waste, where high levels of waste are generated from the continuous re-furbishment and consumption patterns of the interiors sector, as a result of keeping up with trends and popular/material culture.

This book is an excellent in-depth look at the many complex environmental issues that need to be considered by interior designers. By using the cycle of nature as a model for sustainable design, Jones draws attention to the philosophical arguments of a designer's moral obligation to protect the natural environment.

***Sustainable by Design*, by Stuart Walker (2006)**

Sustainable by Design takes an novel approach to the fundamentals of design. Primarily focused on product design, Walker explores the philosophical meaning behind sustainable design and its practice. He challenges the ways in which product designers are practicing, what really matters and the obstacles

that designers encounter when attempting to design in a more sustainable way. The book proceeds to discuss our relationships with ourselves, the environment, and material culture. Stuart uses examples of historical artifacts and folk/craft traditions as models of inspiration for sustainable designers.

One of the most interesting arguments that Stuart makes is in addressing our fascination and obsession with material culture. He discusses the relationships that develop between fashion, trends and sustainability, and whether or not the world has the capacity to overcome the many obstacles that result from them. He questions our awareness of this relationship, this 'saturated culture' that we continue to be a part of, -almost an ongoing cycle of creating, wasting, consuming, wasting, etc.

Although Walker's ideals are focused mainly on product design, they can still benefit all designers, especially those who design furniture for interiors. from the concept stage to the finishing materials chosen for an interior, designers are too often influenced by the current trends of the moment.

the innovative, timeless –'trend-less'- designs of a Le Corbusier chaise-longue, or the interior of Mies Van der Roe's Barcelona House, that forever will remain design classics- unrepresentative of the most popular trends of their time- that make the biggest and immortal statements. Designs that epitomize functionality and quality, durability and endurance and are a direct result of form following function.

***Sustainable Commercial Interiors*, by Penny Bonda and Katie Sosnowchik (2007).**

Penny Bonda is a LEED accredited professional who has been an active member of the green building industry since its early stages, pioneering the development of many accepted practices and recognized standards in the sustainability movement (http://www.interiordesign.net/blogger/3534.html, 2009) . Some of her prestigious professional titles include founding chair of both the

U.S. Green Building Council committee for LEED Commercial Interiors and the American Society of Interior Designers (ASID) Sustainable Design Council. She is also a principal developer of REGREEN, the USGBC/ASID green residential renovation and interior remodeling program. originally trained as an interior designer, Bonda chose to expand her expertise into the areas of green business practice, materials, evaluation, application, training and leadership ((http://www.interiordesign.net/blogger/3534.html, 2009). *Sustainable Commercial Interiors* is one of her most highly regarded published works (http://www.interiordesign.net/blogger/3534.html, 2009).

In the book, Bonda collaborates with Katie Sosnowchik to deliver comprehensive coverage of many of the same topics as Louise Jones, but with a more introductory focus -perfect for practicing designers who are only beginning to skim the surface for ways to implement sustainability into their practices.

Bonda's work includes an informative overview of some of the most eco friendly products that are currently on the market, especially in the areas of furnishings and finishes (lighting, appliances, toilet and faucet options, and finishes relating to indoor air quality such as paints). The comparisons of the individual characteristics, efficiency and performance of various plumbing fixtures and lighting systems are accompanied by well-presented data relating to specific models.

Comprehensive comparisons of materials, and the debate of natural vs. man-made is discussed in detail. in the chapters on material selection for furnishings and finishes, Bonda reveals the many benefits behind making ecologically sound choices, by explaining the environmental trade-offs of certain products. Moreover, she dispels the many myths and misconceptions that are commonly associated with sustainable products and materials, in terms of their durability, longevity and aesthetics.

***Sustainable Design for Indoor Environments*, by Susan M. Winchip (2007)**

In the comprehensive textbook, *Sustainable Design for Indoor Environments*, Susan Winchip focuses on 'environmentally responsible design', presenting similar major environmental concerns for interiors as those addressed in the previously mentioned texts. The introductory chapters provide a thorough foundation of environmental issues, including the consumption of natural resources, indoor air quality and contaminants, environmental building regulations, and a detailed summary of materials, finishes and furnishings.

The book also includes detailed information regarding the mechanical systems of interiors, such as lighting, yet lacks in depth information on the various types of water-efficient plumbing fixtures.

Winchip provides a great guide to the distinction of environmental certification and eco labeling, with a focus on LEED CI when referring to the specific standards that are most applicable to for interior designers. For example, for each interior design topic addressed throughout the text, the LEED CI standard of compliance is presented and a means in which it might possibly be adhered to.

Finally, there is only a minimal amount of focus on innovativion in design, for example, the ability of a designer to continue inspiring and developing creatively whilst implementing sustainable solutions. It is a very practical guide and most useful for well-seasoned designers who are looking for a quick how-to guide on specific design solutions. It is crucial for students studying interior and furniture design in third level education. Any professional designer would find this text perfect for re-working the design processes of their design practice, with an entire section focused on integrating sustainability with the design process.

The works reviewed and referenced in this dissertation contain a large quantity of detailed information on the many issues associated with sustainable interior

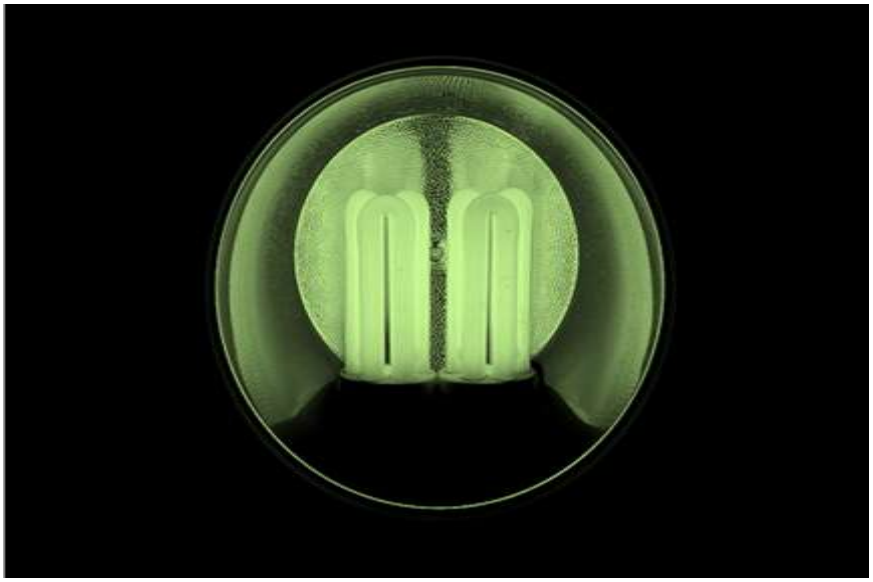
design. However, the majority of this previous research that has been undertaken has been done so predominantly by US-based authors, with virtually no research into sustainable interior design being completed within Ireland -apart from a handful of Irish interior designers who may specialize, or have a specific interest in, sustainability within the interior design sector. Therefore, the findings of this dissertation and the information that is highlighted should be of value to Irish interior designers. This dissertation should also be interpreted solely as an introduction to the benefits and importance of implementing sustainable solutions when designing interior spaces. Literature reviewed was selected for its content relating to the foci of this dissertation. Moreover, all literature reviewed is not restricted to the publications discussed in this chapter. There is an abundance of research available on this topic that focuses on the wide range of issues that comprise sustainable interior design. Sustainable interior design encompasses much more than the main discussion topics of this dissertation.

CHAPTER THREE

Energy Efficiency: Lighting and Water

"Perhaps in 30 years it will be interesting to come back and speak about the beauty of a chair or a lamp, but today that seems a bit obscene. Even during the time it takes to do this interview, people will die from a lack of water. We must try to stop design for design's sake. Design has always been political, and now more than ever we must focus on new goals, which I call democratic ecology."

-Philippe Starck, renowned interior and product designer



For the sake of the planet and more importantly for the moral obligation to save human life, democratic ecology must be given more consideration by design professionals. Interior designers must implement sustainable solutions for certain mechanical systems, such as lighting and plumbing fixtures. By doing so, energy and water consumption can be optimized and natural resources conserved in a responsible way.

According to the Siemens Research Project on Ireland, 'Sustainable Urban Infrastructure', more efficient lighting in buildings could lead to an annual reduction of 0.19 Mt CO_2, and save approximately €78m annually on their

energy and maintenance costs. Upgrading to more efficient washing machines, dishwashers, fridges, and other appliances could also provide a further reduction of 0.12 Mt CO_2, resulting in annual energy savings for investors of €24m (Siemens, 2009). These are some of the major components that are frequently specified by interior designers. By becoming more familiar with emission lowering properties and cost savings, designers may be more inclined to specify more energy- saving products.

Likewise, the report provides figures for water reduction potential, based on more efficient water fixtures. Dublin faces future potential water shortages and needs to consider reduction options (Siemens, 2009). Irish commercial businesses are charged water rates, which creates the incentive to consume less water. Siemens stated that the implementation of water-saving devices such as dual flush toilets and aerated taps could lead to a combined saving of over 2.5 million cubic meters of water by 2025 (Siemens, 2009).

The building sector is a major consumer of energy, accounting for approximately 40% of Irish energy consumption. (http://www.sei.ie/Your_Building/, 2009). Therefore, efficient lighting systems have a major role to play in conserving energy. By implementing energy efficient lighting solutions, one is also conserving the natural resources which are being used to generate electricity, and reducing the pollutants that are being emitted from those various power plants (Winchip, 2007).

Fig.3 is from Ireland's National Energy Efficiency Action Plan 2009-2020, and illustrates the potential economic efficiency savings from lighting within the commercial sector. It is obvious from this that the commercial sector in Ireland holds strong potential for economic savings by conserving energy through more efficient lighting:

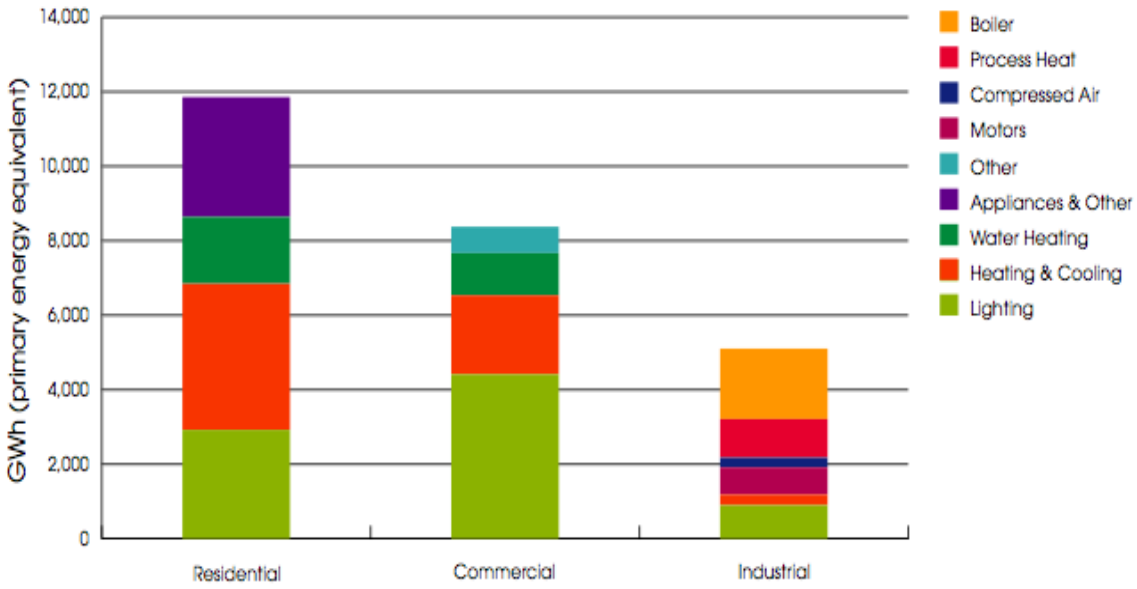


Fig.3: Energy saving potentials in Ireland

The above graph clearly indicates that commercial lighting within the commercial sector is one of the largest energy consumers within the commercial sector. The graph shows that the potential for energy savings in the commercial sector is far greater than that of the residential or industrial sectors. Therefore, designers implementing energy efficient lighting solutions in commercial interior design would be extremely beneficial.

3.1 Interior Lighting Systems: Bulbs

The initial cost of energy efficient bulbs such as compact fluorescent lamps (CFLs) is usually more than other types of lamps which consume larger quantities of electricity. Many people will opt for the cheaper bulb, yet these bulbs have a short lifespan and more resources are used to replace them, thus more unnecessary waste is created and sent to landfill. Waste can be particularly hazardous from lamps since some can contain materials such as mercury (Winchip, 2007).

A lighting system consists of various components: lamps-or bulbs, luminaries, fixtures, ballasts, controls, etc. Each component should be energy efficient, and

compatible with each other (Winchip, 2007). There can also be huge differences between the lighting performances of different manufacturers. However, aside from an interior designer focusing on energy efficient *artificial* lighting, *natural* daylight should also be a designer's priority. Maximizing natural light to its full capacity so as to illuminate interiors as much as possible is an integral part of designing any lighting plan. The natural daylight that infiltrates a space should be assessed in detail so as to ascertain sunlight patterns.

The type of bulb will determine the amount of energy consumed. Properties to be considered by the designer are a lamp's color, efficiency, lifespan, output and cost (Winchip, 2007). Sustainable Energy Ireland's (SEI) Power Of One campaign lists choosing energy efficient light bulbs over traditional light bulbs as one of their top ten energy saving tips (http://www.entemp.ie/trade/environment/phasingoutofincandescentlightbulbs.htm, 2009).Energy efficient lighting can also aid in obtaining an improved rating on a BER certificate (Building Energy Rating), and demonstrate Corporate Social Responsibility (CSR) (Danlers, 2008). Part L of the Irish building regulations requires certain minimum energy efficiency and energy efficient lighting will aid enormously in compliance (DOEHLG, 2008). In addition, renewable energy sources should be used to power a building's lighting systems where possible (Winchip, 2007). The types of renewable energy systems that work well in most buildings are systems powered by wind turbines and photovoltaic roof panels.

3.2 Types of Light Fittings

Compact Fluorescent Lamps (CFLs) are the energy efficient alternative to traditional light bulbs. CFLs use almost 80% less electricity than ordinary light bulbs, last up to 15 times longer, and can save up to €170 over the lifetime of the bulb (http://www.esb.ie/esbcustomersupply/residential/energy_efficiency/cfl_light_bulbs.jsp, 2009)

The phasing out of incandescent light bulbs has been implemented through the EU Regulation on non-directional household lamps (light bulbs), under EU Regulation (EC) No 244/2009. Ireland's Department for Enterprise, Trade and Employment describes the aim of the new regulation will ensure that,

"Inefficient incandescent light bulbs will be phased out throughout Europe with effect from the 1st September 2009 and will be replaced by more energy efficient alternatives such as halogen lamps and compact fluorescent lamps (CFLs)." (http://www.entemp.ie/trade/environment/phasingoutofincandescentlightbulbs.htm, 2009)

The aim of the Regulation is to remove the most inefficient light bulbs from the market and replace them with more energy efficient options, which will last longer and consume less energy, lowering environmental impact. After an energy efficient bulb type is selected, designers must ensure that they select luminaries that will maximize the distribution of lumen output, e.g. direct, indirect, diffused, etc (Winchip, 2007).

The following table is a brief overview of various bulb types, comparing their efficiency in regard to interior design applications:

Table 2:
Light bulb energy efficiency comparison for interior applications

Incandescent bulb	Incandescent bulbs are one of the oldest forms of electrical light sources, whose operational components have not changed since their invention by Thomas Edison and Joseph Swan (Winchip, 2007). An electric current heats a tungsten filament which creates light yet this method uses only 10-15% of the energy which it consumes for illumination; the remaining 85-90% percent goes towards the heating of the filament, and is therefore

	an unsustainable source of energy use for lighting (Winchip, 2007). Eventually, the filament becomes destroyed by the heat and the bulb burns out.
Halogen Bulb	From the incandescent family, yet have a regenerative cycle which continues to redeposit tungsten onto the filament, prolonging the bulb life and making it that much more efficient than regular incandescent bulbs (Winchip, 2007).
Fluorescent Bulb	Much more efficient than incandescent bulbs, consuming approximately 80% less energy and lasting up to 18 times longer, with some lasting 20,000 hours. In addition, they generate very little heat and there have been various new models introduced onto the market which continue to exceed previous models' efficiency ratings (Winchip, 2007).
Compact Fluorescent Lamp (CFL)	Incorporate the efficiency of fluorescent bulbs for incandescent applications; available in a wide range of shapes and sizes, and basically bending the tube shape of the fluorescent bulb into a more traditional shape creates CFLs (Winchip, 2007).
High-intensity discharge (HID) bulb	Extremely efficient electrical light source. Most efficient types are metal halide and high-pressure sodium. Excellent choices when requiring high efficiency, long life and economic savings. Some color-rendering problems.

Light-Emitting Diodes (LED)	Greatest potential for energy efficient lighting in interiors. Still relatively new technology. Excellent for very focused/directional lighting. Excellent color saturation. Long life of up to 100,000 hours. Ideal for decorative and ambient applications. Producing LEDs in an attractive white color has been challenging. Low lumen output. Some LEDs can generate a lot of heat which may need to be drawn out so as not to affect thermal comfort. Every year the technology advances and improves (Winchip, 2007).

