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CREATEHK

INTERIOR DESIGN BODY OF KNOWLEDGE

Book 3

PRODUCTS AND MATERIALS

JOINTLY RESEARCHED AND PUBLISHED
by Hong Kong Interior Design Association & The Hong Kong Polytechnic University

Contents

PREFACE

At present, there are no formal educational materials for Hong Kong interior design learning, and educators can only rely on ad hoc literature produced overseas (particularly in the West), or architectural-based materials to learn about interior design. Given that interior design has already established a unique and well-defined body of professional knowledge, and is firmly rooted in the cultural and social practices of a place, there is a need for interior design textbooks to reflect this context and allow interior design students to keep pace with rapid development of the industry. This series of interior design textbooks is aimed at satisfying the needs of Hong Kong interior design students at different academic levels from diploma, higher diploma to bachelor's degree. Filled with case studies of award winning works from across the Asia-Pacific region and beyond, as well as interviews and articles written by well-known professionals and academics from Hong Kong and around the world, these are the first interior design textbooks researched and written in Asia.

The series contains six books, related to the 6 body of knowledge areas well-defined in the Interior Design Professional Guideline, published by the Hong Kong Interior Design Association (HKIDA) in 2014. Based on research of reputable international standards and confirmed by surveys of local interior design educators and practitioners, this guideline sets out in a systematic way the knowledge and skills that Hong Kong interior designers should possess. The 6 body of knowledge areas covers and follows the typical process of any interior design project, which includes:

- Human Environment Needs
- Design
- Products and Materials
- Communication
- Interior Construction, Codes and Regulations
- Professional Practice

This book 3, "Products & Materials", focuses on the key knowledge related to Interior Designer's choice of Products and Materials that safeguard sustainable environment, public safety, health & well-being: topics cover British Standard (BS), Properties & Applications of key construction materials in interior design projects (Stone, Glass, Metal, Plastics, Bio-composite & Aerogel Materials, Concrete, Fabric), Lighting Specifications, Nanotechnology and Future Trend.

Our greatest challenge in compiling this book series was deciding which key content to select from the vast pool that is relevant to not only global but also local context and turn them into useful teaching resources and materials for educators' future elaboration. For this reason, choosing examples to fit within the physical constraints of a book required a rigorous edit. We hope it will be of enormous benefit to interior design students, educators and practitioners and inspire everyone to look for more.

Horace Pan
Project Chief Investigator

CHAPTER 1

British Standards
By Anna Whitehead

1. An Introduction to Standard

The International Federation of Interior Architects and Designers (IFI) states that interior designers need to practice:

"… with the highest regard for engaging the world's economic and natural resources in a sustainable manner. We design for health, safety, well-being and the needs of all..." [1]

On built environment projects, approximately 90% of specification decisions relating to interior product or material choices are made by interior designers,[2] making it one of the most significant areas where the industry can exert influence and impact.

A balanced responsibility however, needs to be applied when specifying products for clients to ensure they will not only add aesthetic beauty and comfort to the environment but also will not adversely affect their health, safety and well-being after the project is completed.

Responsibility also extends to the natural environment and its resources. Specification needs to be managed in a way that does not negatively affect the ecology, biodiversity and use of our planet's diminishing resources, both finite and renewable.

One of the ways a balance can be achieved is to consider specifying products that comply with national and international standards, such as those developed by the British Standards Institute (BSI).

But what exactly is a Standard? And why are they necessary?

Standards form part of our daily life -- from the standardised A4 paper size used in our printers to the standard size for a light fitting.

They provide transparency in a global market place, responding to growing consumer demand for quality products that are safe and reliable, and with an increased concern for the health and environmental issues that are associated with their manufacture.

A Standard provides design professionals with information, such as product safety, or clarifies a product's health or environmental risk. Specifying Standard compliant products gives interior designers a reliable expectation of a product's quality, characteristics and assurance that it is fit for purpose.

Interior design practices can also benefit from implementing Standards that provide operational business tools and improve business efficiency, as well as reducing waste or potential negative environmental impact.

Navigating the volume and terminology of Standards however, can be overwhelming. There are tens of thousands of products and processes across different Standards and international organisations, with variously attached acronyms such as BS, EN, CE, ISO and Kitemark symbols.

But what do they mean? And which Standards do interior designers need to know about?

2. The British Standards Institute (BSI)

The British Standards Institute, or BSI, was the world's first National Standards body.

Founded in 1901 by Sir John Wolfe-Barry, civil engineer and designer of Tower Bridge[3], it is now a leading global standards maker worldwide, and represented in 181 countries.[4]

Fig. 1.1 British Standards logo

In its simplest terms, a Standard is a document that sets out a principle, criteria, a specification or guideline for: [5]

- manufacturing a product,
- managing a process, or,
- delivering a service.

Developing a Standard can take between one to four years [6], with BSI Technical Committees participating in the development of international standards such as ISO or European (EN), as well as British Standards (BS).

How to Read a British Standard

The current BSI catalogue runs to over 30,000 Standards. Each one has a unique reference number as follows: [7]

BS XXXX [-P]: YYYY

Where:

BS indicates that BSI has developed the British Standard at a national level in the UK

XXXX is the unique reference number relating to the Standard

P refers to a part of the Standard, if it is sub-divided into a series of multiple parts

YYYY refers to the year the Standard was introduced.

For example: [8]

BS 5385-3:2014

BS indicates it is a published British Standard,

5385 is the unique Standard reference number, in this case, referring to one of a series of Standards for Wall and Floor Tiling

5385-3 refers to Part 3 of the Standard and is titled:

Design and installation of internal and external ceramic and mosaic wall tiling in normal conditions

2014 refers to the year the Standard was published and is referenced as the most current

To streamline the catalogue, Standards are separated into the following categories depending on how they function: [9]

- Specification
- Codes of Practice
- Methods
- Guides

Fig. 1.2 Floor and wall tiles

Specification Category

The most common is the Specification Category, where Standards are very prescriptive and detailed, listing the absolute requirements that must be met and usually apply to products that have an impact on safety, such as electronic equipment.