In summary, the bulb manufacturing industry has been one of the most responsive in terms of addressing the need for energy efficient options in the past decades (Jones, 2008). Because of this, selecting the right bulbs has almost become a more complex issue for designers, due to the wide range of bulb types available that promote energy efficiency. Most important, however, are the end-use criteria when selecting a bulb: to reduce the hazardous waste in bulbs (Jones, 2008). Also very important is their lumen output, light characteristics, patterns, physical size, lifespan, ease of control, initial cost, maintenance and auxiliary components (Jones, 2008). A detailed description of the various bulbs available within each of the categories described above is beyond the scope of this dissertation, so an overview is merely presented. It is imperative that interior designers investigate the most energy efficient options within each bulb category/type.

3.1 Interior Lighting Systems: Controls

Highly efficient lighting fixtures when combined with the right controls can achieve further power savings on top of choosing the right bulbs. Daylight-linked dimmers, or photo sensors, measure light within the space and make

adjustments (Lite Times, 2009). Photo sensors focus on incoming daylight, adjusting to the sufficient light levels needed by using dimmers. Even more efficient would be to choose a closed-loop photo sensor that reads electric light *and* daylight –in preference to an open-loop sensor that only reads the daylight (Jones, 2008). The dimmers change as natural light and electric light levels change within any building, from a small office to an entire floor (Lite Times, 2009). For example, light fixtures located adjacent to windows which allow sufficient amounts of natural daylight to infiltrate into a space will dim accordingly to pre-set light levels required by occupants. Theses sensors can also sense the portion of light reflected from a surface and dim accordingly. A perfect application for photo sensor systems is within retail design. Many retail outlets and stores incorporate window displays to push products and advertise current promotions, which require a substantial amount of directional lighting. A significant amount of this lighting can sometimes be wasted during certain times of the day, should a large quantity of direct sunlight infiltrate the window display. By incorporating a daylight sensing system into the window, the lights will dim accordingly to the amount of natural daylight infiltration and re-illuminate as natural light diminishes.

Yet another potential application for retail design for light sensors is in fitting rooms, where infra-red occupancy sensors can switch on and off when occupied, stimulated by movement (Fig. 4) (Lite Times, 2009)

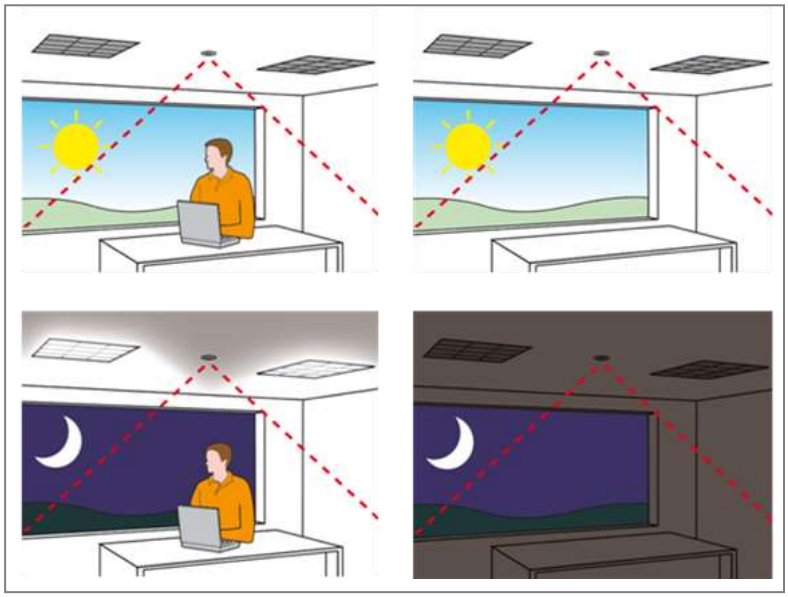


Fig. 4: Above clockwise from left to right: Enough daylight, occupied: LIGHTING OFF, enough daylight, unoccupied, LIGHTING OFF, Night, occupied, LIGHTING ON, night, unoccupied, LIGHTING OFF. Source: Danlers (2008), *Introduction to Energy saving Lighting Controls*

Designers and manufacturers of lighting controls in the UK, Danlers Lighting, calculated a cost saving analysis based on using their PIR occupancy switch in a single office:

- Lighting load of 0.576kW
- 4 hours per day of lighting saved
- For 250 days per year
- Annual saving of £29 from electricity bill
- This represents a 40% saving on electricity
- Payback period of approximately 20 months
- Life expectancy of approximately 20+ years

Source: Danlers (2008), *Introduction to Energy Saving Lighting Controls*

Other lighting controls that can enhance energy efficiency include:

Photocells: switch on and off according to daylight level

Reset photocells: manual on and off by daylight level

Daylight linked dimmers: dim lights according to daylight level

Occupancy switch without photocell: switch on when occupied, off when unoccupied

Occupancy switch with photocell: switch on when occupied and insufficient daylight, otherwise off

Occupancy switch with daylight linked dimming: switch on when occupied and dim according to daylight level

Source: Danlers (2008), *Building Regulations and Lighting Controls*

The above listed types of lighting controls are capable of providing the correct light, in the correct amount, at the correct place and at the correct time. commercial application types that suit energy saving lighting controls also include, but are not limited to, offices, hospitals, schools, hotels, restaurants, recreational facilities, corridors/stairwells, W/C, etc (Danlers, 2008). Part L2 of the Irish Building Regulations also promotes the use of lighting controls to achieve energy efficiency, with the controls being based on occupancy and the maximization of the available daylight (http://www.sei.ie/Your_Business/Accelerated_Capital_Allowance/Technical_Guidance/Lighting_Controls/, 2009).

Sustainable Energy Ireland (SEI) offers some general technical guidance in regard to lighting controls, informing the public and businesses of the benefits of their use. According to the SEI, lighting controls can:

- Dim luminaires in response to daylight (daylight harvesting/constant light)
- Dim luminaires in response to lumen depreciation of the luminaire and room surfaces (maintained luminance)
- Provide the correct light level for different tasks and circulation areas
- Provide presence detection to turn lights off if the area is unoccupied
- Prohibit the artificial lighting from coming on if daylight is abundant
- Be linked to time-based controls to turn lights on or off depending on the time of day
- Be used to changing the color temperature of light, in response to natural light and the body's circadian rhythms.

Source: *Sustainable Energy Ireland's Technical Guidance for Lighting Controls*, http://www.sei.ie (2009)

Obviously, window treatments and blind systems that effectively direct natural light will also preserve a lighting system's energy use. Choosing the right

combination for energy efficient lighting requires an appreciation for the characteristics of the different lamps, bulbs, systems and controls available. Interior designers must also carefully consider light position and maintenance. For detailed guidance on energy efficient lighting specification, designers should refer to professional bodies such as The Chartered Institution of Building Services Engineers (CIBSE) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) or other specialist sources on lighting design (SEI, 2008).

By implementing a combined approach to lighting that consists of the appropriate energy efficient bulb and fixture, along with the most efficient controls appropriate to the context, the benefits can be plentiful, in terms of power consumption, cost savings, no compromise in light quality or appearance, and low maintenance over a long life span.

3.2 Water Efficiency

As water demands increase due to rises in populations and the global climate changes, there is a strong possibility that Ireland is going to become more susceptible to water shortages (European Environment Agency Report, 2009). This could have devastating social, economic and environmental effects. Poor quality drinking water, increased water charges, food shortages and depleted Irish water resources are just a few of the effects that might occur. In order for Ireland to combat any future water shortages, sustainable water management is essential. More efficient use of water, raising awareness and promoting a change in behavior towards water use are all important methods for tackling water conservation (EEA Report, 2009).

There have been many water efficient products introduced recently that can contribute to a building achieving sustainable recognition, such as BREEAM credits and hence aiding the building to achieve a higher overall BREEAM rating. New sustainable strategies that deserve much more attention from interior designers, in particular when designing with new builds, are renewable

water systems, such as capturing rainwater or establishing grey water systems to use in toilets (Bonda, 2007). Since the water that is used to flush toilets can be potable, the key tactic is to reduce the amount of potable water being flushed as much as possible, as well as installing energy efficient appliances such as dishwashers, low volume toilets, or small pantry sink faucets that have flow restrictors such as aerators (Bonda, 2007).

However, whether a designer is refurbishing a new or existing building, huge reductions in water consumption can be achieved by specifying the right plumbing fixtures. Water fixtures in interiors can unnecessarily consume massive amounts of water. For example, the flushing of urinals can account for 20% and 30% of a commercial organization's annual water consumption (Water Efficient Solutions, 2009). Thankfully, product development within the water fittings industry has seen a significant amount of innovative bathroom technologies come onto the market, especially because customer satisfaction in bathroom design is crucial, especially within the hospitality sector.

3.3 Low Volume and Waterless WCs

Some of the new toilets available today are excelling at how little water they require. Cleverly shaped water channels and fast flow sumps are now being created to flush fluids with as little as 2.6 litres of water and still comply with all current standards ((Water Efficient Solutions, 2009). These new efficient WCs are a huge improvement on the current average WC flushing amounts, some of which require 9 litres per flush (Water Efficient Solutions, 2009).

Ever since dual flush and low flush (less than 6 litres per flush) toilets came onto European markets, the amount of water used per flush has decreased dramatically (EEA Report, 2009). Dual flush toilets have two flushing systems that use different quantities of water, depending on flushing needs (Winchip, 2007).

In some cases, under UK building standards, for example, regulation has also enabled positive changes; the maximum cistern volume allowed has fallen from over 12 litres in the 1950s to just over 4 litres today (EEA Report, 2009). Cistern replacement devices are inexpensive and can also reduce flush volumes, typically by about 1 litres per flush (EEA Report, 2009).

According to the Environmental Preference Method (EPM), the most sustainable method for choosing WC suites is as follows (note: the Gustavsberg WSS toilet system uses a flow enlarger, where waste water is drained by using only 4 litres per flush (Anink, 1996) :

Preference 1	**Preference 2**	**Preference 3**	**Not Recommended**
Gustavsberg WSS system	Adjustable flush	Dual flush	Fixed flush

Source: Anink, Boonstra et al. (1996) *Handbook of Sustainable Building: An Environmental Preference Method*

Two other recent technologies are waterless and vacuum toilets, and waterless urinals. The most common form of waterless toilet is a composting toilet, which composts the waste, which must usually be removed manually (EEA Report, 2009). However, composting toilets are best suited to public buildings in remote sites without a water supply and therefore may not suit all commercial interior design projects. However, it is an option that should be promoted and implemented if suitable. Vacuum toilets pull waste through the toilet by using a powerful vacuum, together with only about 1L of water to rinse the bowl, thus reducing the actual amount of sewage that is produced (EEA Report, 2009). Since the vacuum toilet uses only minimal amounts of water, there is a great potential should the building have rainwater and greywater recovery systems incorporated

into it, producing even greater water savings (Water Efficient Solutions, 2009).. Also reliable and effective are the No-Touch WC flushing devices that operate by infra-red sensors. Their benefits from the 'no-touch' feature include hygiene, ease of use and aesthetics, with some models saving 30%-40% of water when retro-fitted to old larger cisterns (Water Efficient Solutions, 2009).

In the past, many older urinal installations did not have controls and would flush continuously, wasting significant volumes of water in public and commercial buildings (EEA Report, 2009). Waterless urinals are a perfect example of water conservation through efficiency. These small units are cistern-free and cistern-connecting pipe work-free, offering further savings on plumbing maintenance and replacement as well as water use (Water Efficient Solutions, 2009). Waterless urinals consist of a one way valve that allows liquid to pass through, then seal itself as soon as the flow is complete, also sealing off odours (Water Efficient Solutions, 2009). Estimates have shown that the flushing of urinals account for a minimum of 20% of a commercial organization's water consumption, based on a regular single urinal's half-hour flush pattern which consumes almost 125,000 litres of water per year (Water Efficient Solutions, 2009). Moreover, research undertaken by the Building Research Establishment (BRE) has shown that water-free urinals are less liable to contamination than those with a regular water flush, because the lime scale from tap water that absorbs urine, generating bacteria is not present (Water Efficient Solutions, 2009). Interior designers are in a unique position to recommend water free units to their clients, so as to avoid high financial repercussions should water charges increase over the coming years.

3.4 Faucets and Taps

Some of the most recent developments of faucets and taps have been focused on retaining water speed and pressure but with reduced water flow. Showers and taps can also aid in reducing water use considerably by aerating the water flow, helping to simulate the feel of a power shower yet without requiring high

volumes of water, and aeration can also be applied to water flowing through taps (EEA Report, 2009). Thermostatic mixing valves in both showers and taps are useful for maintaining selected temperatures, resulting in considerable savings of both water and energy (EEA Report, 2009). Finally, taps with infra-red sensors which provide water only when an object is detected beneath them, can result in water savings of 70 % or more (EEA Report, 2009).

No-touch automatic taps can save between 50% and 65% of water consumption. These are another effective means of water conservation because they provide a very convenient solution for hand washing, with benefits that include ease of use, safe pre-set temperatures, hygiene and aesthetics (Water Efficient Solutions, 2009). Similar to this product is the self-closing push tap, which is also more hygienic than twist or lever taps since they shut off automatically without the need for further contact, saving 40% water (Water Efficient Solutions, 2009). This tap design is a critical feature in public toilets so as to ensure users do not leave taps running, eliminating the risk of flooding.

Some tap manufacturers have developed a new technology described as ‘click-stop’, where an internal ceramic valve provides an audible click to the user, to alert them is the tap is on full or half flow ((Water Efficient Solutions, 2009). For example, if the user needs to fill the washbasin a full flow can be chosen, whereas if the user is simply brushing their teeth, a half flow would be sufficient (Water Efficient Solutions, 2009).

3.4 Water-Conserving Design Features

In addition to the plumbing fixtures themselves, there are a number of approaches to sustainable water use and reducing water consumption, preserving natural water resources and reducing impact on waste-water treatment facilities. Water distribution and disposal systems from buildings should now be replaced by more environmentally responsible alternatives.

These types of systems would enhance the efficiency of sustainable water fixtures. It is important that interior designers are familiar with the many alternatives that are now available for buildings as a whole. Two notable examples are:

1. Rainwater capture: designs that capture rainwater and store it in catchment systems to use in non-potable applications;

2. Graywater recycling: systems that collect and recycle water from activities such as bathing, laundry and dishwashing for non-potable applications like flushing toilets;

(Source: Jones, 2008)

In order for the built environment to sustainably manage its water consumption, it will depend strongly upon raising awareness of water conservation issues amongst the interior designers who specify water fittings. This awareness could be promoted in a similar fashion to that of raising awareness of energy conservation: websites, school education programmes, local authority leaflets and the media (EEA Report, 2009). Hotels can also play an important role by helping guests to make informed choices about water efficiency and conservation (EEA Report, 2009). It is imperative than when considering products for replacement, water efficient fixtures are implemented, and this will only occur if interior designers understand the impact of their current practice on water resources and changing their behavior towards it. The promotion of new water conservation technologies within the water fittings industry will play a vital role in Ireland, in order to implement sustainable water management nationally (EEA Report, 2009). Thankfully, this industry has come a long way in terms of advancement and efficiency and it continues to progress.

Sale control of water fittings would be desirable in order to enforce water conservation. Perhaps Ireland must look towards water supply regulations that would encourage the use of water efficient fittings that can lower environmental and financial costs? An initiative similar to the ban on incandescent light bulbs that would phase out inefficient water fittings would be an extremely positive reaction by government, and highlight the progress of water efficient technology. This could also be implemented by way of a water-efficient labeling scheme, highlighting the products recognized by government that assure consumers the product meets minimum water efficiency standards. Innovative technologies will continue to be developed and the use of electronics will be combined on a greater scale than ever, such as digital showers, and electronic controls for taps (Water Efficient Solutions, 2009).

The environmental awareness of an interior designer will dictate their decisions when they are choosing products that operate in conjunction with various mechanical systems in buildings. Minimizing energy and water consumption are two key areas where interior designers have a substantial amount of input, and by choosing the most efficient option they will be lowering a building's environmental impact as a whole. Although there has been a great deal of attention in Ireland devoted to energy conservation, the same cannot be said about Ireland's promotion of water conservation. Perhaps if awareness in this area was raised on a national level, designers and users alike would be more inclined to consider their actions. However, should water efficient fittings not be specified in buildings and/or interiors, a national campaign would do little to conserve water. Interior designers are the professionals who can 'make it happen', offering users no other choice but to interact with the products that they specify. This is certainly an area that should be further examined and explored and both energy and water conservation should be high on the priority list of any interior designer, in order to successfully adopt sustainable design practice.

CHAPTER FOUR

Choosing Interior Finishes and Furnishings

"I don't think that brand new materials are going to be the answer, I think it's about finding ways of using existing ones in new ways. One of the 21st century materials which has got potential in engineering terms is bamboo, given that in some uses it's stronger than steel and that it grows a meter a day,…its one of those materials which really is a miracle material and it needs to be worked in more modern ways than it has been historically…"

-Tom Dixon renowned furniture and product designer

When choosing interior finishes and furnishings, it is vital that interior designers know where to find the right answers. Sustainable design is all about implementing new techniques and new ways of thinking; new trains of thought. Designers are no longer designing for the user, but for the environment.

Interior designers must carefully research the environmental attributes and possible health effects, of finishes and furnishings, prior to specification. In

addition, once finishes and furnishings are installed, maintenance must be carefully considered (Jones, 2008). Numerous recommendations are discussed in this chapter, in terms of choosing the most sustainable materials for finishes, such as flooring, and also how to select finishes based on their impact on indoor air quality (IAQ). Embodied energy is also an area interior designers must consider, as it takes into account the energy associated with raw material extraction, manufacturing, distribution, and the life of a product (Jones, 2008). It is necessary to consider the embodied energy of a product in order to understand its true environmental advantages. For example, a product may contain environmentally responsible materials, but consume significant amounts of energy during its manufacturing and transportation (IBID). The life cycle of a product must also be considered: its Life Cycle Assessment (LCA), where the a product's inception right through to its manufacturing, use, and end of life issues are assessed. IAQ, embodied energy and LCA are three major sustainability criteria that will require interior designers to work with a consideration for human health and well-being, and with placing importance on natural systems.