Codes of Practice Category

Commonly used on construction and interior design projects, Standards from the Codes of Practice Category offer best practice advice, ensuring products and their application are of replicable quality but offer users an element of flexibility depending on the nature of the project. They are less rigorous than a Specification Category Standard, containing no absolute requirements or prescriptive directives.

Sourcing British Standard Compliant Products

Sourcing Standard compliant products for an interior project is currently not an easy task. The interior designer needs to find out whether an applicable Standard has been developed for a product intended for project specification, as well as know the Standard's unique reference number, and then source a product compliant manufacturer.

However, if it is not known whether the product has a manufacturing Standard associated with it, or if the Standard reference number is unknown, the BSI catalogue website can be searched under different heading types, for example, by:

Subject Matter, such as, **Health and Safety**[10] for products such as electronic equipment,

Or by **Industry Sector**, for example, **Building and Construction**[11] for products, such as, paints.

However, currently there is no single and direct way of searching the existing catalogue of over 30,000 Standards to see which are particularly applicable for an interiors project, although this may change in the future.

To source compliant products more efficiently, interior designers may prefer to consult directly with manufacturers and identify Standards that apply to products they manufacture, or consult specific trade associations, or refer to tools and websites from professional institute organizations.

3. British Standards for Interior Designers: A Case Study

An example of a British Standard, which could be referenced for an interiors project, is the Code of Practice Category Standard, **BS5385**. It provides guidance and best practice for Wall and Floor Tiling and has 5 Parts associated with it as follows: [8]

- **Part 1:** Design and installation of ceramic natural stone and mosaic wall tiling in normal internal conditions. Code of Practice.
- **Part 2:** Design and installation of external ceramic and mosaic wall tiling in normal conditions. Code of Practice.
- **Part 3:** Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions. Code of Practice.
- **Part 4:** Design and installation of ceramic and mosaic tiling in special conditions. Code of Practice.
- **Part 5:** Design and installation of terrazzo, natural stone and agglomerated stone tile and slab flooring. Code of Practice.

What does the Standard Provide?

We can look at **Part 3** of this Standard in detail [8]

BS 5385-3:2014

Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions.

Introduced in 2014, this British Standard offers guidance on the product's manufacturing design and installation, for example, how to fix the ceramic or mosaic tile to concrete or timber flooring or other recommended substrates, as well as recommendations for maintenance and cleaning.

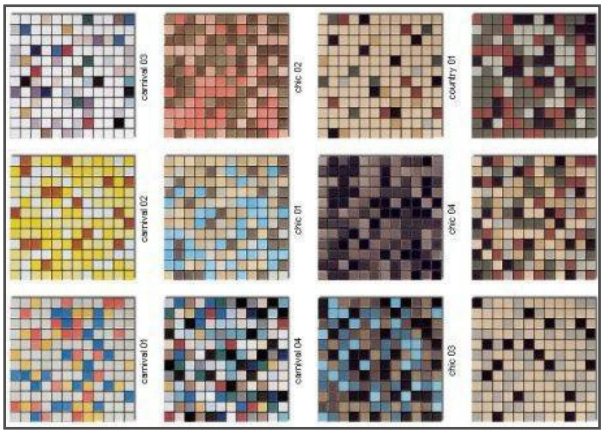


Fig. 1.3 Mosaic files

The Standard cross-references national and international acts of legislation, such as the Disability Discrimination Act 2005 and provides a useful reference for:

- Product Designers
- Manufacturers
- Interior Designers
- Architects
- Specifiers
- Main Contractors
- Specialist Tiling Contractors
- Clients /End Users

What Information Does The Standard Contain?

The following information is included within the Standard:

- The criteria of the Standard, its scope and associated reference documents.
- Guidance on tile material choice and specification for manufacturers and interior designers.
- Recommended methods and materials for tile installation.
- Guidance on inspection to ensure the tiles can be assessed for conformity and compliance.
- Recommendations on tile maintenance and cleaning for the end user.

What are the Benefits of Specifying BS 5385-3:2014 Compliant Tiles?

There are a number of potential benefits for Interior Designers choosing to specify a **BS5385- 3:2014** compliant Ceramic or Mosaic Floor Tile, including assurances that:

- The tiles' material composition, thickness and size are standardized, are of a consistent grade of quality. Replicable tile size ensures accurate quantity specification, minimising project cost and environmental waste.

- The surface of the tile has been tested for potential protection and maintenance issues, such as chemical stain, abrasion, frost resistance or breaking strength, ensuring it is robust and fit for purpose, preventing potential future costs for repairs or replacements.

- The Standard provides guidance for tile installers on the recommended type and quantity of substrate materials as well as adhesives and fixings, ensuring the most compatible and effective materials are used to provide a durable, quality installation. The quantity of materials can be accurately specified, minimising product failures, environmental waste and costs.

- By providing detailed installation guidance authored by technical experts, the Standard potentially enhances the technical knowledge of contractors and installers, minimising the time and cost of installation.

- It provides guidance on the recommended protocol for cleaning and maintenance giving interior designers the opportunity of professionally advising clients how best to preserve the life and quality of tiles post installation.

The full details of this Standard can be purchased from the BSI Shop website.[8]

4. The Benefits of Specifying Standard Compliant Products

The British Standards catalogue may be substantial to navigate but there are significant benefits to specifying Standard Complaint Products for the built environment industry, and specifically, for interior designers.

Benefits for the Built Environment Industry [12]

- Harmonised Standards enable manufacturers in a global marketplace to offer products and services that are replicable with consistent characteristics. The design, manufacture and installation of products are delivered to an agreed specification, compatibility and safety standard.

- Standards reduce manufacturing research development and production costs globally, facilitating fairer trade and allowing available natural resources to be used more efficiently

- They identify safety issues and promote healthier and safer products, benefitting the lives of manufacturers, installers and clients.

- Standards promote a culture of sustainable specification, encouraging manufacturers to examine the energy and resource use of their manufacturing process, reducing operational costs, waste, and negative environmental impact.