Ultimately, what would be of the utmost value to the world of interior design, is a guideline for material and product selection that includes straightforward answers that address these complex areas of design. This guideline is not likely to be available in the short-term; the potential solutions discussed in this dissertation are rooted in a respect for nature as a whole, and with a consideration for sustainable development: the economic, social and environmental impacts.

The Environmental Preference Method, which is discussed in detail in this chapter is a successful, practical tool that assesses the environmental impacts of products and materials by way of comparative assessment, enabling designers to make more informed choices (Anink, 1996). The model of the EPM is used throughout this chapter at various stages as a strategy that interior designers can use when specifying certain materials and finishes.

4.1 Life Cycle Analysis and the Environmental Preference Method

Life Cycle Assessment (LCA) is a technique used to assess the environmental aspects and potential impacts associated with a product, process, or service. This can be done by:

- compiling an inventory of relevant energy and material inputs and environmental releases;
- evaluating the potential environmental impacts associated with identified inputs and releases;
- Interpreting the results to help you make a more informed decision.

(http://www.epa.gov/nrmrl/lcaccess/, 2009)

The term ‘cradle to grave’, is a term that is used during a LCA to describe the entire life of a component or product, from its creation to its disposal- which is often before the end of its defined life and with no consideration of environmental responsibility (Jones, 2008). The term ‘cradle to cradle’ is used to describe the entire life of a component or product, and this extends from the sourcing of raw materials to recycling into raw materials at the end of its defined life (Jones, 2008). This concept of ‘no waste”, modeled after nature, was introduced by architect William McDonough (Jones, 2008). For example, carpet has traditionally been made from virgin nylon, installed, and, when replaced, it is sent to a landfill: cradle to grave. By following the cradle to cradle method, the carpet is manufactured, installed and when replaced, it is returned to the mill to be regenerated as the raw material for new carpeting: cradle to cradle- a closed-loop process (Jones 2008). However, the cradle-to-cradle method is not sufficient on its own and must be used with a simultaneous focus on lowering product consumption, the use of natural/raw materials, and toxins in the production of material goods (Jones 2008). LCA is useful for assessing the lifespan of a material or product, but may remain too complex and confusing when attempting to choose the most *preferred* sustainable options available.

Yet another complex issue can be a product's service life: its replacement factor. Replacement can occur due to durability failure, change of use and fashion change. How can sustainable interior designers address these issues? Survey data conducted for this dissertation, discussed in chapter 5, illustrates durability as one of the main concerns that Irish designers cited when specifying furniture and/or materials. It can be difficult to ascertain the trade-off between eco materials and durability.

LCA can identify the environmental profiles of individual products, materials and processes, mapping out the environmental effects from extraction, production, transport, use, demolition and recycling. Yet there is much agreement that LCA is unsuitable for *comparing* choices during the design process (Anink, 1996).

A more suitable guide for interior designers to follow when choosing materials, products or finishes is the Environmental Preference Method (EPM). The EPM ranks materials according to their environmental impact, based on the following criteria:

-raw material availability
-ecological damage from extraction
-energy consumption including transport
-water consumption
-environmental pollution including waste
-human health and well-being
-repair, reuse, recycle

Source: Haslam, M. (2009)

In this chapter, various examples of interior finishes and furnishings are discussed and a model for selection, based on the EPM, is suggested, in order to illustrate the environmental considerations that interior designers should be aware of when selecting materials. This guide for selection is extremely useful for selecting finishes and furnishings that will reduce harmful effects to indoor

air quality, since most material selection criteria should be based on the needs of the occupants. The model can be applied to most material selections and is a more viable option for interior designers, because by enabling designers to choose more sustainable alternatives, they will be demonstrating their ethical responsibility to both nature and human health. Also, by choosing sustainable alternatives, designers will be forced to continuously keep well-informed, so that they can evaluate, compare, and eventually rank materials or products before specifying them (Jones, 2008).

4.2 Indoor Air Quality

Well designed buildings are those which are fit for purpose. The design of schools, hospitals and other commercial buildings can have direct and indirect effects on human health (Irish Public Health Institute, 2006). For example, good school design, as well as directly affecting the health of children, has been linked to improved educational attainment and better job prospects in adult life (Irish Public Health Institute, 2006).

According to National University Ireland (NUI) Galway's Centre for Climate and Air Pollution Studies, the average European spends 90% of their time indoors, and the quality of that air plays a significant role in health and well-being (http://www.nuigalway.ie/iapah/iapah_why.html, 2009). As expected, indoor air quality is affected by outdoor pollution. However, scientists have recently become concerned about indoor air pollution that is attributable to interior materials and substances (Winchip, 2007). The content in various finishes and furnishings can have an impact on indoor air quality (IAQ). IAQ environmental problems in commercial buildings can be divided into two categories: building related illnesses (BRI) and sick building syndrome, with the symptoms of BRI being considered more serious than SBS (Winchip, 2007).

BRI is a diagnosable disease or health problem that can be directly attributed to a specific pollutant source within a building (e.g. Legionnaire's Disease), whose symptoms do not abate or diminish after leaving the building (Jones, 2008). Sick Building Syndrome (SBS) is caused by a building whose occupants experience acute health and/or comfort effects (e.g. headache, runny nose, inflamed, itchy eyes, cough, etc) that appear to be linked to time spent therein, but where no specific illness or cause can be identified (Jones, 2008). Complaints may be localized in a particular room or zone or may spread throughout the building; symptoms diminish or abate on leaving the building (Jones, 2008).

Indoor Air Quality (IAQ) should be a major concern for interior designers because it can affect people's health, comfort, well being and of course, productivity, as illustrated below in Fig 5:

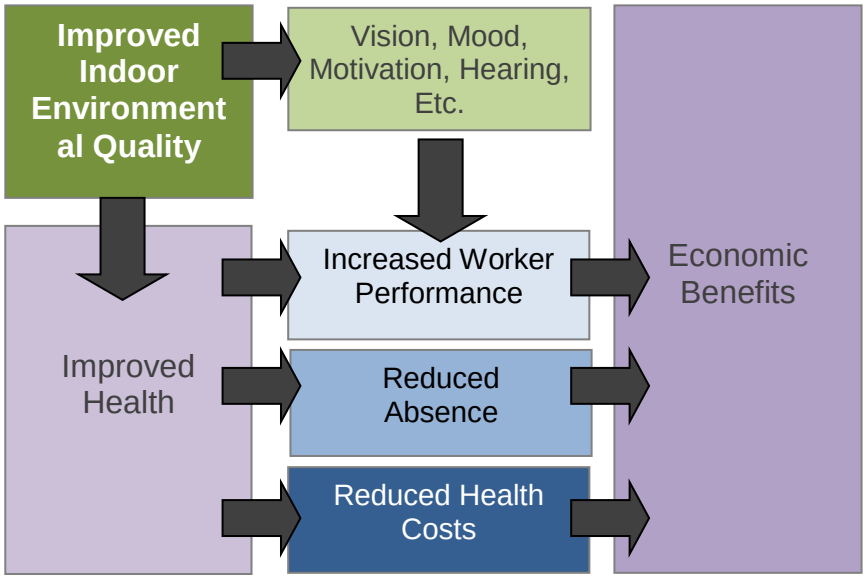


Fig 5:. The benefits of improved indoor air quality according to Bonda, P. and Sosnowchik, K. 2007. *Sustainable Commercial Interiors.*

Fig 5 not only suggests the potential productivity gains from improved IAQ, but it also illustrates the potential economic savings, where respiratory disease, allergies, asthma, and other sick building syndrome-related illnesses are reduced resulting in reduced health costs, absences and increased worker performance.

Indoor air pollutants from materials and products contain toxins that can be extremely harmful to human health. Toxins such as Volatile Organic Compounds (VOCs), Formaldehyde, Urea-Formaldehyde, and certain flame retardants are all toxins that can be found in interior finishes and furnishings. These toxin levels can be minimized by specifying the right products by an interior designer who has enhanced environmental awareness, who is committed to implementing sustainable strategies when choosing them.

4.3 Volatile Organic Compounds (VOCs): Paint

Volatile Organic Compounds are compounds that vaporize (become a gas) at room temperature (Jones, 2008). VOCs have been identified by the World Health Organization as one of the 5 main harmful substances in indoor air, and they are linked to respiratory diseases including asthma, lung cancer and mesothelioma (Irish Public Health Institute, 2006).

Common sources that can emit VOCs into indoor air include various building and furnishing materials (Irish Public Health Institute, 2006). Examples include: paints, lacquers, paint strippers, building materials, furnishings, glues, adhesives, urea-formaldehyde foam insulation (UFFI), pressed wood products (hardwood, plywood, wall paneling, particleboard, and fiberboard, including any furniture made with these pressed wood products (BREEAM Offices, 2008). By specifying finishes and furnishings that have a low or zero VOC content, a designer is implementing a sustainable strategy to improve indoor air quality.

The Decorative Paints Directive addresses the need to reduce the risk to the user and the environment due to exposure to VOCs, by limiting the VOC content in certain paints (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009). The Directive was enacted into Irish law by the Limitation of Emissions of Volatile Organic Compounds due to the use of certain Paints, Varnishes and Vehicle Refinishing Products Regulations 2007 (External link Statutory Instrument 199

of 2007) (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009). It is estimated that the Directive will reduce the VOC emissions from decorating materials by approximately 297k tonnes per year by 2010 (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009). According to the Environmental Protection Agency of Ireland, the decorating products listed in the Directive can only be sold on the market if their VOC contents are equal to or lower than the values outlined in the Directive, in its ready-to-use form (http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/, 2009). The second phase of the Directive sets emission limits on VOCs and goes into effect in 2010, so paint manufacturers are now endeavoring to comply in time, following the trend of producing more water-borne paints versus solvents (Hartman, 2009).

Reading the content labels of interior paint is crucial. When specifying paint, it should contain ‘low’ or ‘zero’ VOCs. ‘Zero’ or ‘low’ VOC paints are available from most mainstream paint manufacturers. Also to be considered are ‘eco-friendly’ paint alternatives, which are made from organic plant sources and also powdered milk-based products. Over the last five years, most paint manufacturers have improved the sustainability of their products and as a result, there is now a niche market for eco and natural paint (Hartman, 2009). Natural paint can be distinguished from eco-paint by their goal to reduce their environmental impact through addressing embodied energy and maintaining performance in terms of durability (Hartman, 2009).

The Environmental Preference Method for choosing interior paintwork for walls is as follows:

Preference 1	**Preference 2**	**Preference 3**	**Not Recommended**
Whitewash	Mineral Paint, water-based natural stain	Natural paint, water-based acrylic paint	Alkyd paint

Source: Anink, Boonstra et al. (1996) *Handbook of Sustainable Building: An Environmental Preference Method*

The Environmental Preference Method for choosing interior paintwork for wood is as follows:

Preference 1	**Preference 2**	**Preference 3**	**Not Recommended**
Untreated wax, water-based natural stain	Water-based acrylic paint	Natural paint, high-solids alkyd paint	Alkyd paint

Source: Anink, Boonstra et al. (1996) *Handbook of Sustainable Building: An Environmental Preference Method*

Whitewash is made up of lime dissolved in water with no further additives, with limestone or shells used for extraction, a relatively clean process (Anink, 1996).

Mineral paint and Water-based paint: mineral and water based paints use water as a solvent, and one of the great advantages of mineral paint is that it contains very few synthetics and can cover surfaces in a single layer, resulting in less paint needed (Anink, 1996).

Natural paint: is usually made of renewable materials but can be at a disadvantage to mineral paints because of the numerous organic solvents that are released, affecting indoor air quality (Anink, 1996).

Acrylic paint: water-based acrylic paints contain fewer solvents than alkyd paints yet contain more harmful additives such as biocides and emucifiers (Anink, 1996).

Alkyd paint: contains 40%-50% organic solvents that can threaten the painter and hinder IAQ (Anink, 1996).

Natural paints that contain plant-based solvents including linseed oils, plant or earth-based pigments are a very good alternative to synthetic paints, which usually contain petrol-based solvents and titanium dioxide pigments, causing respiratory problems, headaches, cancer, etc. (Haslam, 2009). There is no real need to preserve wood when it is being used solely internally, and a natural wax, such as beeswax is an ideal choice if woodwork must be treated (Anink, 1996). It is also more durable when it is allowed to breathe (Haslam, 2009).

4.4 Formaldehyde: Wood Furnishings

Formaldehyde is a colorless, pungent-smelling gas that can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans when exposed to high levels (http://www.epa.gov/iaq/formalde.html#Health%20Effects, 2009). It is both a naturally occurring and an industrially created chemical, and a colorless gas, which cannot be seen, smelt or tasted, which can be inhaled or absorbed through the skin (http://www.holistic-interior-designs.com/dangers-of-formaldehyde.html, 2009). The American EPA has classified formaldehyde as a potential human carcinogen (Bonda, 2007).

The most significant indoor sources of formaldehyde are likely to be pressed wood products that are made using adhesives that contain urea-formaldehyde (UF) resins. UF is also used in adhesives in plastics, as a no-iron additive for textiles and drapes, as a paper coating, and as paint preservative (http://www.holistic-interior-designs.com/dangers-of-formaldehyde.html, 2009). Common interior pressed wood products that it can be found in include: particleboard (used as sub-flooring and shelving and in cabinetry and furniture); hardwood plywood paneling (used for decorative wall covering and used in cabinets and furniture), and medium density fiberboard -MDF- (used for drawer fronts, cabinets, and furniture tops). MDF contains a higher resin-to-wood ratio than any other UF pressed wood product and is commonly recognized as being

the highest formaldehyde-emitting pressed wood product (http://www.epa.gov/iaq/formalde.html#Health%20Effects, 2009). These types of composite wood products (fiberboards) have generated serious IAQ issues for interior design because the UF binders they contain can off-gas over long periods of time (Jones, 2008). These toxins are being off gassed, not only inside our workplaces and interior environments, but also into our atmosphere. Moreover, fiberboards that contain formaldehyde-based resins can be difficult to recycle, resulting in more waste being sent to landfill (Jones, 2008).

Wood products containing phenol-formaldehyde (PF) generally emit formaldehyde at considerably lower rates than those containing urea-formaldehyde (UF). Although formaldehyde is present in both types of resins, pressed woods that contain PF would be preferable to those containing UF resin (BREEAM Offices, 2008). Table 3 lists where some of the most common sources of formaldehyde in interior materials can be found:

Table 3. Common Sources of Formaldehyde in Interior Materials

Composite wood products	Adhesives and glues	Finishes	Foams	Health effects
Plywood Particleboard Chipboard Medium-density fiberboard (MDF) furniture	Laminated products Furniture, floors and paneling, carpet backings, vinyl wall covering	Fabrics (permanent-press finishes) Floor (acid-cured) Paints Paper, Furniture stains, water-based paints (especially gloss finish), fire retardants	Mattresses Upholstery stuffing	Irritant, Headaches, Sore throat/coughing/wheezing, Eye irritation

Sources: Bonda, P. and Sosnowchik, K. (2007). *Sustainable Commercial Interiors*, Winchip (2007). *Sustainable Design for Interior Environments.*

It is alarming the number of common furnishings that formaldehyde content can be found in. Plasterboard and carpets are able to capture formaldehyde

emissions and emit them during their lifecycles; however, their own chemical content has minimal levels of formaldehyde (http://www.holistic-interior-designs.com/dangers-of-formaldehyde.html, 2009). evaporating fumes can also tend to be absorbed and released over time by large interior surfaces such as ceiling tiles and carpeting (Bonda, 2007).

It is important for designers to continually search for safer options when it comes to the toxicity of interior materials and finishes. Manufacturers have responded to the environmentally conscious consumer by creating alternative products, such as wheat board as an alternative to conventional plywood and particleboard (Bonda, 2007). Wheat board (Fig 6) is produced from compressed straw rather than wood fibers compressed with chemical resins, and it is a waste by product from harvesting (http://www.holistic-interior-designs.com/eco-wheat-board.html, 2009). It is bound together with formaldehyde-free resins and is an ideal material for countertops and cabinets, laminate surfacing, painting and staining (http://www.holistic-interior-designs.com/eco-wheat-board.html, 2009).

Fig 6: Wheat board

Straw particleboard is also an excellent alternative to wood particleboard because it is 20% lighter (Jones, 2008). Thankfully, the availability of

sustainable composite wood furnishings has improved significantly and this is a result of the research and development of new binders, such as MDI (methyl diisocyanate), which contains no formaldehyde and is used for binding medium-density fiberboard and straw-based particleboards (Jones, 2008).

4.5 Flame retardants: Textiles

Brominated (or halogenated) flame retardants (BFRs) are commonly found in textile products such as polyurethane foam cushioning, upholstered furniture, carpet underlay and textile coatings, and are used for slowing combustion once ignited (Bonda, 2007). It is important for designers to avoid polyurethane foam furnishings, such as carpet underlay, where as the underlay disintegrates, dust can be dangerously ingested (Bonda, 2007). An environmental alternative to polyurethane foam in underlay products is jute underlay (Fig. 7). Jute is environmentally friendly because its contents are cellulose and lignin, which are biodegradable (http://www.naturalfloorcoverings.com.au/CARPETS/Jute-Carpets/info/jute_information.htm, 2009). Like other synthetic products, it doesn't generate toxic gases when burnt (Bonda, 2007). The Jute fiber is naturally biodegradable because it disintegrates into the soil when exposed to water for prolonged periods, and it is available in inexhaustible quantities, at comparatively low prices (http://www.naturalfloorcoverings.com.au/CARPETS/Jute-Carpets/info/jute_information.htm, 2009).

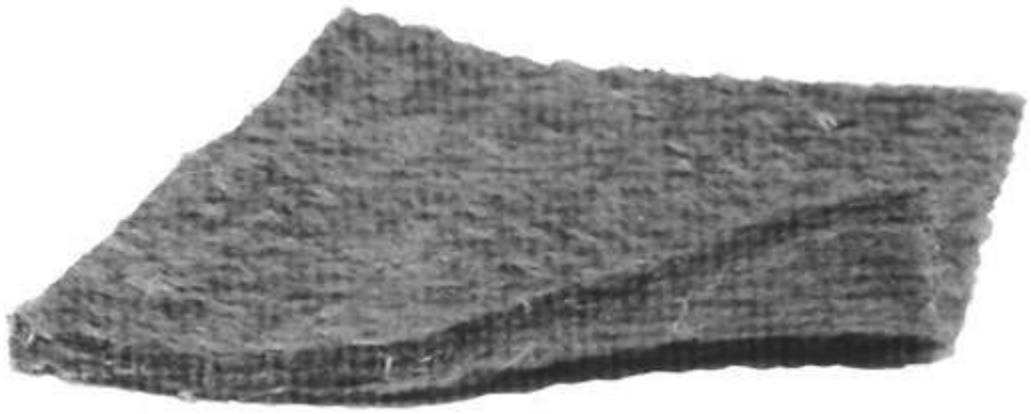


Fig. 7: Jute Underlay

Many manufacturers are not obliged to reveal which flame retardants they use in their products due to labeling laws (Bonda, 2007). Yet some companies, such as Herman Miller and IKEA are honest about communicating what efforts they are taking to eliminate halogenated compounds from their products (Bonda, 2007). IKEA applies the precautionary principle with regards to the use of chemicals and other potentially hazardous substances in their products and their impact on human health and the environment (http://www.ikea.com/ms/en_IE/about_ikea/our_responsibility/products_and_materials/making_home_furnishing_products_safe.html, 2009). IKEA has successfully eliminated BFRs from all of its furniture (Bonda, 2007). Their products also comply with the chemical restrictions of the new European Community Regulation on chemicals and their safe use, entitled REACH (EC 1907/2006). REACH deals with the Registration, Evaluation, Authorization and Restriction of Chemical substances. The aim of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. The REACH Regulation gives greater responsibility to industry to manage the risks from chemicals and to provide safety information on the substances (http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm, 2009).

Some examples to be admired, set by IKEA:

- an early voluntary ban on PVC (decided 1991) except in cables
- an early ban of all organic brominate flame retardants in furniture (effective from 2000)
- A ban on formaldehyde emitting paints and lacquers on all products (effective from 1993).

Designers should be continually persistent in asking questions about BFRs in products. By asking manufacturers for halogenated-free flame-retardants, even though it may not be possible to obtain them today, awareness can be raised which will eventually lead to changes in the future.

4.6 Finishes: Flooring

The majority of peoples' lives are spent in indoor environments- in our homes, schools and workplaces, and in these environments the choice of flooring material has a major role to play. The Healthy Flooring Network (HFN) is an alliance of organizations and individuals concerned about human health and the environment (Cooper, 2001). Research by the HFN has shown that in an attempt to control dust mites, the carpet industry adds chemicals to carpets which are highly toxic and have been banned in other applications (Cooper, 2001). After an independent laboratory analysis, HFN discovered that both carpets and vinyl are loaded with chemicals that could escape into the indoor environment. brominated flame retardants, formaldehyde and permethrin, a chemical added to carpet treatment to kill dust mites, were among the most harmful chemicals used (Cooper, 2001).

Another unsustainable flooring material is Vinyl, the second favorite flooring in UK homes and schools, with few buyers realizing that it is created from a concoction of highly toxic chemicals. There is growing evidence that some of these chemicals, called phthalates, used to soften PVC, or vinyl, can contribute to allergic disease and other health problems (Cooper, 2001). Scientific studies have shown that PVC contains dangerous chemicals that can escape into the indoor environment, with some chemicals linked to asthma (Cooper, 2001). vinyl flooring is petroleum-based (therefore nonrenewable) and its manufacturing processes also emit toxic pollutants (Winchip, 2007). It is not durable, has a negative effect on IAQ, and holds a short life cycle of 10 years, after which it is non-biodegradable and cannot be recycled (Winchip, 2007). The life span of linoleum compared to vinyl is three times greater and comes with added long term economic savings (Winchip, 2007).

Interior designers need to know how to choose the least polluting floors. The HFN points out that linoleum, wood, rubber and other alternatives are just as

hard wearing and easy to maintain as carpet and PVC in their detailed *Guide to Healthy Flooring*, and are much less likely to accumulate allergens or contain high levels of chemical additives (Cooper, 2001). It provides up-to-date information on alternative options and advises on how to safely remove carpets, also providing a comprehensive list of suppliers (Cooper, 2001).

Certain types of hard flooring materials do not retain dust or allergens as much as soft flooring materials like carpet, and it is much easier to remove contaminants from hard florring (Winchip, 2007). The following are some alternative, more sustainable choices for durable flooring:

Fig. 8

Wood (Fig. 8) is very durable and easy to clean. Choose reclaimed wood or wood certified by well-managed sustainable forestry schemes such as the Forest Stewardship Council (FSC). Laminates are cheaper than wood, however some use glues containing formaldehyde, so look for low or zero emitting boards (Cooper, 2001). Salvaged or reclaimed wood flooring are the most preferred option if specyfing wood floors, with FSC certified wood next in the order of preference (Jones, 2008). It is also advisable to obtain a list of all wood species that are endangered from the Convention on International Trade and Endangered Species (CITES) (Winchip, 2007).

Bamboo (Fig. 9) holds great environmental properies such as having low embodied energy, and beautiful graining and colour aestetics. it is becoming a more popular choice in the US due to its rapid renewable growing characteristic (Winchip, 2007). Bamboo is a grass and not a tree and therefore has a shorter

growth time than trees that are used for hardwood flooring (Winchip, 2007). Although bamboo is a sustainable flooring material, bamboo product specifications should alsways be reviewed by designers since it might not be sustainable if VOCs or any other toxic materials are present (IBID).

Fig. 9

Two excellent types of resilient flooring for the environment and IAQ are linoleum and cork (Winchip, 2007). Both are available in sheets and tiles. Both materials are biodegradeable, antistatic, recyclable and both are thermal and acoustic insulators (Winchip, 2007).

Linoleum (Fig. 10) is a very durable material, anti-bacterial, anti-static, easy to clean, flexible, warm and a good sound absorber, with an expected lifespan of 30-40 years (Cooper, 2001). The content is made up from natural substances such as linseed oil extracted from the flax plant, wood flour, natural pigments and limestone dust (Winchip, 2007). Content is locally available and requires

little energy for processing (Winchip, 2007). It is hypoallergenic, fire and mold resistant (Winchip, 2007).However, there have been some concerns about linoleum's effect on IAQ, due to the continuous oxidation of linoleum acid that is in the material (Jones, 2008). This oxidation contains VOCs that provide the bactericide properties in it yet can be a health threat to occupants (Jones, 2008). Investigation should be done into its adhesives which may not always be water-based and solvent-free (Jones, 2008).

Fig. 10: Linoleum flooring with a grained effect

Cork (Fig. 11) is warm, rich looking and durable with excellent insulation and noise reduction qualities. It is a highly renewable resource because removing its contents from Mediterranean oak trees does not require the tree to be felled,

and once the cork is removed, the tree replenishes its bark (Winchip, 2007). Binders should be UF-free. Not suitable for floors with under floor heating as it is sensitive to heat, and also unsuitable for rooms with excessive moisture such as bathrooms (Winchip, 2007).

Fig. 11: Cork flooring in an office environment, where noise reduction is essential

Natural Rubber is also very durable with good shock and sound absorbing qualities. This is particularly effective in commercial or public buildings. However, rubber floorings not recommended for most sustainable interior applications because of its off-gassing properties; the only appropriate interior applications for rubber flooring are buildings with a considerable amount of ventilation (Winchip, 2007).

4.6 Finishes: Carpet

Much of the confusion that surrounds material selection is often rooted in the debate of natural versus synthetic materials. It is essential for designers to be

aware of the comparisons between natural fibers (cotton, jute, wool, linen, hemp) that are more eco friendly than their man-made opponents (nylon, polyester) made from petroleum. Yet a textile is more than just fibers. It includes additives, dyes, resins and other residues and what also must be taken into account is their manufacturing process(es) (Bonda, 2007). Adding to the complexity are new plastics that are being made from plants instead of petroleum: fibers from agricultural products such as corn, rice and beets, which are biodegradable. Yet these newly developed fibers must also be treated with dyes, bleaching etc so those processes must also be considered. It is also vital to understand that carpet is the flooring material that most directly affects IAQ (Jones, 2008).

There are also major end-of life issues to consider with textiles. According to the Cradle to Cradle design paradigm proposed by McDonough, the ideal answer lies in *intelligent* synthetic fibers, and fabrics made from them, or else the closed-loop process of the fiber's production, use and recovery (Bonda, 2007). Petroleum-based synthetics that can be recycled at the end of their use safely, or plant based fibers that can safely return to the soil to support repeated plant growth are both viable options (Bonda, 2007). Yet, the chemicals used to treat fibers must also be considered. Therefore, interior designers must possess a broad understanding of the data that surrounds materials before they can make a selection. Their awareness of the entire life cycle of materials is essential. Fortunately, the environmental awareness of the interior design industry, in terms of its textile manufacturers and suppliers is growing significantly, as a response to new environmental legislation, that addresses pollution and waste (http://www.co-design.co.uk/jhealey.htm, 2009). A sample of complex issues to consider when debating between natural and man-made fibers is shown in Table 4:

Table 4: Comparison of Fibers

Natural Fibers	Man-Made Fibers
Biodegradable	Not biodegradable, but can often be recycled
Manufactured from renewable resources, but often produced through agricultural or farming processes, which involve the use of petroleum-derived pesticides and harmful fertilizers.	Manufactured using petroleum, a depleatable resource; however, very little petroleum is used in the manufacturing of synthetics. A heavy metal called antimony required to make polyester, can cause harmful environmental and human health risks, particularly during production, disposal and recycling.
Water and energy is consumed in the cleaning, dyeing, finishing and transporting of natural fibers. Labor-intensive processes and crops can repeatedly deplete soil year after year.	Water and energy are used in all the processing stages of all fibers, but most extensively in man-made fibers. Yet most of their production processes are essentially clean.

Source: Bonda, P. and Sosnowchik, K. 2007. *Sustainable Commercial Interiors.*

These interesting comparisons illustrate the complexity of comparing the environmental impacts of various fibers. It shows that the entire life cycle of fibers used in textiles should be researched by interior designers in order to specify the most sustainable options. It is only by researching that designers can become familiar with the textile companies who are implementing the best manufacturing practices.

The following is a summary of some the world's leading sustainable carpet collections:

1. The perfect life cycle of a product has come closest to being achieved by an upholstery fabric product called Climatex Lifecycle, developed by Swiss manufacturer Rohner Textile (Bonda, 2007). Penny Bonda details the astounding environmental attributes of the product:

"The wool, ramie, and other components of the fabric are completely compostable, so much so that the trimming waste is used as mulch in nearby gardens. The entire manufacturing process was scrutinized for environmental optimization and redesigned to completely eliminate all toxins and waste. The factory itself has become a water filtering plant, with the water coming out actually cleaner than the water going in. standing in the way of achieving a completely closed loop cycle is the use of fossil fuels both in the manufacturing of the product and its transportation from factory to end user."

Source: Bonda, P. and Sosnowchik, K. 2007. *Sustainable Commercial Interiors*

Fig. 12: Climatex Lifecycle is made up of a compostable biological nutrient designed to turn back into soil at the end of its life.

2. the Eco Intelligent Polyester (EIP) fabric developed by Canadian textile manufacturer Victor Innovatex is designed for office furniture such as seating and panels, and matches the performance and aesthetics of traditional polyester (Bonda, 2007).

Fig. 13: Eco intelligent Polyester fabrics by Voctor Innovatex represent a closed-loop technical nutrient suitable for panel and seating applications within offices.

3. Interface Fabrics' Terratex is made up of 100% recycled or compostable materials, they are manufactured with increasingly sustainable processes; they meet or exceed textile industry standards and are completely recyclable at the end of their useful life (Bonda, 2007).

Fig. 14: Interface's Terratex fabric

Other sustainable textile collections whose manufacturers seriously invest their time in recycling technology and the development of new sustainable carpets include:

- The Eco-tex collection by Arc-Com Design Studio (100% recycled polyester);
- The Re: stitch Collection by TVS Interiors for HBF Textiles (sustainable fabric collection manufactured from recycled and recyclable polyester);
- The i2 collection from Interface. No matter how the modular tiles are arranged they all work together, eliminating waste and making replacement easy
- Shaw Contract Group's L7 Collection. A C2C product
- Lees' Visio Collection of broadloom carpeting

Improvements towards the sustainability of interior textiles will continue so long as designers, architects and end-users are demanding healthier buildings, finishes and workplaces for their employees and occupants (Bonda, 2007).

Finally, a useful tool for the designer when attempting to ascertain the toxicity of a material is the Material Safety Data Sheet (MSDS). Material safety data sheet (MSDS). An MSDS is a document containing information about the characteristics and actual or potential hazards of a substance. It identifies the manufacturer of the material and usually includes (1) chemical identity, (2) any hazardous ingredients, (3) physical and chemical properties, (4) fire and explosion data, (5) reactivity data, (6) health hazards data, (7) exposure limits data, (8) precautions for safe storage and handling, (9) need for protective gear, and (10) spill control, cleanup, and disposal procedures. Mandated in America by the US Occupational Safety and Health Administration (OSHA), it is used also in many other countries in one form or the other. It is also called a Chemical Safety Data Sheet (CSDS) in Europe (http://www.businessdictionary.com/definition/material-safety-data-sheet-MSDS.html, 2009).

4.7 Sustainable Furniture Strategies

Some of the most important sustainable considerations when selecting materials are the material's reusability, its recycled content, it recyclability, if it's a rapidly renewable material, its manufacturing processes, and its place of origin. From an interior perspective, wood and plastics are two of the most widely used materials in modern furniture.

Salvaged wood or remilled lumber are both excellent choices for a designer to specify for furniture or wood flooring. New wood products, as pointed out previously in this chapter, should carry an FSC (Forest Stewardship Council) certification. Environmental damage assessed by the EPM, such as harvesting damage to tropical hardwoods should also be researched in wood products.

Solid, non-tropical wood, in cabinetry for example, is a more sustainable and a healthy choice for IAQ because it does not contain adhesives (Anink, 1996).

Plywood contains less adhesives and is longer-lasting than chipboard, and it is also important to remember that chipboard's high synthetic (melamine) chemical substances hinders its efficient waste disposal (Anink, 1996). Cost wise, the difference between choosing a solid wood over chipboard is quite significant, and in certain applications such as social housing, chipboard is the most feasible option available (Anink, 1996). However, it is hoped that major corporate companies who are embracing sustainable manufacturing processes such as IKEA continue working towards developing more affordable sustainable wood furniture.

The Environmental Preference Method for choosing wooden cabinetry is as follows:

Preference 1	**Preference 2**	**Preference 3**	**Not Recommended**
European wood	Sustainable Plywood	Chipboard, fiberboard	Plywood made from Tropical wood

Source: Anink, Boonstra et al. (1996) *Handbook of Sustainable Building: An Environmental Preference Method*

Most cabinetry is made of medium density fiberboard (MDF), yet for healthy IAQ it is crucial to ensure that the MDF doesn't have UF binders as previously discussed in this chapter (Winchip, 2007). FSC certification can also be sought out in wood fiber particleboard, hardwood veneers, and even butcher-block countertops, and ultimately, all wood products should be solvent-free, zero-UF or at minimum, contain low amounts of UF (Winchip, 2007).

Another sustainable strategy for choosing furniture is to Specify existing furniture: millions of pieces of used furniture are for sale at stores, auctions, online etc. and they can also be bought already refurbished, reupholstered, refinished, and/or remanufactured, offering significant economic savings over purchasing brand new pieces (Winchip, 2007). Finally, it is important for interior designers investigate the end of use properties of furniture pieces and address the quantities of waste that can result from various pieces. Innovative designers

are implementing new concepts to reduce waste and minimize the amount of large furniture pieces that end up in landfills. One such new concept is 'designing for disassembly' a concept that has been developed by furniture manufacturer Herman Miller. Herman Miller's Celle chair, introduced in 2005 is composed of 33% recycled content, is 99% recyclable, can be disassembled in less than five minutes, and is also produced using alternative energy (http://www.hermanmiller.com/Products/Celle-Chairs, 2009).

Innovative designers are also producing furniture from a wide range of other materials that contain sustainable properties, such as cardboard. Cardboard is a material which is practically CO2 neutral, has low embodied energy, is a benign material, holds a potentially long life span and can be a re-used material (Haslam, 2009).

In conclusion, it is important for interior designers to always consider the life cycle of materials. Focus should always be kept on reducing the amount of materials required, reducing indoor air pollutants, reducing energy needs and reducing waste (Winchip, 2007). Also, consider the most environmental alternatives: as a substitute for wood, for example, consider bamboo, which is now growing in popularity in the United States (Winchip, 2007). Any wood furnishings or finishes should be reclaimed, remilled or salvaged, or for custom specifications hold an FSC certification so as to ensure its origin is from a sustainably managed source. For healthy IAQ, designers should attempt to specify textiles, flooring and carpet systems that have low or zero VOCs, be made from recycled matter, be recyclable at end of use and/or biodegradable (Winchip, 2007). Finally, when specifying furniture pieces, serious consideration should always be given to the restoration and reuse of existing furniture, rather than specifying new products. There exist many pieces of furniture that have been designed to last for centuries. This occurs when (1) the right materials are used, (2) suitable construction techniques are employed, (3) people maintain

the furniture and take care of it, (4) proper cleaning and maintenance is performed and (5) its appearance represents an excellent standard of design and/or craftsmanship (Winchip, 2007). Again, perhaps there is a need to address our values of material culture and our links to historical craft and workmanship?