- They promote a culture of continual improvement and vigilance, helping to advance the skills and expertise of the industry as a whole.

Benefits for the Interior Designer: [12]

- Specifying Standard compliant products can reduce project time required for specification, and potentially financial operating costs as products are assured to be of consistent quality, safety and sizeand so less likely to incur costs associated with product inconsistency or failure.

- Choosing Standard compliant products may help interior designers demonstrate Best Practice in specification and procurement 13 on a project and may contribute to meeting obligations under the Health and Safety Act, showing a Duty of Care to contractors and clients.

- The technical information contained in each Standard is authored by leading global sector experts. Sharing this knowledge and information with contractors and clients professionalises the interior design industry, positioning it as "… experts in the built environment" [1] as aspired to in the IFI Declaration.

Supplementary Information

5. British Standards and the European Union: EN, BS-EN, CE

International and European Standards are developed in the same way as National Standards, and in line with World Trade Organisation principles that include transparency, effectiveness & relevance. [14]

Fig. 1.4 European Standards logo

BSI collaborates with the International Organisation for Standardisation (ISO), to develop International Standards, and with the European Economic Area (EEA) to develop European only Standards, through its membership of CEN and CENELEC Committees which, along with ETSI, form the ESO (European Standardisation Organisations). [15]

The policy of the European Commission is to primarily develop Standards at an international level, through ISO. European only Standards are usually developed if there is a specific European or National regulatory need. [16]

Whether developed at a European level, or adopted from an international Standard, European Standards are assigned the acronym EN, preceding the unique Standard reference number, and are released to EU member countries. [17]

Each EU member country must adopt the EN Standard after competing national or historic Standards are withdrawn. Once adopted, the EN Standard is prefixed with a national acronym, so for the UK, the Standard now reads BS-EN preceding the reference number.

To streamline the vast number of competing Standards across countries and economic regions, the European Directive's harmonisation process was introduced. It ensures that products certified with the same EN Standard will have consistent characteristics and quality across all EEA member countries.

For example: [18]

BS-EN 13748-1:2004

EN indicates it is a European Standard developed by ESOs Adopted as a UK National Standard (**BS**) in the year **2004**

The Standard Reference Number **13748** refers to *Terrazzo Tiles*

13748-1, refers to **Part 1** of the Standard titled: *Terrazzo Tiles for Internal Use*

Fig. 1.5 Terrazzo tiles

6. BCE Product Marking System

The CE symbol is a conformity mark required for certain products sold within the European Economic Area (EEA). It does not mean the product is manufactured in the EU, but provides assurance that the manufacturer has tested it at source and that it complies with the EU's harmonised, strict, minimum legislative requirements for health, safety and the environment. [19]

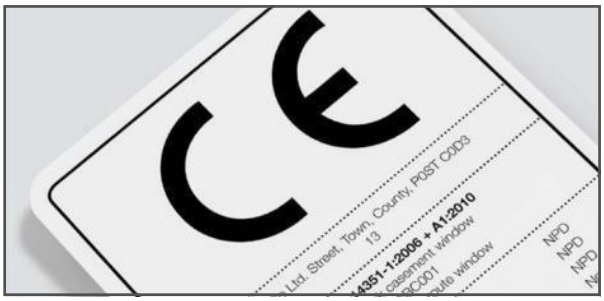


Fig. 1.6 CE symbol

Unlike most BS-EN Standards, which are voluntary, CE marking is mandatory on products that fall under its directive, such as certain construction products, eco design of energy related products and electronic equipment. [19]

It is important to note however, that the responsibility falls to the manufacturer to ensure that its CE marked products do meet the legislative requirements and provide full supporting technical documentation as evidence.

Only certain CE-marked products require independent auditing through an authorized third party such as the BSI, to verify the manufacturer's claims. For interior designers requiring independent verification of a product's quality & safety, an option may be to specify products with a third party product certification, such as a the BSI Kitemark, in addition to the CE mark of conformity, or request further evidence from the manufacturer of independent audit testing or certification of the manufactured product. [19]

To streamline the vast number of competing Standards across countries and economic regions, the European Directive's harmonisation process was introduced. It ensures that products certified with the same EN Standard will have consistent characteristics and quality across all EEA member countries.

Further references on which products legally require CE markings are available on the European Commission's website. [20]

7. British Standards and the ISO Standard

ISO Organisation

Similar to BSI, the International Organisation for Standardisation, or ISO, is an independent non-governmental Standards making body. Founded in 1947, with the UK as one of 25 founding countries [21] it now includes membership of 163 countries, and over 100,000 world sector experts involved in the development of global ISO Standards. 22

Fig. 1.7 ISO logo

The catalogue runs to over 21,000 Standards to date, amongst them, the popular process Standards:

ISO 14001:2015 Environmental Management Systems, and,

ISO 9001: 2015 Quality Management Systems.

Over 1.5 million ISO certificates were issued in 2015 alone. 23

The ISO Standard

The extensive ISO Standards database is divided into numbered categories, or ICS numbers (International Classification for Standards).

For example, the ICS number for Paints & Colour Industries is ICS 87.

The ICS 87 Category is subdivided into 5 further categories, reflecting the different types of paint sector industries. For example, ICS 87.040 includes Standards for Paints and Varnishes as finished manufactured products and has 154 associated Standards prescribing requirements for product safety, quality and durability under various conditions and applications. [24]

Fig. 1.8

The benefit for Interior Designers specifying ISO Standard compliant products, is the assurance that they will provide world class specification for products as well as processes that are replicable across international manufacturers and businesses, ensuring their quality, safety and efficiency. [25]

Further information on ISO product and process Standards are available on the ISO website. [26]

8. British Standards and the BSI Kitemark

"A BSI Kitemark is a voluntary certification system. Those that achieve a BSI Kitemark have openly stated their intention and commitment to delivering quality products or services." [27]

Fig. 1.9

The Kitemark is a registered trademark owned by the BSI, and recognised internationally as a mark of quality. It is a voluntary scheme with over 450 individual Kitemark schemes listed, such as for PVC-U windows and doors. [28]

It is one of the most recognized and trusted, global trademark symbols, and manufacturers receiving an accredited Kitemark can enhance their reputation as a company with a strong commitment to pursuing the highest quality standard of product manufacture.

BSI issues a Kitemark license once it has rigorously and repeatedly tested a product or process in excess of minimum legislative requirements, and against the relevant British, European or International Standard, or trade body guideline. [28]

The product's manufacturing process is also audited against an accredited quality management system, such as ISO 9001, and a BSI Kitemark is only awarded once a tested product and its manufacturing process demonstrate a continual and reliable level of quality.

Once the Kitemark license is received, the manufacturer is routinely inspected and audited to ensure continued product and manufacturing compliance.

The rigorous Kitemark accreditation process typically includes [29]

- Independent laboratory testing of the product design;
- An accredited assessment of the manufacturing site;
- A commitment to continuing assessments of the product and its manufacturing site to ensure the quality of design, process and procedures are maintained.

For example, for a window manufacturer to be awarded a BSI Kitemark, its manufacturing process can be audited and its window tested for product properties such as weather tightness, durability and security, against core national and international Standards. [30]

How do Interior Designers Benefit by Specifying Products Awarded with a BSI Kitemark?

Specifying products awarded with a BSI Kitemark provides assurance that the product not only meets, but exceeds minimum legal requirements, that it is compliant with relevant national and international Standards, and not only the product but the company's manufacturing process is continually audited and independently verified by BSI for safety, efficiency and quality. [31]

In a recent survey, Kitemark was one of the most recognised and respected trademarks in the UK with 93% of respondents believing that Kitemark products were safer, and 91%, believed that the product would be of better quality than a competitor's product without a Kitemark. [28 32]

Further information on BSI Kitemark, including Directory of Kitemark awarded products, is available on the BSI website. [33 34]

CHAPTER 2

Stone - A natural building material from pre-historic period
by Dr. Tris Kee

Fig. 2.1 Flying buttresses

Stone covers a wide range of earthen materials that have been known to the human civilization since the Stone Age (2.9 mya – 6500 BCE). Early humans began using this durable material to construct monumental buildings such as Stonehenge and the Great Pyramids of Egypt. Stone building technology reached its apex in the Middle Ages with its use in Gothic churches. The vaulting and buttressing technology in the Gothic churches brought stone architecture to unprecedented soaring heights.

Today, the application of stones in construction and interior design is multi-faceted. From the most common use of marble, to sandstone, limestone, slate, brick, and coral stone, stone is favored by many interior designers for its wide variety of types and its natural properties. The unique patterns of each stone, the origin and various finishes on the stone allow interior designers to express unlimited imagination to articulate different spaces, offering contemporary interpretations to an ancient material.

Physical Characteristics

Stone is a popular choice in interior design because it is a natural material that can bring warmth to any setting, both physically and psychologically. Suitable for both indoor and outdoor spaces, stone is a good material for exterior construction due to its load bearing ability and as an interior surface decoration such as wall cladding. Stone has an earthy charm that represents a close connection to nature and is available in many different types, shapes, colours and sizes, making it suitable for a wide range of applications and ambiance. For example, sandstone imparts a sense of warmth, while the smoothness of granite or marble can provide a sleek and modern look.

Types of Stones: Marble, Travertine and Granite

Marble

Marble is a metamorphic rock that forms when limestone is subjected to the heat and pressure of metamorphism. Composed primarily of the mineral calcite ($CaCO_3$), marble usually contains other minerals such as clay minerals, micas, quartz, pyrite, iron oxides and graphite. Because it is strong, sturdy, and durable, marble makes an excellent material for flooring, wall and even furniture.

Travertine

Travertine is a form of limestone deposited by mineral springs, especially hot springs. Formed by a process of rapid precipitation of calcium carbonate, travertine often has a fibrous or concentric appearance and comes in white, tan, cream- coloured, and even rusty varieties.

Considered a luxury material, travertine is often used in luxury homes, hotel lobbies and spas. The porous nature and colour tones of this stone appeal to many designers, who also appreciate its earthly and natural appearance.

Fig. 2.2 Marble and travertine

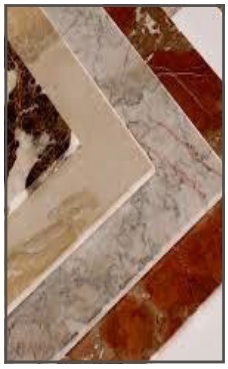


Fig. 2.3 Granite

Granite

Chosen for its hardness, toughness and durability, granite has been used by humans as construction material for buildings and bridges for centuries. Granite can come in a variety of colours, including white, pink, or gray, depending on its mineral content. Compared to marble, granite has low porosity and is also resistant to heat. This makes it an excellent material for flooring, kitchen countertops and bathroom fixtures.

Hotel lobbies and conference center interiors often utilize granite as a main material for flooring and wall for the appearance of grandeur and serenity. When the stone is applied with different finishes, it can create a different interior atmosphere ranging from contemporary, countrylook, domestic or fully natural.

Fig. 2.4 The structure of Mies van der Rohe's Barcelona Pavilion rests on a plinth of travertine.

Stone Finishes

Stone can not only be used in its natural state, but also in a range of finishes to make its surfaces suitable for different applications such as flooring, walls and decoration.

Fig. 2.5

Polished

Stone surfaces can be buffed to create a polished finish, and the result is a high shine which gives the stone a very elegant and rich look.

Fig. 2.6

Split Face

Split face finish is a result of the stone being cut by a guillotine that fractures the face and turns it to a rocky finish. A good example of split finish in outdoor application is the split travertine Richard Meier had used at the Getty Centre in Southern California. Split along its natural grain, many of the stones bear fossilized leaves, feathers, and branches.

Fig. 2.7

Natural Cleft

This finish is associated with materials that are layered and thus, when split, do so on a natural fault creating what is known as a natural cleft finish. Slates are the most common types of stone that can be split naturally.

Fig. 2.8

Honed

This finish is created by buffing the stone, leaving a smooth but dull surface. A honed finish encompasses many levels of dullness.