The sustainable options discussed here for interior finishes and furnishings will only continue to be developed should the demand be present. Interior designers can no longer turn a blind eye and not consider the environmental impacts that their work can have. It is their environmental responsibility to request more sustainable finishes, materials and furnishings from manufacturers and suppliers. However, without a keen and well-rounded awareness into the many issues involved in sustainable interior design, how will this demand gain strength? The following chapter assesses the environmental awareness of Irish interior designers, since ultimately the green movement in this sector in Ireland cannot make an impact until this obstacle is overcome and environmental awareness is dramatically raised.

CHAPTER FIVE

Research Methodology and Findings

"We shape our buildings and our buildings shape us."

-Winston Churchill

Sustainable interior design is based on sustainable design principles and strategies that are focused within the built environment (Kang, 2008). People interact with buildings almost every day, whether it is their home, place or work, study or recreation. The concept of sustainable development was borne out of the ideal that we must realize the developmental needs of humans without sacrificing the earth's capacity to sustain life for future generations.

The Interior furnishings, materials and finishes for buildings require significant amounts of natural resources for their extraction, transport, processing,

manufacturing, installation, use, reuse, recycling and disposal (Kang, 2008). Thus, by specifying sustainable interior materials, interior designers can promote the conservation of nonrenewable resources such as energy, water and raw materials (Kang, 2008). However, in order to accomplish this, interior designers must be knowledgeable about these environmental issues, and consider this as important design criteria in the interior design process.

In Ireland, the environmental awareness of interior designers has not been assessed to any extent at the time of this dissertation being written, to the best of the author's knowledge. Although there may be very helpful literature on the subject, the majority of this literature –especially the major texts reviewed in chapter two- were unavailable in Irish libraries, and they are predominantly focused on the United States. It is the opinion of this author that there is a lack of sustainable interior design practice present in Ireland. Interest is certainly growing, in terms of sustainability being discussed within the interiors sector, and several environmentally- conscious interior design firms, yet there remains no sustainable interior design modules present in universities, very little sustainable interior design material in third-level institution libraries and no Irish building code or regulations that focus on the sustainability of commercial interior design. Without environmental awareness, interior designers cannot make the right decisions and may be incapable of understanding the importance of implementing sustainable solutions.

5.1 Methodology

To determine the levels of environmental awareness amongst Irish interior designers, a national, internet-based survey was conducted of 232 interior designers who practice in Ireland, conducted during the months of August to October 2009. The number of respondents was 102, giving an overall response rate of 44%, which is highly acceptable for an internet-based survey. The population for this study was obtained from the practicing members of the 2

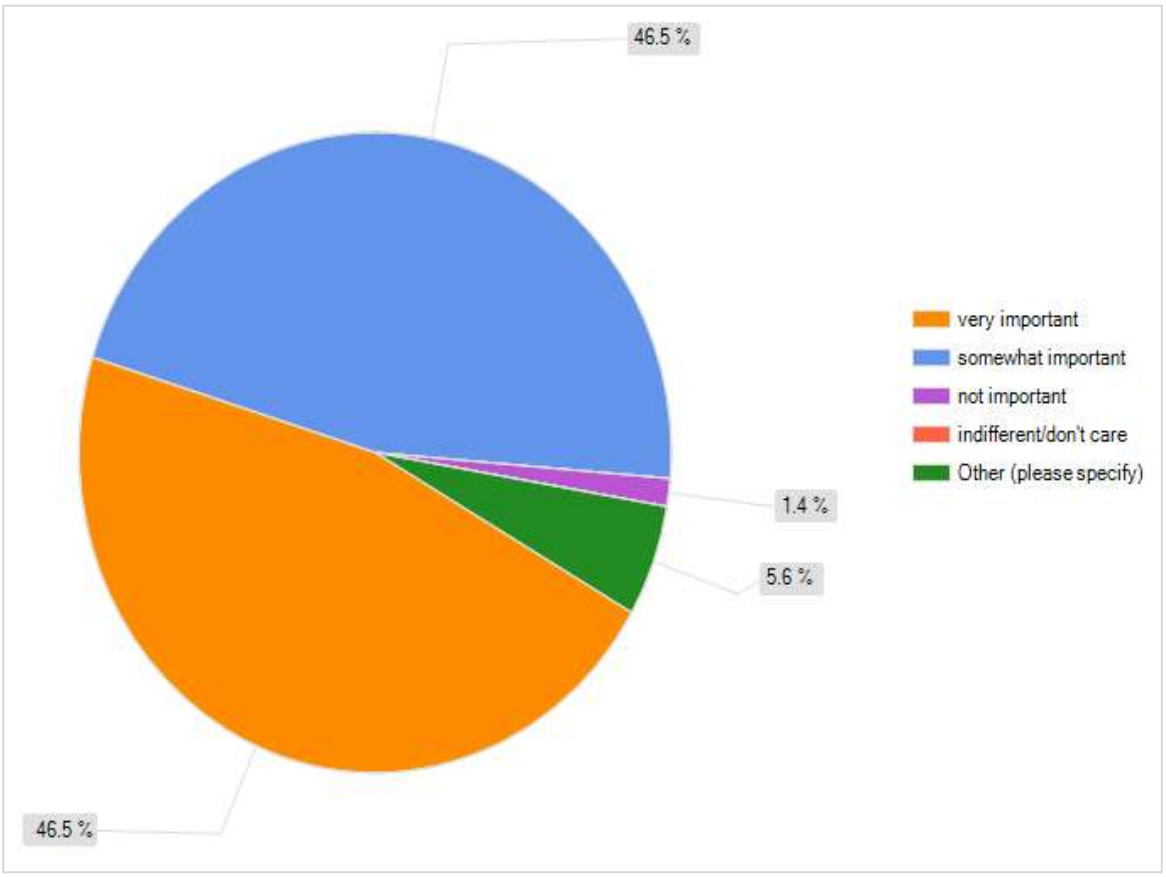
largest professional interior design bodies in Ireland, the Institute of Designers of Ireland (IDI) and the Interiors Association (IA). Data was collected using a survey of 11 questions based on sustainable interior design practice. Questions were divided into categories of: professional practice, design specialization, project type and environmental awareness. The extent of application of sustainable interior materials/products, and the awareness of environmental policy, legislation and building regulations was also measured.

5.2 Results and Findings

The following tables highlight some of the most interesting findings from this survey.

Data Collection Table 1.

Q: On a personal level, how important is practicing environmentally sustainable interior design to you?



Regarding personal practice, the majority of the respondents considered practicing sustainable interior design as either very (46.5%) or somewhat (46.5%) important, with only 1.4% citing it as not important and 0% citing indifference. This demonstrates that nearly half of the population surveyed considers their work to have an environmental impact. Yet to what extent are these designers practicing sustainably?

Designers were asked to indicate their design specialty area(s). If applicable, they could select more than one option. After residential interior design (68.4%), 48.4% of the designers surveyed specialized in corporate or office design, followed by 42.1% working in retail. Office and Retail design are both sectors

that hold great potential for sustainable solutions, as suggested in the chapters focused on lighting and water fixtures, finishes and furnishings.

Data Collection Tables 2 and 2a.

Q: Please select the sustainable solutions you currently implement in your relevant field(s):

Table 2: Response breakdown

	Energy efficient lighting	Energy efficient appliances	Environmentally friendly paints/finishes	Recycled materials	Carbon neutral materials	Water efficient plumbing fixtures
Hospitality	100.0% (18)	72.2% (13)	55.6% (10)	22.2% (4)	11.1% (2)	61.1% (11)
Residential	88.9% (32)	75.0% (27)	61.1% (22)	36.1% (13)	16.7% (6)	61.1% (22)
Health	100.0% (11)	63.6% (7)	54.5% (6)	36.4% (4)	27.3% (3)	63.6% (7)
Bar/Nightclub	81.3% (13)	68.8% (11)	37.5% (6)	18.8% (3)	0.0% (0)	56.3% (9)
Retail	84.6% (22)	46.2% (12)	50.0% (13)	34.6% (9)	7.7% (2)	26.9% (7)
Exhibition/Merchandising	83.3% (5)	16.7% (1)	33.3% (2)	33.3% (2)	16.7% (1)	16.7% (1)
Corporate/Office	95.5% (21)	68.2% (15)	54.5% (12)	40.9% (9)	9.1% (2)	50.0% (11)
Bathroom/Kitchen	77.3% (17)	63.6% (14)	59.1% (13)	18.2% (4)	9.1% (2)	54.5% (12)
Industrial	85.7% (6)	57.1% (4)	71.4% (5)	28.6% (2)	42.9% (3)	57.1% (4)
Other	80.0% (4)	40.0% (2)	60.0% (3)	20.0% (1)	0.0% (0)	40.0% (2)

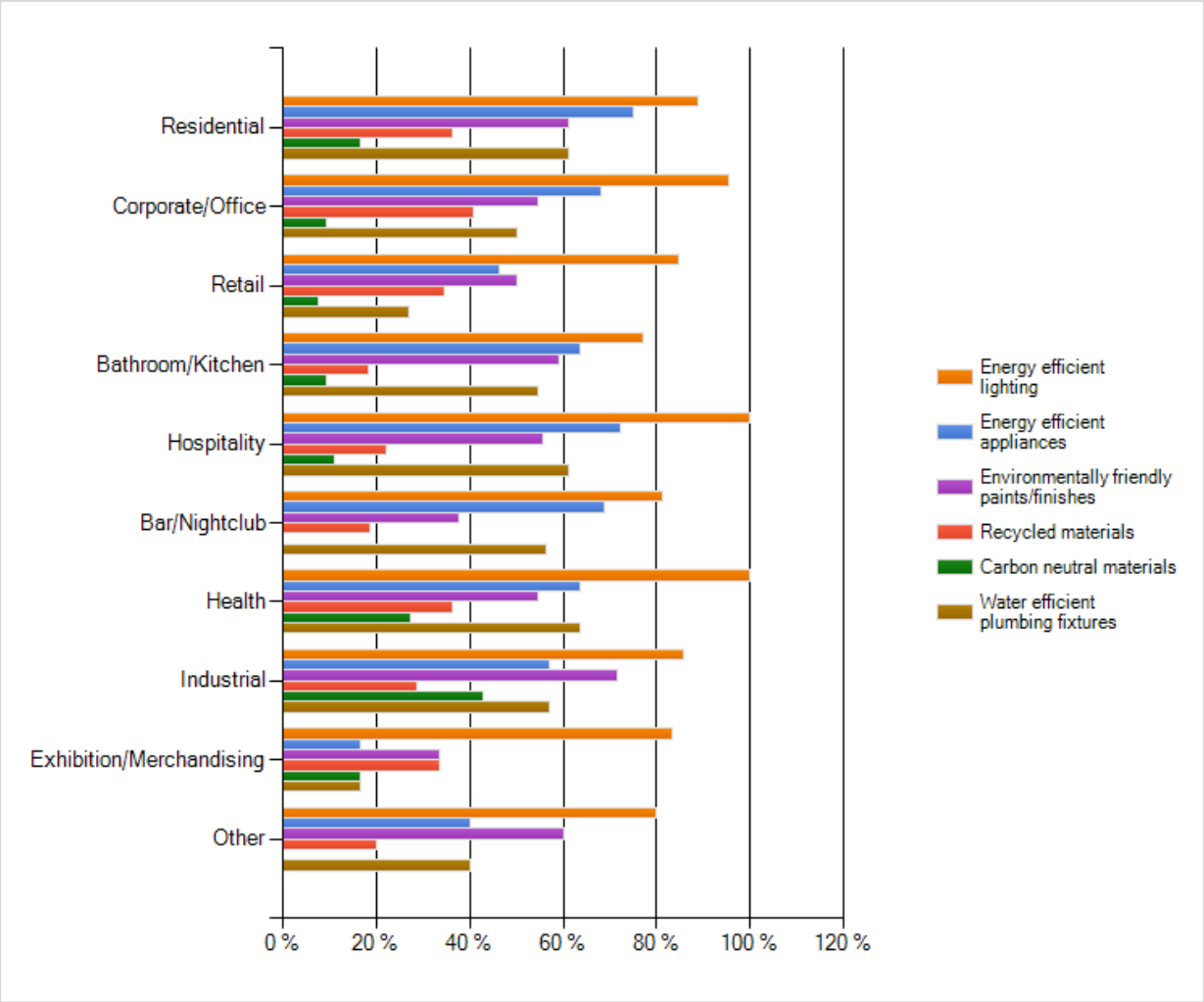


Table 2a: Response comparison graph

The findings from Tables 2 and 2a indicate that the most widely used sustainable solutions are energy efficient lighting and appliances. This may be due to public campaigns related to energy conservation, such as The Power of One. Surprisingly few respondents appear to be familiar with implementing recycled materials, or carbon neutral materials such as wood. Perhaps a national campaign should be created for addressing the CO2 neutral properties of certain materials? Are interior designers not implementing the right sustainable solutions because they are unaware of the overall benefits they include? These findings suggest that there is very little sustainable practice present within Ireland's interiors sector. However, the results also suggest that designers are viewing energy conservation as a priority in most commercial building types. This is a positive result. Yet compared to the low percentage of environmentally friendly paints/finishes used within the Heath sector, for

example, where human health is of the utmost importance, the results show that very little consideration is given to the indoor air quality of interiors.

Data Collection Table 3.

Q: Please select the most common reasons for not implementing sustainable solutions in your design projects:

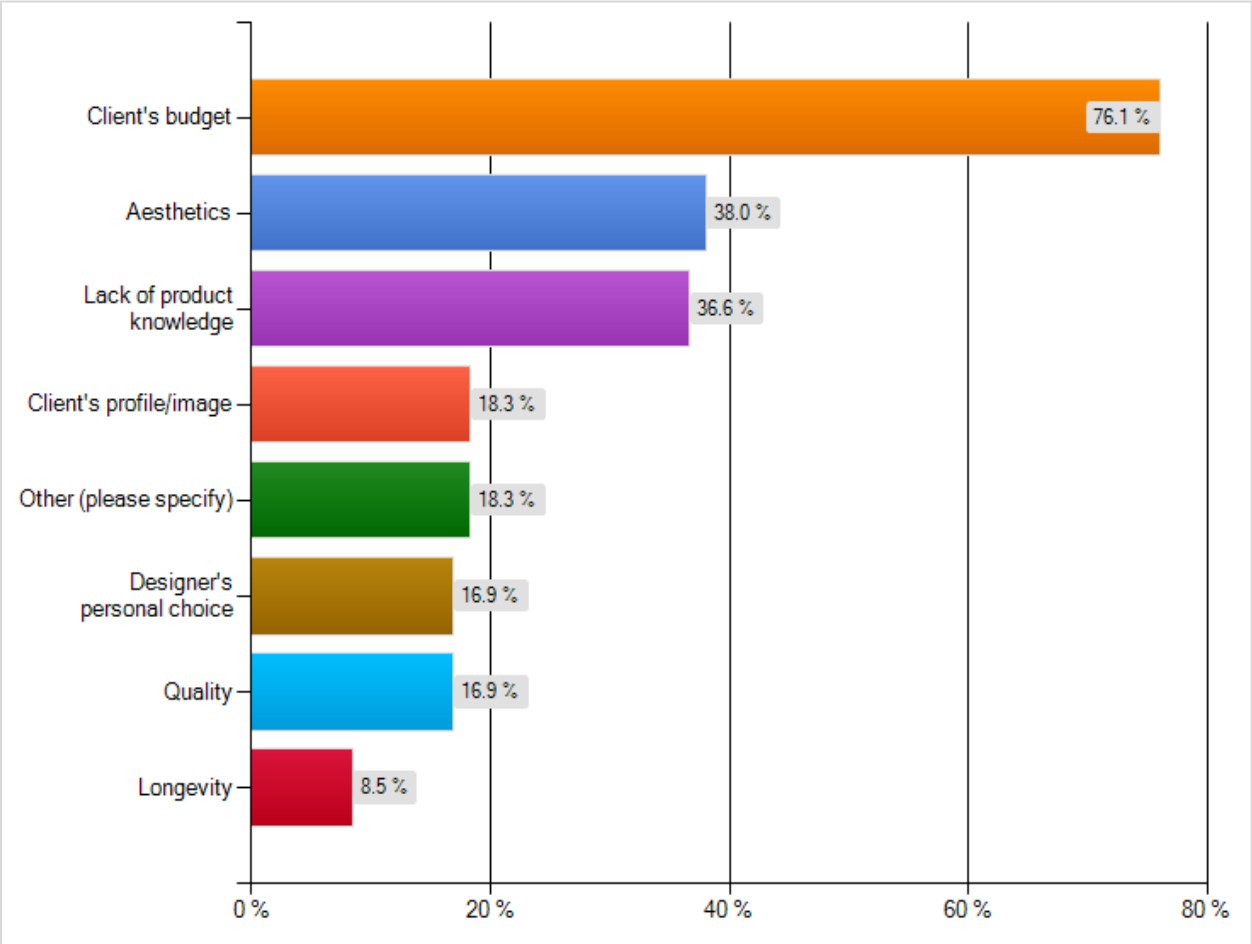


Table 3 indicates that the majority of designers cited client's budget, aesthetics and a lack of knowledge as the most common sustainable design obstacles. Perhaps these issues could be addressed by educating designers so that they can communicate environmental benefits to clients, through professional training and/or interior design literature targeted towards interior design in Ireland? 'Lack of information' - most likely including *misinformation*-was cited as a key obstacle in implementing sustainable design solutions. Additionally, that it

would involve a sacrifice in aesthetics, cost, or performance. Budget was the most highly cited obstacle at 76.1%.