Fig. 2.9

Flamed

A flamed finish is produced by applying intense flame to the stone, causing the surface to burst and become rough. This finish is used primarily for exteriors applications to obtain a slip-resistance surface.

Fig. 2.10

Flamed and Brushed

This process involves heating the stone surface with a high-temperature flame and then brushed to create a time-worn look. This effect is more evident in materials composed of minerals with various degrees of expansion, (such as granites). The resulting surface is rough, non-slip and generally faded in colour, thereby hiding defects and tone variations.

Fig. 2.11

Bush-Hammered

A bush hammer is a specialized stone-working hammer with a head that resembles a meat tenderizing hammer, which can be used to create an uneven surface with rich texture on stones. A bush-hammered finish can be applied to nearly all stones, and the result is a fairly smooth surface with small indentations.

Tips for designers on the choice of stone.

1) Each piece of stone is unique in texture and pattern - many designers find using natural materials challenging as they wish to achieve a consistent colour and tone. Therefore, designers need to respect that stone has its own character and pattern because each quarry produces different stocks of stone.

2) Stone finishes can bring out an element of surprise to the design – whether it is a split surface or a honed finish, the treatment will bring forth new colour, texture and dimension. Therefore, if designers are struggling with the monotonous feeling of one material, they can consider using different finishes of the same stone to create diversity.

3) Keep up to date with new technologies – for example, traditionally, stones are cut in quarries usingchainsaws, but nowadays, new technologies such as laser arm can be used to precisely locate the cutting point of each stone block. Such machines can store data such as the cutting point, the speed at which the arm is lowered and the chain's speed, so that the machine can operate automatically without the presence of an operator.

Case Study 1

Project: Yoo Residence I & II
Firm: Steve Leung Designers' Ltd

To create a stylish and cozy ambiance for this show flat in Hong Kong, the interior designer made use of white marble in some of the accented areas, including the bathroom walls and shower walls, the walls that frame the walk-in closet as well as the coffee bench that separates the living room from the study room.

Marble becomes a consistent motif throughout the space, giving it a sense of unity, while bright marble surface provides contrast with the dark wood panels. The overall effect is one of elegance and sophistication, with the natural patterns of the marble providing a strong design accent.

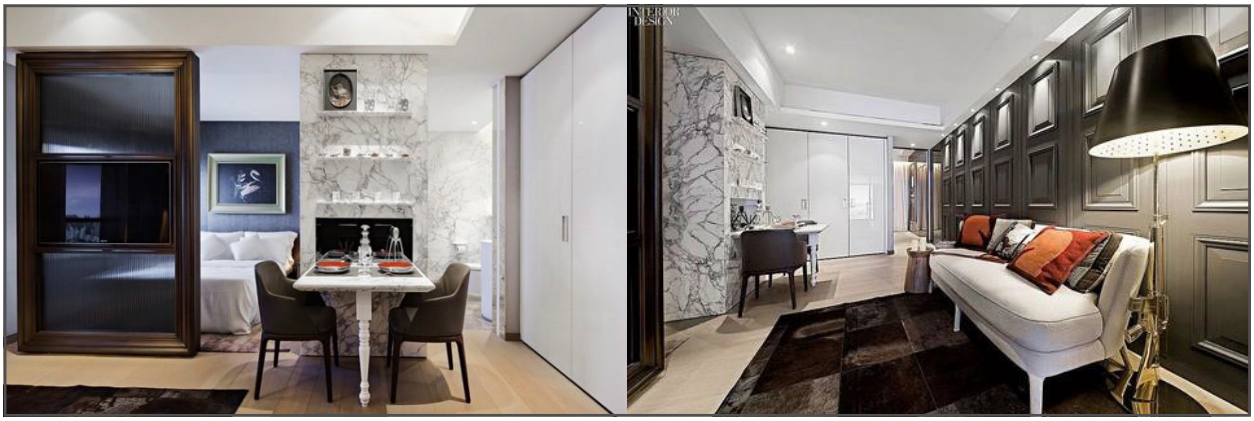


Fig. 2.12-13 Yoo Residence

This Hong Kong hotel is named after a series of images by Danish architectural and landscape photographer Kim Høltermand, which features misty lake-side scenes and half submerged rocks. Inspired by these images, the interior designers made use of flecked marble and textured concrete to create a feeling of quiet refinement.

Each of the rooms features grey marble, concrete and timber surfaces, while bathrooms have walls with swirling grey and white patterns. The designers enhanced the materials' natural beauty by exploring material textures with surface treatment techniques, and by the clever use of lighting.

Fig. 2.14 One of photographer Kim Høltermand's works.

Fig. 2.15 Tuve Hotel

Fig. 2.16 Tuve Hotel

Fig. 2.17 Tuve Hotel

CHAPTER 3

Wood - From traditional woodworking to high technology applications by Dr. Tris Kee

Many interior designers favor natural materials due to their timeless appeal and suitability for all interior contexts, and among them, wood is probably the most popular. Relatively inexpensive and easily workable using various kinds of tools, wood is a versatile material that can be made into structural elements, furniture and ornaments within an interior space. This chapter discusses some properties of wood and how its use in construction and interior design has evolved from traditional carpentry to contemporary high technology applications, using parametric technology as a process of fabrication.

Fig 3.1 Various types of wood

Uses for Wood and Timber as Interior Design and Decorating Finishes

Wood or timber has been used for the framing of houses, external cladding and joinery in traditional construction for many years. Timber products come in a variety of form, including wood flooring, timber wall paneling, solid or timber veneer doors, skirting, moldings, window joinery, kitchen joinery and furniture. Wood is known for its toughness and durability, and its strength and elasticity make it easy to be bent without breaking. As a rule, hardwoods are more resistant to wear than softwoods, while the moisture content of the wood and the maturity of the timber also affects its hardness. In general, straight grained timber like cherry and hard maple is stronger than a cross grained or wavy timber like pine. Defects like cracks, decay or a knot will decrease the strength of the timber.