These results directly relate to the misconceptions associated with sustainable interior design. In regard to budget, some sustainable products *do* cost more than other products, but this initial cost is often *offset by long-term savings*, such as the durability of the product, the reduced maintenance costs, the reduced energy/water consumption, or other benefits such as the health benefits to building occupants through enhanced indoor air quality (Bonda, 2007). Furthermore, new manufacturing technologies and economies of scale have created a market for a wide range of sustainable products that do not cost more than regular ones (Bonda, 2007), with companies targeting the gap in the market for sustainable products within the affordable price range level.

In regard to the respondents' perceptions of functional and aesthetic requirements, these are, of course, 2 major interior design priorities. Are they impinged by sustainable design? Sustainable products today meet the same performance requirements as any other product (Bonda, 2007). In the early days of the eco-design movement, some products did have quality-related issues; yet many of these issues were not related to the sustainable characteristics of the product (Bonda, 2007). There has now been a decade or more of continuous research and development as well as more modern manufacturing processes, ensuring that most sustainable products meet, and often exceed, high performance standards (Bonda, 2007).

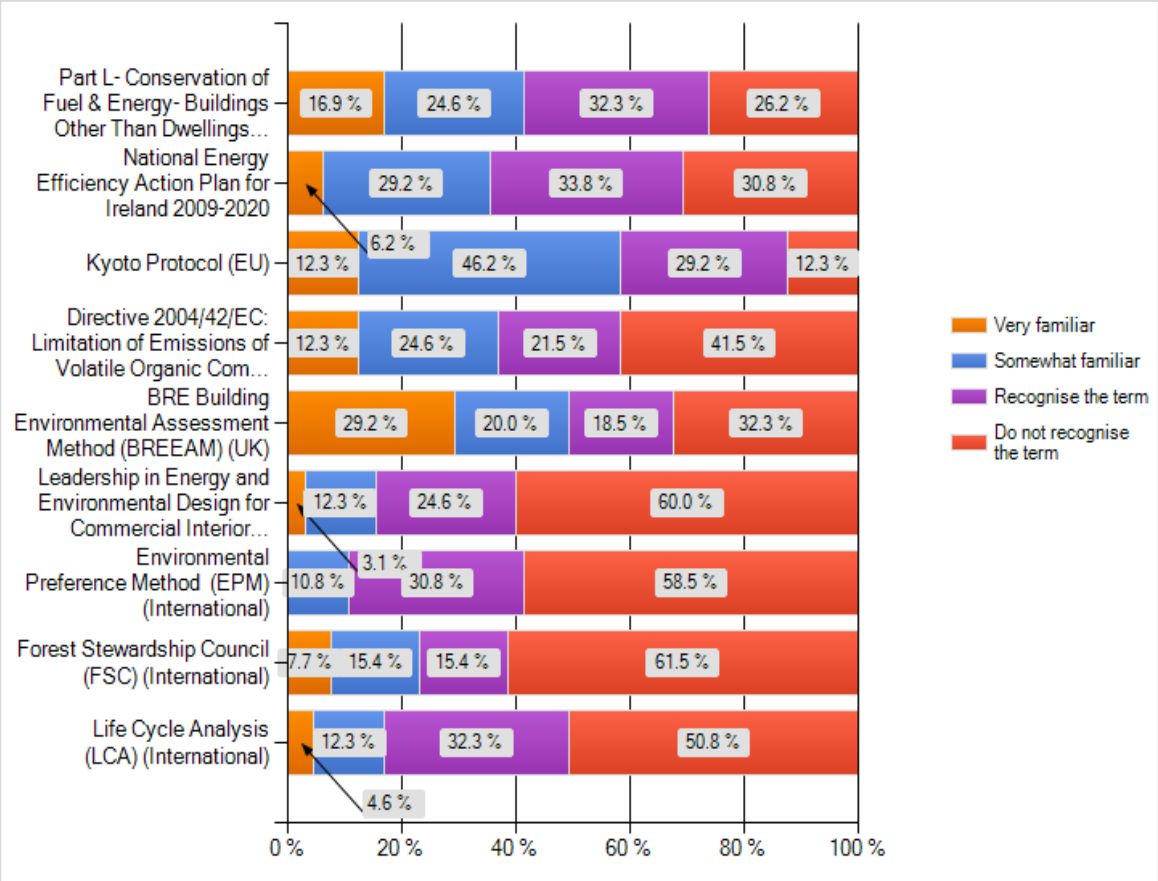
While with some sustainable products it may be evident aesthetically that they are environmentally friendly, it is often that way because they are *designed to convey that message* (IBID). Many sustainable products are unidentifiable by their appearance, as will be presented in the following chapter on case studies.

The availability of sustainable product choices is most likely a further misconception for many interior designers. Manufacturers are constantly monitoring the potential for sales opportunities that are associated with green building technologies, which are becoming increasingly prevalent (IBID).

Furthermore, these companies are also striving towards improving their own environmental responsibilities. This is leading to more sustainable products becoming readily available everywhere, with companies also changing their own inefficient waste and energy processes, instead investing in their research and development into a whole new generation of sustainable products (IBID).

Data Collection Table 4.

Q: Please indicate your familiarity with each of the following building standards and regulations:



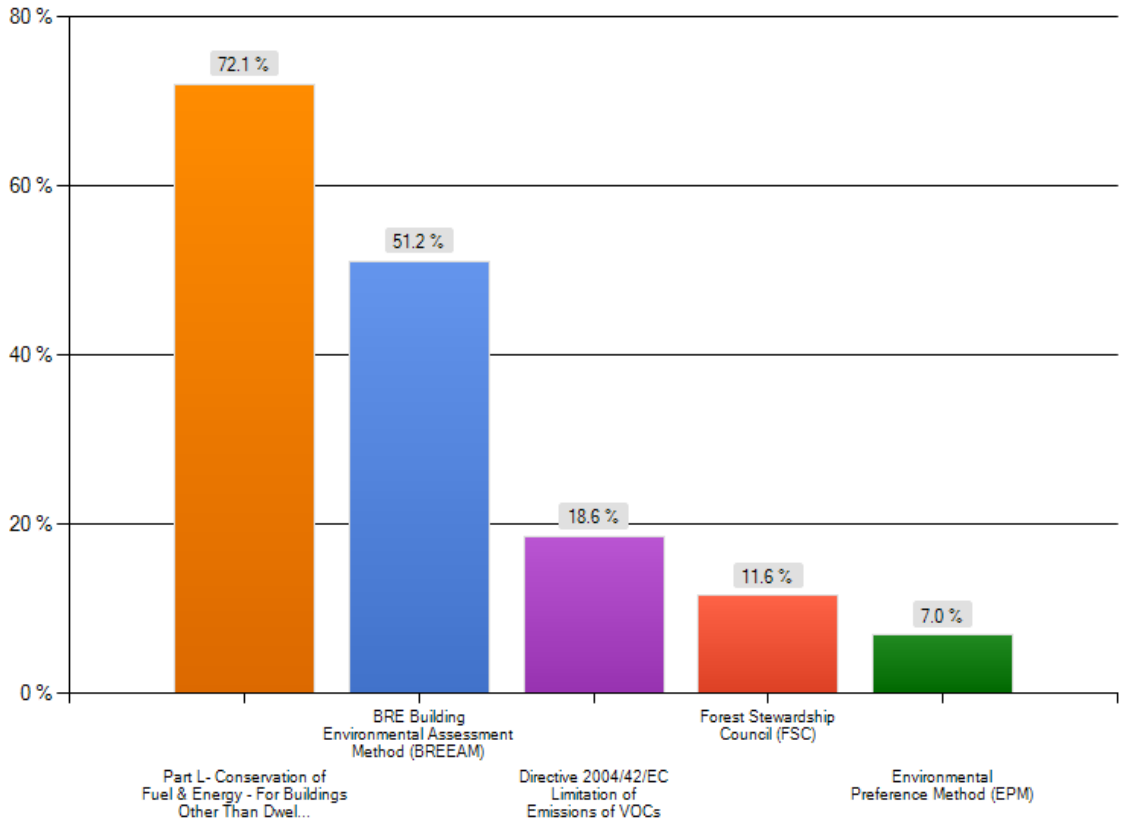
In relation to the large international sustainable design standards, the results presented in Table 4 suggest that as expected, the most familiar standards and regulations are those that have legal compliance in Ireland. These documents are also used by architects, planners, technicians and engineers, suggesting that interior designers may only be aware of their compliance through their joint workings with the abovementioned professionals. This analysis relates back to the theory of Jones, 2008, that sustainable interior design must be a joint effort from government, planners, developers, financiers, architects, engineers,

interior designers, construction managers, code officials, landscape architects and facility managers, as well as trades people.

EU legislation and policies such as the Decorative Paints Directive, the National Energy Efficiency Action Plan and the Kyoto Protocol received a minimal amount of familiarity. This suggests that many interior designers do not consider government environmental policy to relate to their professional practice, or be of little concern. It is also a reflection of their environmental awareness on Ireland. Astonishingly, the most unfamiliar guides were the FSC and EPM, which are *directly applicable* to interior designers since they relate to the specification of interior materials. Likewise, the building standard LEED CI (currently the *sole* standard that has a focus on the interior design of buildings), was one of the most unfamiliar. Overall, there was surprisingly very little awareness for the majority of the environmental standards and regulations listed, apart from BREEAM UK, which may be due to the latest emergence of BREEAM in Ireland, as discussed in chapter 1.

Data Collection Table 5.

Q: Please select from the following the environmental regulations that you currently comply with in your professional practice:



The findings illustrated in Table 5 show the extent to which interior designers comply with the sustainable design literature and guidance that is available to them. Again, very little compliance or use appears to be made of the FSC or the EPM. In addition, the Decorative Paints Directive has received very little compliance, and these results follow the pattern of Table 4 in regard to how a low level of environmental awareness can dictate what is being complied with. One confusing result from Table 4 is the low level of familiarity cited for Part L, yet in Table 5 it is cited as the response that is most complied with. This suggests that interior designers may not have an in-depth understanding of Part L in its entirety, yet state that they comply with it regardless.

Finally, designers were asked to what extent they considered indoor air quality when choosing certain finishes:

- 41.5% said they ‘always’ considered IAQ when specifying paints, with 20% citing ‘rarely’;
- 30.8% said they ‘always’ considered IAQ when specifying flooring, with 27.7% citing ‘rarely’;
- 46.2% said they ‘always’ considered IAQ when specifying adhesives, with26.2% citing ‘rarely’;
- 26.2% said they ‘always’ considered IAQ when specifying textiles and fabrics, with 32.3% citing ‘rarely’.

The results for ‘rarely’ considering IAQ when specifying the above finishes were alarmingly high and should have been lower, especially for paint and flooring.

5.3 Limitations and Considerations

This study was conducted with the following assumptions and considerations in mind:

- That sustainability is important to interior designers;
- That this survey examined only the environmental aspects of sustainability and not its economic and social aspects;
- That those who specialized in key areas may be more likely to recognize the importance of sustainable interior design, for example, a healthcare designer’s awareness of indoor air quality;
- Individuals who were more interested in sustainable interior design were more likely to respond to the survey;
- Only interior design practitioners who are members of the IDI and the IA and who had an email address were included in the survey;

5.4 Conclusions and Implications

In conclusion, this study gathered data to determine the level of environmental awareness that exists amongst interior designers in Ireland, and to what extent they employ sustainable solutions in their projects. Two major findings were concluded from this study:

- Irish interior designers possess an extremely low level of awareness for the most useful specification tools for materials, furnishings and finishes such as the FSC and the EPM, nor have they been very exposed to leading green building guides such as LEED CI;

- The lack of familiarity shown for EU environmental policy and legislation, such as the Kyoto Agreement and the Decorative Paints Directive, demonstrates the lack of environmental awareness amongst designers as to what environmental issues are the most important for the country.

In conclusion, there is a need to increase the awareness of the importance of sustainable interior design within Ireland. The development of sustainable interior design guidelines and/or continuing education and training for designers in this area is key to updating them on the most relevant environmental issues associated with their sector. It is hoped that by improving sustainable design education, more designers and design students will apply sustainable solutions more often to increase the health, safety and well being of all who live, work and play in interior environments. This cannot be achieved without overcoming this first obstacle: improving the environmental awareness amongst Ireland's interior designers.

C A S E S T U D I E S

Overcoming Obstacles

"Regardless of how efficiently we use resources, if design doesn't inspire people, it will not last. If we get it right, sustainable design promises to bring art and science together."

- Lance Hosey, sustainable architect and designer

1. World Resources Institute Headquarters Office Interiors Washington, D.C

An office environment that expresses the company's mission through environmentally-friendly design.

a. Energy: lighting consists of personally controlled dimming switches, sensors and smart controls to enhance energy savings by cutting or reducing power supply when products are not in use. Pendant fixtures hold low-mercury fluorescent lamps, all directed according to tasks. All fixtures have integral occupancy and daylight dimming sensors. All office equipment and appliances are "Energy star" efficiently rated.
b. Materials: wall facings are covered with 100% recycled paper and finished with a low-VOC joint compound. Wall partitions are made of gypsum board with high recycled content.
c. Paint: walls, ceilings and miscellaneous metal are treated with water-based paint that is free of petroleum- based solvents and VOCs. Accents

in the lunchroom are done with milk paint from paint made with milk protein, lime, earth pigments and clay fillers, created from the Old Fashioned Milk paint Company.

d. Flooring: Elevator lobby flooring is made of cork, a natural, renewable and sustainably harvested material. The cork tiles are finished with a UV-cured acrylic coating, which is durable, formaldehyde-free, zero VOC and low maintenance, requiring only sweeping and mopping. Reception area flooring is bamboo, with a water-based polyurethane finish that is durable and easy to maintain.
e. Carpeting: offices and hallways are tiled with a 100% solution-dyed Interface Carpet tile system, installed with a water-based, zero-VOC releasing adhesive which can be replaces as and when needed, reducing waste. Tiles are water impermeable meaning that they cannot retain moisture, so there is no possibility for the growth of mold or mildew. At the end of the carpet's lease period, interface removes the carpet and recycles it into new carpet.
f. Furniture: office design was configured to maximize workspace and to enable the best integration of technology. Soft curves, natural finishes and mobile pedestals enhance comfort and flexibility. Work surfaces are made from a durable wood fiberboard finished with a low-emissions, zero-waste, UV-cured process (Fig. 15). Workstation panels are covered in fabric made from 100% recycled plastic. Chairs are by Danko, and made from just 11 pounds of laminated maple each, with their woven seats and backs made from surplus automotive seatbelt material.
g. Sustainably Harvested Wood: wood paneling in the reception area, handrails, guardrails and reception desk are constructed from certified sustainably harvested wood sources (Fig.16).
h. Reclaimed Wood: used in the reception area furniture
i. Cabinets and Work Surfaces: cabinets in kitchens and workrooms are made from bio-fiber materials and are formaldehyde-free. Kitchen countertops are made of linoleum on a wheat board substrate (Fig. 17). Other work surfaces are made from Environ, a solid, formaldehyde-free biocomposite made from soybeans and recycled newspaper. All millwork

is sealed with zero-VOC clear finishes made of polymerized linseed oil, with all finishes holding extremely well after five years occupancy.

Case study source: Odell, et al.(2006)

Fig. 15

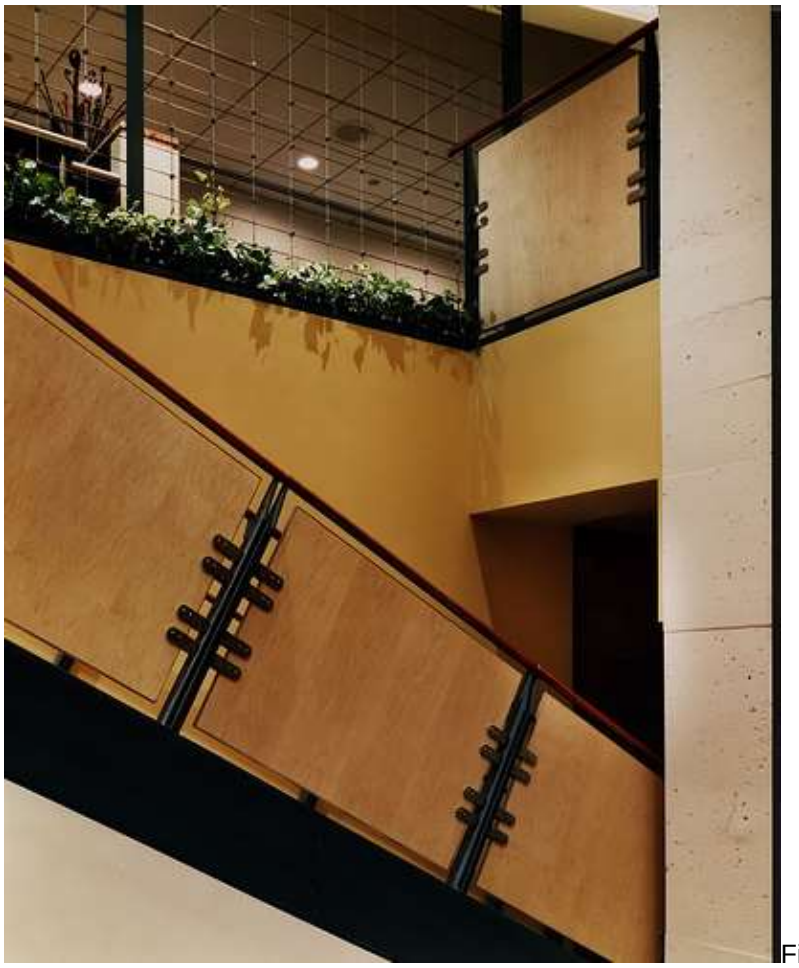


Fig. 16

Fig. 17

2. National Wildlife Federation Headquarters Office Building, Reston, Virginia

a. Energy: occupancy sensors are located throughout the building, with daylight switching in perimeter zones. Pendant direct/indirect fixtures mounted over workstations provide an even distribution of ambient light, supplemented by task lighting.
b. Materials: Ceilings use a high-reflective ceiling tile with high recycled content (Fig.18). linoleum and carpeting are main flooring materials (Fig.19). Doors, millwork and accent materials use natural, renewable, bio-fiber materials as an alternative to wood or synthetics. All wood veneering is FSC certified.
c. Furniture: all systems furniture were selected based on functionality requirements as well as manufacturer's initiatives to eliminate waste and pollution from their manufacturing processes (Fig. 19, 20).
d. Indoor Air Quality: contaminants released during construction were limited due to the use of water-based, low-VOC paints, adhesives and finishes.

Case study source: Odell, et al.(2006)

Fig. 18

Fig. 19

Fig. 20

3. Haworth Merchandise Mart
Office Furniture and Interiors Showroom
Chicago, Illinois

a. Features: a striking feature of the showroom is the variable-height raised-floor system; modular, elevated floor panels improve air circulation naturally by increasing the efficiency of the sub-floor HVAC system while adding visual interest. The floor panel materials consist of stone, glass, carpet and cork with wheat-board substrate.
b. Energy: low-voltage, light- and motion-sensitive lighting system. All of the Haworth showroom's electrical systems are powered entirely by wind.
c. Materials: Haworth reused many materials left by previous tenants, diverting more than 50% of all construction materials from

landfills. Most of the showroom's new fixtures and architectural elements were manufactured in Michigan, Wisconsin or Illinois—all within a 500-mile radius of the Merchandise Mart. Furthermore, many of the products Haworth sells are GREENGAURD Indoor Air Quality and Forest Stewardship Council Certified. Haworth's fabrics are made of 100% recycled fibers and products made of post-consumer or post-industrial recycled content (Fig.21).

Case study source: Hoyer (2009)

Fig. 2

4. Herman Miller Office Furniture

Herman Miller is a furniture manufacturer leading the way in environmentally-intelligent design. They strive to use environmentally safe and healthy materials; design for material reutilization such as recycling or composting; use renewable energy and efficient use of water, and implement strategies for social responsibility (http://www.hermanmiller.com/About-Us/Environmental-Advocacy/Cradle-to-Cradle-Certification, 2009) .

The following are examples of Herman Miller products that have earned McDonough Braungart Design Chemistry (MBDC) Cradle to Cradle certification (Miller, 2008):

Aeron Chairs - Silver certification: adapts to body shape and is 94% recyclable

Celle Chairs - Gold certification: dissasembles in five minutes and is 99% recyclable

5. Chest of Drawers

By Tejo Remy, Droog Furniture Design

Remy's chest is a criticism of overproduction and consumerism. His design also addresses waste, one of the biggest issues of the furniture design profession. The chest has no fixed form and the drawers can be combined and changed at will. All drawers are reclaimed second hand individual pieces.

Fig. 22

6. Favela Chair

By the Campana Brothers

The Favela chair is a low-tech, artisanal approach to design, employing sustainable, readily available, and often recycled materials. It is inspired by the favela constructions in Sao Paulo, and by using scraps of wood they found on the streets, the Campana Brothers created this intricately fabricated chair.

Fig. 23

7. Spring Chair

By Modern Bamboo Furniture Co.

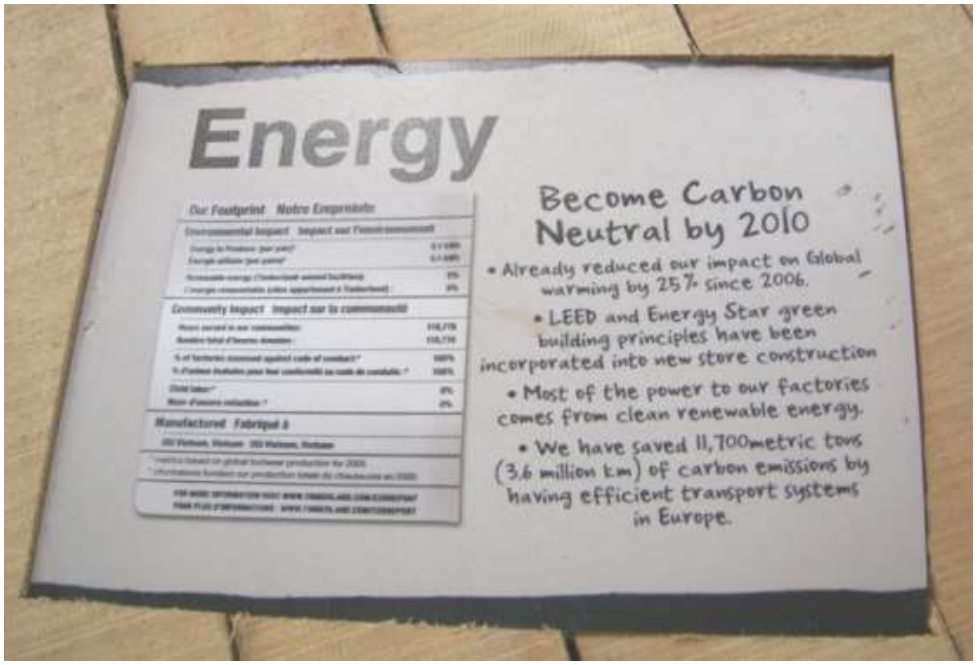
This piece of furniture has gentle curves reminiscent of molded ply, but it is made of 100% bamboo, and is both an example of sustainable furniture at its best and simple, minimal, exuding elegant functionality (www.apartmenttherapy.com/.../spring-chair-010048, 2009).

Fig. 24

8. Timberland shop fit in major Dublin retail department store Arnotts

The social communication power of retail design is used extremely well here in the new menswear Timberland shop fit in Arnotts, installed in autumn of 2009. Not only is the shop fit made with reclaimed timber slats, Timberland has gone as far as to include references to sustainable materials that can be used and how they can reduce energy consumption. This design is a perfect example of a designer's awareness, enthusiasm and commitment to environmental issues so as to inform their clients and consumers.


• We have created an electronic database of materials that includes materials' environmental attributes and climate impact ratings. Designers can now search for materials that meet their environmental objectives.


Energy
Our Footprint Notre Empreinte
Environmental Impact Impact sur l'environnement
Community Impact Impact sur la communauté
Manufactured Fabriqué à
Become Carbon Neutral by 2010
• Already reduced our impact on Global warming by 25% since 2006.
• LEED and Energy Star green building principles have been incorporated into new store construction
• Most of the power to our factories comes from clean renewable energy.
• We have saved 11,700metric tons (3.6 million km) of carbon emissions by having efficient transport systems in Europe.

C O N C L U S I O N

Providing Designers with Environmental Solutions

"Design is an integrative process that seeks resolution (not compromise) through cross-disciplinary teamwork. Design is intentional. Success by design simply means prospering on purpose."
- Michael Smythe, Partner, Creationz Consultants

The special skill that a designer brings to a problem is their unique ability to problem solve. Interior designers and their clients are heading forward into a new generation that is uncertain and there will most likely be immense professional challenges (Grant, 2006). The complexity of the issues involved can be overwhelming for designers and many issues are technical, relating to energy use and other mechanical systems of the building, leading designers to believe that they can go without educating themselves and leaving the decisions up to engineers and other professions, beyond the scope of interior

design (Bonda, 2007). Yet, as Jones (2008) and Bonda (2007) both concede, one of the most fundamental issues in sustainable interior design is that its execution is an integrated process, one that includes *all* project participants from the very beginning.

It is unlikely that there is going to be an abrupt shift in the way interior designers work and implement sustainable solutions. It will happen gradually, but steadily. Changes will encourage more widespread sustainable thinking within the interior design sector. By focusing on improving the selection process when specifying furniture, finishes and fittings, some of the most common components of an interior will spread this message throughout the industry. Designers need to learn how to balance the conflicting issues of sustainability by integrating individual solutions in creative ways, to use less, and use what is available rather than always specifying new components and materials. There is no one solution –it will be a gradual build-up and a self-disciplining process that will progress change. This is not a bad thing: designers must always be kept on their toes, it will keep things fresh and innovative –exactly what design is all about. Designers should also remember to continuously monitor which sustainable design decisions work and which do not. This fundamental practical research will be useful for future projects. Some learning outcomes from sustainable decision-making will be restricted to specific project types and some may apply to all.

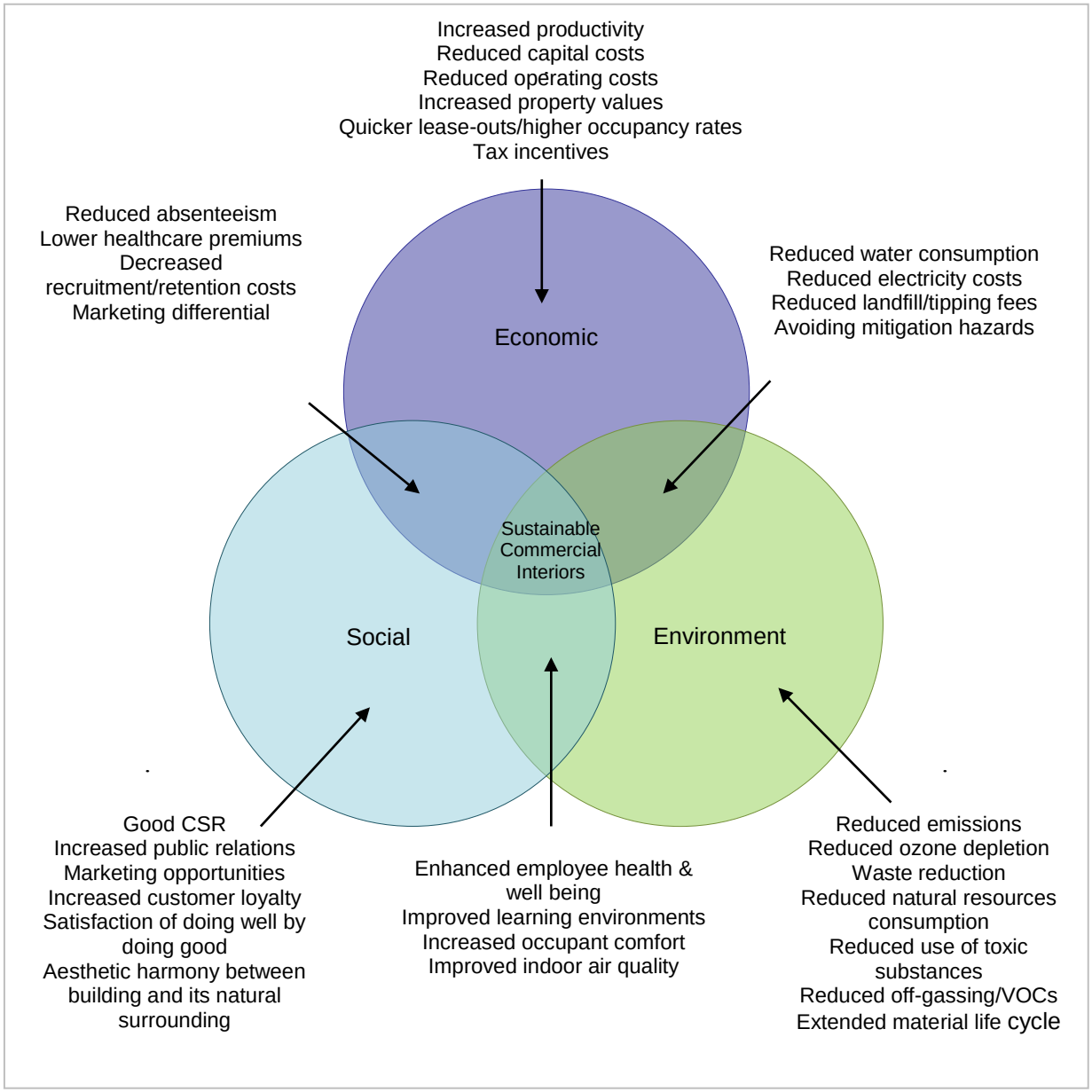
Design Education

The field of sustainable interior design, especially within the commercial sector, requires constant continuing education, and designers should take advantage of any professional learning opportunities, and keep up to date with environmental design news, events and happenings. It is the responsibility of industry bodies such as the Interiors Association and the Institute of Designers of Ireland to make these types of continuing education opportunities available as leading design accrediting bodies in Ireland. Professional CPDs that address environmental ethics and the role of sustainability within a design practice

should be available for professional interior designers. In addition, this training must incorporate a global environmental perspective, and not be just related to Ireland. The development of training courses for capacity building in environmental administrations and companies within the interiors sector is also a viable option, to enhance awareness in lesser-known regulations, such as the Decorative Paints Directive.

Irish universities that accredit interior design programs should require that students attain a solid understanding of sustainable interior design. As the Irish environmental regulations and rating continue to progress, clients will prefer to employ designers who have the ability to achieve these ratings and comply with environmental building standards. It makes good business sense to not only understand the moral obligation of sustainable interior design, but also to be able to practice it to a high standard, understanding the issues of Corporate Social Responsibility (CSR). Take for example the US's Council for Interior Design Accreditation's (formerly FIDER) new professional standards that were set in January 2006: the standards ensure that interior design education-and the graduates it produces- is fully prepared for what lies ahead of them in the profession (Bonda, 2007). It includes specific sustainable design criteria that reflect the increasing impact of sustainable design on professional practice, both today and in the future (Bonda, 2007). This initiative will prepare America's interior design education to move forward as the sustainable design movement progresses.

Finally, it is crucial that interior designers are aware of the long term benefits and multiple savings from sustainable interior design discussed in this dissertation, and as graphically illustrated by Penny Bonda (2007):



Source: Bonda and Sosnowchik, 2007, p.13

Education highlighting the *economic, social and environmental foundations of sustainable development, as it pertains to commercial interior design*, needs to be communicated and promoted within Ireland's design *and* its construction industry, to help raise awareness.

Sustainable Interior Design Strategies

To summarize some of the key sustainable strategies discussed in this dissertation, the following are some general considerations to remember when selecting interior furnishings and finishes, according to Bonda, 2007:

- Recycle: use materials and products made up of recycled propertied such as polyester fabric made from recycled plastic bottles, other examples.. Plan for recycling at the construction and design stages. For example, specify recycling bins and their required storage space to be allocated to enable full recycling capabilities.

- Overcome time inconveniences: separating waste for recycling, refinishing damaged furniture rather than sending it to landfill, recycling ink cartridges, tasks that may take longer can, when done collectively, have significant ecological benefits.

- Reduce embodied energy by buying local (within 500 miles) to minimize fuel use, and negative transport impacts on land, water and air. By refurbishing an existing building, the embodied energy that is already present within their structural massing is preserved, and reduces the need to build something new.

- select products with low or no VOC content and always choose water-based finishes wherever possible, to address indoor air quality issues;

- consider the entire life cost of the product- their durability, maintenance, and embodied energy;

- Try to use products that have a high recycled material content, or products that can be recycled, reused or salvaged, to address their end of life issues; if possible, use products that are made up of naturally

renewable materials, that can be more easily recycled at their end of use, or which are biodegradable if sent to landfill.

- Only use precious materials sparingly, such as tropical hardwoods, and only when they are certified from a sustainably managed forest, certified by the Forest Stewardship Council (FSC). Also, specify all wood to be from same; Make eco-wise decisions such as re-finishing an original wood floor rather that installing a new one. Where this may be unsatisfactory, use rapidly renewable materials, such as bamboo flooring-, which is harder than oak.

- Consider the adaptability and flexibility of a space: designing spaces for multiple uses and/or different user groups that can easily be re-adapted and reused, without requiring major refurbishing. For example, dividing spaces with dismountable partitions.

- Safety comes first when specifying materials and fire codes must always be met, especially when selecting textiles, and this takes precedence over any environmental concern (Bonda, 2007). Fortunately there are a number of excellent sustainable solutions available which meet both needs (Bonda, 2007).

- Design an energy-efficient lighting plan; specify energy-efficient electrical appliances and equipment

- Specify water-efficient plumbing fixtures that help to reduce and conserve water use

- The most sustainable product choice is not always obvious. As examined in chapter 4's section of natural fibers, many designers would consider natural materials such as cotton to be the more environmental choice, but some natural materials require extensive and often negative land

use, whereas synthetic yarns such as polyester can often require less energy and less processing than natural fabrics.

It is also imperative that Irish interior designers attempt to utilize and comply with the relevant policies and regulations so as to guide them towards sustainable solutions. The following is a list of green building and assessment guides that should be used by interior designers:

- BREEAM applies to interior design because it addresses refurbishments, the use of artificial lighting and the emissions of VOCs in finishes(Volatile Organic Compounds), which can impinge on indoor air quality (BREEAM Offices, 2008).
- TGD Part L- Conservation of Fuel and Energy for Buildings other than Dwellings- applies to interior design because it gives the limits of energy consumption of a commercial building. Interior designers specify non-structural components such as lighting and appliances, so awareness is crucial.
- Directive 2004/42/EC applies to interior design because designers must be knowledgeable of which finishes comply with the directive, and inform their clients. VOCs are emitted by a wide range of products such as paints and lacquers, furnishings, glues and adhesives, pressed wood products (hardwood plywood wall paneling, particleboard, fiberboard) and furniture made with these pressed wood products (BREEAM Offices, 2008).
- FSC certification applies to interior design because it is the most widely accepted certification for sustainably managed forests and can be sought when specifying wood furniture, flooring, etc.
- The EPM applies to interior design because it is a tool in which to aid designers when specifying materials, in order of environmental preference; it ranks materials according to their environmental impact.