Different kinds of wood have various density, characteristics and tactile quality. Designers may select a particular type of wood due to its physical properties such as strength and durability, or even its unique characteristics such as smell or pattern.

The denser the timber, the longer it takes to ignite. Jarrah, teak and kauri are all dense woods that are partially fire resistant and can be used in construction. Chemical treatments as well as specialized fire-resistant paint products are available to provide timber with added fire resistances.

Traditional wood working

Traditional wood working carve out from a large log of lumber the component necessary pieces for construction, be they for roof rafter, planks or beams. The art of joinery is a part of woodworking that involves joining together pieces of timber or lumber to produce more complex items. Some wood joints employ fasteners, bindings, or adhesives, while others use only wood elements. The characteristics of wooden joints, such as strength, flexibility, toughness and appearance, derive from the properties of the materials involved and the purpose of the joint. For example, the joinery used to construct a house is different from that used to make toys.

Fig. 3.2. Wooden entrance of a temple in Japan

Chinese and Japanese craftsmen have utilized the art of joinery for centuries in ancient architecture and temples. The book, *The Art of Japanese Joinery* by Kiyosi Seike, documents over a hundred of different types of joinery used in Japanese carpentry, some are for functional purposes while others are so intricate that they can be considered pieces of art. This book is a good reference for any furniture makers or carpenters if they want to consider using traditional joinery methods in their work.

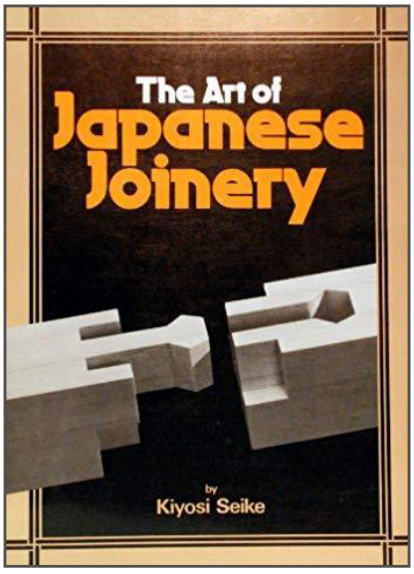


Fig 3.3 The Art of Japanese Joinery by Kiyoshi Seike

Wood Craftsmanship

Wood's grain and colour make the material unique and pleasing to the senses. When we touch wood, we feel a sense of warmth whether it is hardwood or softwood. By choosing the correct wood material, designers may deeply affect the overall performance and aesthetic value of the furniture. Craftsmanship itself is a kind of humanized expression, with artisans defining every single radius of furniture according to their past experience so that the quality of each piece is not pre-determined but depends on their judgment on wood's grain and material property. Joinery represents a visual delight that goes beyond structural necessity. Adhesive and mechanical connections like mortise-and-tenon, dovetail, rabbet and miter joinery, and more than eighty types of traditional wood joineries can be found in handcrafted furniture.

There is no doubt that the finishing on a piece of furniture is a vital step in the fabrication process. All finishes will darken the surface of the wood to some extent. Improper painting and staining may deeply affect the value of the furniture. Artisans may apply tung oil to wood surfaces to create a water-resistant effect, in which the oil penetrates the wood and becomes hardened to form an impermeable, effectively waterproof layer. Since tung oil is flexible, non-toxic and resistant to fruit acids, it is widely used in the furniture making industry.

Fig 3.4 Rabbet and miter

Wood Timber Veneer

Timber veneer is a thin layer of timber of uniform thickness. It is formed by either slicing, rotary cutting or wood being sawn. After gluing to a board in a sandwich manner, such as plywood, MDF board or chipboard, wood veneer is ready to be used in many utilizations, including cabinets, wall panels and even doors.

Timber veneer is more cost effective than solid timber, with an equally visually appealing appearance. It is also more environmentally friendly as fewer trees are cut down to make a veneer board than a same size board made of solid timber. Other advantages are that "matching" veneers can be produced from a single log as wood grains from that log have almost identical features, colouring and figuring. Wood veneers are ideal for curved surfaces as they are thin and can be glued over the edges and rounded surfaces. They are mostly seen in furniture as designers often use curves, bends and irregular forms to produce various pieces.

As with all construction and interior design, technologies in manufacturing has led to much more efficient production of timber products that are also more cost effective. In the old days, solid timber planks were the only form of timber available. With new technology, many new milling methods have been introduced, interior designers and carpenters have absorbed new knowledge and new craftsmanship, and new forms of timber product have become a prominent trend in interior design.

The process of digital fabrication allows tools to be programmed to produce detailed and non-repeated geometries with increased efficiency. Paralleled with an increased interest in new ways of using timber with new fabrication methods in interior settings, this has created opportunities for designers to develop new ways of working industrially with wood in order to realize geometrically and structurally complex structures.

Fig. 3.5 Wood veneer boards

Today, architects, designers and engineers are involved in complex projects that utilize new technology such as parametric modelling. Parametric modeling was originally used by architects to set up complex 3D models with computer programs to create structures such as a canopy and a stadium roof with irregular curve forms. This technique has been gradually adopted by interior designers and structural engineers in the past few years.

Parametric design provides great freedom in experimental processes since it pushes technical boundaries by allowing complex forms to be conceived and their building process planned in order to be taken to an optimal level of structure and manufacturing. When parametric design is used in interior planning, it brings a sense of freshness and minimalist style.

Parametric technology can greatly decrease design efforts previously wasted because of lack of information. This better-connected process between design and construction not only helps to decrease project time and cost, but also increases the potential for performance-driven architecture and lead to more sustainable structures. As a result, timber project utilizing parametric technology has become a new trend in many interior projects.

Fig. 3.6 A street library in Bulgaria that utilizes the tools of parametric design to create a wooden structure that is light and transportable (Photo by Emanuil Albert)

On the other hand, CNC (Computer Numerical Control) technology has also become popular in the field of woodworking. With CNC routers, tool paths are controlled via computer numerical control, which typically produces consistent and high-quality work and improves factory productivity. Unlike a jig router, the CNC router can produce a one-off as effectively as repeated identical production. Automation and precision are the keybenefits of CNC router tables, which can be easily adapted to work with various other materials such as composites, aluminum, steel and plastics. CNC routers can perform the tasks of many carpentry shop machines such as the panel saw, the spindle moulder and the boring machine, and they can also cut mortises and tendons, and can create more sophisticated wood joinery than hand held tools.

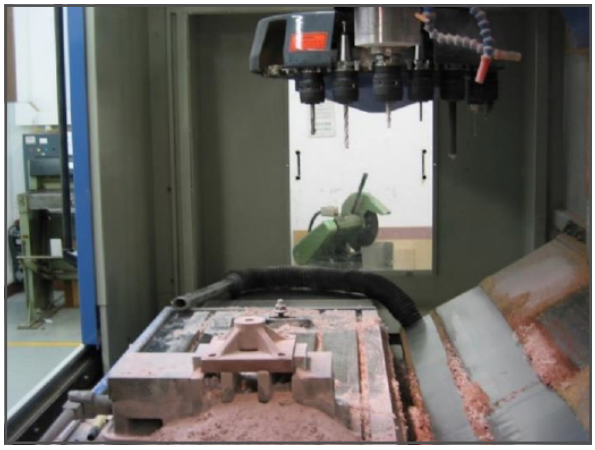


Fig. 3.7 A CNC cutter at the Hong Kong Polytechnic University

Some key consideration in the utilization of wood in interior projects:

1. Understand the nature and characteristics of the natural wood such as contraction, expansion, colour, scent and other properties
2. Selection on hard wood or soft wood can be the primary consideration in determining the strength and durability of the interior;
3. MDF, wood veneer, plywood can be good replacement for hard wood due to their sustainability and reusability;
4. New technology such as laser cut, CNC and parametric modelling can make complex forms and shapes and create unexpected fabrication methods for the making of interior components;
5. Employ the traditional art of joinery when making wood carpentry or wood interior to add a new dimension to the use of wood.

Case Study 1

Project: Expo 2000 Pavilion In Hanover, Germany

Firm: Thomas Herzog (architect) and Julius Natterer (structural engineer.)

For the World Expo 2000 in Hannover, Germany, Herzog designed a giant wooden structural “umbrella” roof that protects a central piazza consisting of a stage area for musicians and artists, small reconfigurable pavilions and restaurants to provide rest areas for spectators taking time out between events. The roof comprises timber double-curved lattice shells, each supported on a central structure, which are manufactured using parametric design techniques.

Fig. 3.8 Roof of the pavilion

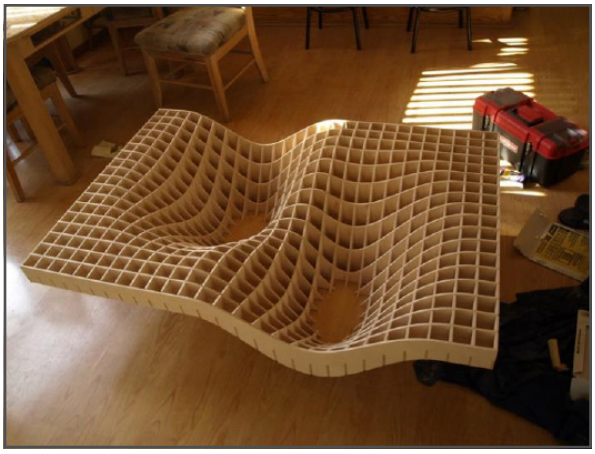


Fig. 3.9 The roof comprises timber double-curved lattice shells.

The project is a fusion restaurant in the financial center of Dubai featuring a gigantic double curved wooden wall. The multi-toned walnut wood finish pops off the all-white furniture and exposed concrete to create a dramatic and eye-catching effect. Opposite the restaurant, a 50-meter-long counter is clad in shiny black laminate to reflect lights from outside, enhancing its clean and organic movement.

The feature wall makes use of Wood-Skin®, a patented composite material composed of a sandwich wood and high-performance mesh that was created by process of excavation with a CNC cutting machine. Using design software that breaks up forms into small triangles, the process allows flowing, three-dimensional shapes to be custom-created.

Fig. 3.10 The restaurant features a gigantic double curved Wood-Skin® wall

Fig. 3.11 A 50 meter-long counter is clad in shiny black laminate.

Fig. 3.12 Reign Restaurant in Dubai

CHAPTER 4

Glass - Versatility and Transparency
by Dr. Tris Kee

Glass is a common material that has been part of human society since ancient times. It is a versatile material due to its transparency, reflective surfaces and ability to be used in both commercial and residential contexts. The history of glassmaking can be traced back to as early as 3500 BC in ancient north Syria, Mesopotamia and ancient Egypt, and glass has been used to make a wide range of objects including drinking vessels, beads, windows and jewelry. In contemporary interiors context, glass is used in many lighting fixtures, furniture pieces, windows, wall panels and other decorative parts.

The Venetian island of Murano in Italy is one of the world's most renowned centres of glass-making. Though just a small island, Murano is home to a vast number of glass factories and individual artists' studios. Known for its multiple colours and intricate craftsmanship, Murano's glassmakers still follow the centuriesold glass blowing techniques today, and are constantly developing and refining this technology to suit modern needs.

Fig 4.1 A Murano glass bottle

Physical Characteristics of Glass

Glass is made up of simple ingredients including sand, soda ash and limestone substances. The process of making glass is to heat these ingredients altogether at high temperature, bonding the materials together form glass. Its special physical properties are its transparency and fragility.

The main advantage of glass is that due to the strong chemical bonds between the molecules, it is a stable material and its physical state does not change easily from solid to liquid. The thickness of the glass determines its strength and durability. For instance, thinner pieces of glass usually break easily, while thicker glass such as those used in aquariums are more sturdy. Unlike materials such as metals or plastic, glass is considered static and is not reactive to other materials. Beside concentrated acid, glass is generally resistant to chemicals, making it very useful as container materials in laboratories as well as storage for acidic food and drinks.