- Remember that not all environmental certifications are equal and it is crucial that interior designers understand how they are testing and exactly what they are validating (Bonda, 2007).

Finally, sustainable interior design requires a fresh new way of thinking, an embracing of a new way of practicing design where designers are ethically -and most likely in the future, legally- obliged to inform their clients of the most sustainable design options. In order for interior designers to embrace sustainability, their firms should possess certain operating principles:

1. -the incorporation of the company's environmental philosophies and it's integration into the long term plan of the company, and in all decision making processes;
2. - continually keep itself updated in terms of solutions for improving the health of people and minimizing the environmental impacts-direct or indirect;
3. support and encourage environmental practices that are cost-effective, and serve to benefit the end user;
4. embrace the wide range of practices that focus on conservation of energy consumption, sustainable management of natural resources and closing the gap between consumption and waste;
5. promote design solutions that reduce pollutants in all stages of the life of products, materials, finishes and furnishings;
6. Support and provide preference for sustainable products that come from manufacturers who keep sustainable practices.

Source: Winchip, S. (2007) Sustainable Design for Interior Environments

Conclusion

It is no longer enough to be an expert in one field but to be a co-learner, a member of a network of mutual learning, because no one person can know all the issues that need to be addressed within sustainable interior design; a collective knowledge is far greater than individual knowledge and in sustainable design, this advice is paramount (Bonda, 2007). Innovation will also be a key driver; LEED CI has become the unofficial interiors industry standard within North America, but it does not address aesthetics, and certification does not guarantee the best of design. Economic savings may be the best way to sell sustainability to a client, but it is important to keep innovation at the forefront, hand in hand with creativity. Innovation is a key player in every step of the design process. Creating an interesting and attention-grabbing element, such as creating a staircase that will encourage its use rather than using elevators will propel users to interact with it, resulting in reduced energy use.

One must keep in mind the industrial revolution: a new one is happening, and it appears it has begun in the US. Green design has become a powerful communication tool of the corporate world, as demonstrated in the previous chapter containing case study examples. Society is learning and green design is spreading. Is this a revolution that Ireland may be left behind in? It is imperative that Irish interior designers begin implementing sustainable solutions today, so as to be prepared for the increasing environmental policy and legislation that is sure to follow tomorrow, as more natural resources are abused and depleted. Interior design students must also understand the urgency and importance of knowing the meaning of sustainable interior design, for the sake of Ireland's design industry future.

Perhaps it is time to re-address one's values of product appearance and material culture in order to tackle the environmental degradations that can result from the many steps of the design process (Walker, 2006). An important aspect of sustainable development is the 'local' characteristics of place. Therefore, it may help interior designers to reflect on their past and return to learning from

craft and folk design traditions. The main challenge for all types of designers is to find ways of bringing together the local and the global, to create designs that suit modern, technologically and economically developed societies (Walker, 2006, p.36). If designers can begin to consider the environmental issues that are a result of interior design, they will be making a step towards fulfilling their environmental duties. This may involve ‘re-designing’ their own designs, a completely new way of working. A return to the ‘local’ characteristics of place.

Interior design decisions can be no longer made based on aesthetics, budget and functionality. Designers now have a responsibility to create indoor environments that reflect environmental awareness, environmental protection and the sustainability of the building itself (Jones, 2008). Interior designers must now question the effects of their work not only on the natural environment, but also in view of human health; they must consider the effects of their work on humanity.

R E F E R E N C E S

Book:

Anink, Boonstra *et al.* (1996). *Handbook of Sustainable Building: an Environmental Preference Method* for *Selection of Materials for use in Construction and Refurbishment.* James & James Ltd., UK.

Armstrong, S. and Botzler, R. 1998. *Environmental Ethics: Divergence and Convergence,* New York: McGraw-Hill.

Bonda, P. and Sosnowchik, K. 2007. *Sustainable Commercial Interiors.* John Wiley & Sons, Inc, Hoboken, New Jersey.

Bryman, A. (2001) *Social Research Methods,* OUP, Oxford.

Building Research Establishment Ltd., (2008) *BREEAM Offices Assessor Manual 2008*, BES 5055: ISSUE 3.0, BRE Environmental & Sustainability Standard. [Online], BRE. Available from www.BREEAM.org (Accessed 20 August 2009)

Building Research Establishment Ltd., (2008) *BREEAM Retail Assessor Manual 2008*, BES 5056: ISSUE 3.0, BRE Environmental & Sustainability Standard. [Online], BRE. Available from www.BREEAM.org (Accessed 20 August 2009)

Danlers (2008) *Controls for Lighting and HVAC,* Product Catalogue July 2008, UK.

Denscombe, M. (2007). 3rd edition. *The Good Research Guide*, Berkshire, Open University Press.

Jones, L. 2008. *Environmentally Responsible Design: Green and Sustainable Design for Interior Designers,* edited by Dr. Louise Jones LEED AP, IDEC, ASID, IIDA. 2008, John Wiley & Sons, Inc. Hoboken, New Jersey.

Kelly, M. 2007. *Values and Behavior in Ireland, Research Programme on Environmental Attitudes, Environmental debates and the Public in Ireland,* Published by Institute of Public Administration.

McLennan, J. (2004). *The Philosophy of Sustainable Design,* Kansas City, Mo: Ecotone.

McWilliams, David. 2005. The Pope's Children Ireland's New Elite, Gill & Macmillan Ltd.

Odell, B., Mendler, S., and Lazarus, M. (2006) *The HOK Guidebook to Sustainable Design*, Second Edition (Wiley, 2006) Review by Muscoe Martin, AIA.

Simms, A. 2005. *Ecological Debt,* London: Pluto Press.

U.S Green Building Council, (2006) *Commercial Interiors Version 2.0 Reference Guide*, Third Edition, October 2006.

Walker, Stuart (2006). *Sustainable by Design: Explorations in Theory and Practice.* Published by Earthscan, University of Michigan.

Winchip, S. (2007) *Sustainable Design for Interior Environments*. Fairchild, Cornell University.

Digital Presentation:

Danlers (2008) Introduction to Energy Saving Lighting Controls (PowerPoint) 05/09/08.

Danlers (2008) Building Regulations and Lighting Controls (PowerPoint) 05/09/08.

Report:

Bruntland, G. (ed.), (1987), *"Our Common Future: The World Commission on Environment and Development",* Oxford, Oxford University Press.

Business and Institutional Furniture manufacturers Association (2005). *Sustainability Guidelines for Office Furniture Manufacturers and Suppliers.* 10 February, 2005.

Department of Communications, Marine and Natural Resources (2007). *Government White Paper*: *Delivering a Sustainable Energy Future for Ireland*. The Energy Policy Framework 2007-2020. Department of Communications, Marine and Natural Resources, ROI.

European Environment Agency *(2009). Water resources across Europe — confronting water scarcity and drought* (2009), European Environment Agency, EEA Report 2/2009. Published 17 March 2009. Denmark.

Forfás (2009) *Overview of the Main Infrastructure Issues for Enterprise*, 28 May 2008. [Online]. Available at: http://www.forfas.ie/publication/search.jsp?ft=/publications/2008/Title,670,en.php (Accessed: 11 November 2009).

Institute of Public Health in Ireland (2006) *Health Impacts of the Built Environment: A Review,* Published by the Institute of Public Health in Ireland, The Institute of Public Health in Ireland, 2006.

Maximizing Ireland's Energy Efficiency- The National Energy Efficiency Action Office of Public Works [n.d] *Sustainability Policy of the Office of Public Works (OPW).* Ireland.

Plan 2009-2020, Department of Communications, Energy and Natural Resources, ROI. October 2007.

Siemens Limited, University College Dublin, *Sustainable Urban Infrastructure, Dublin Edition – A View to 2025.* Siemens Ltd, 2009.

Sustainable Energy Ireland, *A Guide to Energy Efficient and Cost Effective Lighting*, SEI, (2008). [Online]. Available at: http://www.sei.ie/Your_Business/Bright_Ideas_The_SEI_Lighting_Roadshow/SEI%20Lighting%20Guides/General%20Lighting%20Guide.pdf (Accessed: 14 August 2009).

Sustainable Design International Ltd. (2001) *Harmonized E.U Vocabulary: Useful terms and Definitions relating to Fire Safety and Protection in Buildings.* Sustainable Design International Ltd, 2000-2001. Dublin.

Journal Article:

Cooper, S. (2001). Carpets: are they bad for your health? *Nutrition & Food Science Journal,* Volume 31, issue 3. *Emerald e-journal* [Online]. Available at:

http://www.emeraldinsight.com/Insight/viewContentItem.do?contentId=1466693&contentType=NonArticle [Accessed: 24 October 2009].

Hartman, H. (2009). Specifying Eco-Paints. *The Architect's* Journal, 26 March 2009. [Online]. Available at: http://www.architectsjournal.co.uk/specifying-eco-paints/1995943.article [Accessed: 23 October 2009].

Lidacel (2009) Exploring Open Loop, Daylight & Zone Control, *Lite Times,* Issue 01 Jan-April 2009, p.1. Lidacel's quarterly Journal of Product Technology.

Water Efficient Solutions (2009). Various articles. [Online]. Available at: http://www.waterefficientsolutions.net/portal/home/-/ (Accessed: 14 June 2009).

Presentation/Lecture:

Haslam, M. (2009) Natural Materials, Design & Systems, in conjunction with Cultivate Ireland and Easca Green Building Course, February 11, 2009. Dublin, Ireland.

Legislation / Regulations:

Directive on the Limitations of Emissions due to the use of organic solvents in certain Paints, Varnishes and Vehicle Refinishing Products, (Decorative Paints Directive) Directive 2004/42/EC.

Department of Environment, Heritage and Local Government (2008). Technical Guidance document Part L - Conservation of Fuel and Energy - Buildings Other Than Dwellings 2008. Published by the Stationary Office, Dublin.

Research Paper:

Brogan, C. (2008). *The Effects Sustainability can have on Interior Design,* Dissertation for Dublin Institute of Technology, Mountjoy Square, Dublin. 2008

Doran, D. (2004). Green Spec. *Sustainability and Interior Design* [Online]. Available at: http://www.greenspec.co.uk/documents/whitepapers/IDandGreen.pdf (Accessed: 27 July 2009).

Grant, B. (2006) We Are What We Make. Reverb: An Anthology of the Moment, by Tricycle Inc. June 2006. [Online]. Available at: http://www2.tricycleinc.com/reverb/Reverb_Redux.pdf (Password purchase required).

Kang, M. and Guerin, A. (2008) *Environment and Behavior: The characteristics of Interior Designers who practice Environmentally Sustainable Interior Design,* Kang, M. and Guerin, A. Originally published online May 1, 2008. Sage Publications [Online]. Accessed from http://eab.sagepub.com at SWETS WISE ONLINE CONTENT on May 21, 2009.

May, N. [n.d] *Paints and Ecology.* Publication details unknown. [Online]. [Accessed: 26 October 2009]. Available at: http://www.purepaint.co.uk/downloads/painters%20and%20ecology.pdf

Saunders, T. [n.d.] *A DISCUSSION DOCUMENT COMPARING INTERNATIONAL ENVIRONMENTAL ASSESSMENT METHODS FOR BUILDINGS.* [Online]. Accessed at: http://www.breeam.org/page.jsp?id=102, 20 October 2009.

Podcasts / Video Downloads:

Fehrenbacher, J. (2007) *Tom Dixon on Sustainable Design.* 14 June 2007. Inhabitat website [Online]. Available at: http://www.inhabitat.com/2007/06/14/tom-dixon-video/ [Accessed: 26 October 2009].

Volkswagen (2009). *Piano Staircase.* 22 September 2009. Volkswagen Initiative: The Fun Theory website [Online]. Available at: http://thefuntheory.com/ [Accessed 20 October 2009].

Blackboard / Digitized Presentation:

Gallagher, A. (2009). *BRE Ireland: BREEAM in Ireland.* Dublin. *Digital Presentation by Microsoft PowerPoint.* 24 April 2009.

O'Sullivan, R. (2009) *Environmental Preference Methodology.* Dublin. *Digital Presentation by Microsoft PowerPoint.* Dublin Institute of Technology, Bolton Street, 2009.

Email:

Gallagher, A. (2009) BREEAM Ireland. Reply response on 21 October 2009.

Website Article:

Hoyer, S. (2009) *Haworth Merchandise Mart Showroom Sets a LEED-CI Gold Certification Standard.* [Online]. Available at:

http://www.greenbeanchicago.com/haworth-merchandise-mart-showroom-sets-leedci-gold-certification-green-office-green-retail/ [Accessed: 31 October 2009].

Miller, H. (2008) *Environmental Product Summary*. [Online]. Available at: http://www.hermanmiller.com/MarketFacingTech/hmc/products/Celle_Chairs/EPS_CEL.pdf [Accessed: 18 September 2009].

Whitemyer, D. (2007) *The Green Jungle.* [Online]. Available at: http://www.iida.org/content.cfm/the-green-jungle [Accessed: 26 October 2009].

Website:

- http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988 (2009) [Online]. [Accessed: 19 September 2009].
- http://www.usgbc.org/DisplayPage.aspx?CMSPageID=145 (2009) [Online]. [Accessed: 19 September 2009].
- http://www.usgbc.org/News/USGBCNewsDetails.aspx?ID=2158&CMSPageID=159 (2009) [Online]. [Accessed: 19 September 2009].
- http://www.breeam.org/page.jsp?id=66 (2009) [Online]. [Accessed: 19 September 2009].
- http://www.bsi-global.com/en/Standards-and-Publications/About-BSI-British-Standards/ (2009) [Online]. [Accessed: 19 September 2009].
- http://www.thegreenguide.org.uk/page.jsp?id=15 (2009) [Online]. [Accessed: 19 September 2009].
- http://www.greenspec.co.uk/ (2009) [Online]. [Accessed: 9 October 2009].
- http://www.co-design.co.uk/jhealey.htm (2009) [Online]. [Accessed: 9 October 2009].
- http://www.imo.ch/imo_services_textile_gots_en.html (2009) [Online]. [Accessed: 9 October 2009].

- http://www.epa.gov/iaq/formalde.html#Health%20Effects (2009) [Online]. [Accessed: 10 October 2009].
- http://www.holistic-interior-designs.com/dangers-of-formaldehyde.html (2009) [Online]. [Accessed: 10 October 2009].
- http://www.holistic-interior-designs.com/eco-wheat-board.html (2009) [Online]. [Accessed: 12 October 2009].
- http://www.naturalfloorcoverings.com.au/CARPETS/Jute-Carpets/info/jute_information.htm (2009) [Online]. [Accessed: 12 October 2009].
- http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm (2009) [Online]. [Accessed: 10 October 2009].
- http://www.businessdictionary.com/definition/material-safety-data-sheet-MSDS.html (2009) [Online]. [Accessed: 10 October 2009].
- http://www.ikea.com/ms/en_IE/about_ikea/our_responsibility/products_and_materials/making_home_furnishing_products_safe.html (2009) [Online]. [Accessed: 10 October 2009].
- http://www.nuigalway.ie/iapah/iapah_why.html (2009) [Online]. [Accessed: 15 October 2009].
- http://www.epa.ie/whatwedo/advice/air/decopaintsdirective/ (2009) [Online]. [Accessed: 15 October 2009].
- http://www.iso.org/iso/iso_14000_essentials (2009) [Online]. [Accessed: 15 October 2009].
- http://www.globalecolabelling.net/ (2009) [Online]. [Accessed: 15 October 2009].
- http://www.esb.ie/esbcustomersupply/residential/energy_efficiency/cfl_light_bulbs.jsp (2009) [Online]. [Accessed: 15 October 2009].
- http://www.sei.ie/Your_Business/Accelerated_Capital_Allowance/Technical_Guidance/Lighting_Controls/ (2009) [Online]. [Accessed: 16 October 2009].
- http://unfccc.int/kyoto_protocol/items/2830.php (2009) [Online]. [Accessed: 17 October 2009].
- http://ec.europa.eu/environment/climat/climate_action.htm (2009) [Online]. [Accessed: 17 October 2009].

- http://www.iso14000-iso14001-environmental-management.com/iso14000.htm (2009) [Online]. [Accessed: 17 October 2009].
- http://www.bre.co.uk/page.jsp?id=1578 (2009) [Online]. [Accessed: 19 October 2009].
- http://mts.sustainableproducts.com/standards.htm (2009) [Online]. [Accessed: 23 October 2009].
- http://www.fsc.org/about-fsc.html (2009) [Online]. [Accessed: 23 October 2009].
- http://www.aggregatepros.com/images/Waste-hierarchy.png (2009) [Online]. [Accessed: 26 October 2009].
- http://www.rkd.ie/Portfolio_Offices_RoyalDublinSociety-SimmonscourtHouseMinervaHouse.php?PHPSESSID=b89650855ffee8771d7dac705a5bb993 (2009) [Online]. [Accessed: 26 October 2009].
- http://www.dcenr.gov.ie/Energy/Energy+Efficiency+and+Affordability+Division/Programmes.htm (2009) [Online]. [Accessed: 26 October 2009].
- http://www.sei.ie/Your_Building/ (2009) [Online]. [Accessed: 29 October 2009].
- http://www.interiordesign.net/blogger/3534.html (2009) [Online]. [Accessed: 29 October 2009].
- http://www.epa.gov/nrmrl/lcaccess/ (2009) [Online]. [Accessed: 29 October 2009].
- http://farm1.static.flickr.com/177/407103535_47cd85fa49.jpg (2009) [Online]. [Accessed: 29 October 2009].
- http://www.hermanmiller.com/Products/Celle-Chairs (2009) [Online]. [Accessed: 15 October 2009].