Glass is used universally in all interior projects to convey a sense of spaciousness as well as transforming what could be a dark and gloomy interior into a bright setting. From windows to lighting fixtures, furniture to staircases, washing basins to wall panels, the use of glass is favored by many interior designers. Using glass as a material for internal staircases or even flooring can bring a sense of drama and elegance to a space. Made of special architectural glass, such structures are a perfect way to introduce additional light to an otherwise dark interior.

Fig 4.2

Types of Glass

There are many types of glass in the market, and some are created to minimize the hazards resulting from glass breakage.

Fig. 4.3

Tempered Glass

Also known as toughened glass, tempered glass is a type of safety glass [1] processed with chemical treatments in order to improve its strength. If broken, tempered glass crumble into small granular chunks instead of splintering into sharp pieces, thus lessening the chances of injury. Due to its improved strength, tempered glass is used in many commercial applications such as automobile wind screens and glass balustrades in shopping malls. In domestic interiors, tempered glass is found in shower doors, cubicles, glass doors and tables.

Coated Glass

One of the most common usage of coated glass in Hong Kong is the low-emissivity glass used in most curtain walls of skyscrapers. Low emissivity (low-e or low thermal emissivity) glass emits low levels of radiant thermal (heat) energy. The use of low emissivity glass in buildings reduces the use of air conditioning and is thus a good alternative to conventional glass panes.

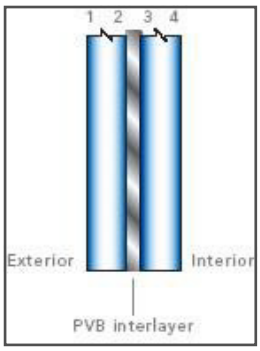


Fig. 4.4 Laminated glass

Laminated Glass

Laminated glass is made of two or more layers of glass with one or more inter-layers of polymeric material bonded between the glass layers, which allow the glass pieces to be held together in case of breakage. The interlayer also provides a way to apply other properties such as colouring, sound proofing, and resistance to fire, ultraviolet filtering.

Fig. 4.5 Patterned glass

Patterned Glass

Patterned glass can provide endless possibility in interior applications, and is particularly common in commercial settings. Once flat glass surfaces are imprinted with patterns, different textures and degrees of transparency can be created. The method for producing patterned glass is to pass heated glass during manufacturing process with rollers whose surfaces contain the negative relief of the desired pattern.

Tips for Designers

With new technologies for glass-making as well as coating and treatment, interior designers are now given more options regarding choices and selection. When selecting glass, one ought to consider the context and desirable effect. The following are some general tips for deciding which type of glass to use in an interior project.

1. SAFETY

Since safety is a major concern for all interior projects, tempered glass is almost never the right choice, since it will break and shatter, splintering into many small pieces and posing serious threat. By contrast, laminated glass will crack upon impact, but will remain in place as one piece, offering increased protection for interior settings such as conference rooms and meeting areas.

2. SOUND

Bent and curved glass is often used for automotive glass and marine glass installations. In both these cases, sound proofing is often a high-priority, since vehicles produce a great deal of noise. Laminated glass is also a good option for any situation in which sound proofing is of concern.

3. SECURITY

If security is a concern, laminated glass is the preferred choice since it does not shatter. By contrast, if used for store-fronts or window displays, tempered glass can be easily smashed into thumb-sized pieces, giving thieves a safe and easy entry-point.

4. MALLEABILITY

For projects requiring bent or curved glass, there are many additional benefits with using laminated glass, which is very flexible and thus suitable for bending and curving into shape.

5. UV PROTECTION

PVB interlayer (polyvinyl butyral) is a type of plastic film that holds the layers of glass together, and can block out 99% of UV rays. This characteristic makes it excellent for window and skylight applications. Valuable art work, carpets and furniture that are exposed to significant levels of sunlight can be protected from damaging UVA and UVB rays.

Case Study 1
Project: City In Love
Firm: TAOA Taolei Archiects

This chain store specializing in diamonds and other gemstones is located in Beijing. The interior design firm makes extensive use of patterned glass and mirrors along with clever lighting to represent the shimmering nature of the store's merchandise.

The company's logo is silk-screened oxnto patterned glass and cut into angled-arrangements that echo the cuts of diamonds. The tilting angle of the glass wall allows it to capture the ceiling lights well as the light reflected off the glass mirrors.

Fig. 4.6

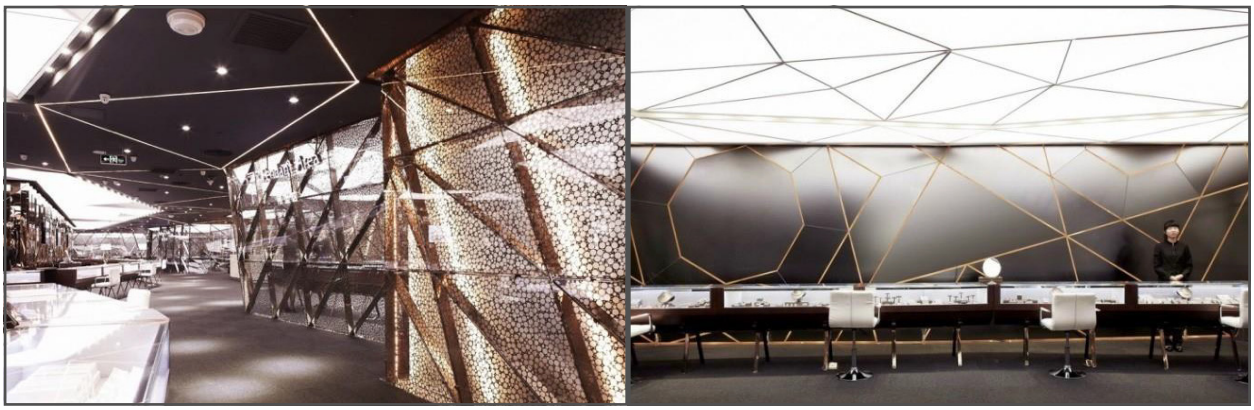


Fig. 4.7-8

Case Study 2
Project: On-Off Plus
Firm: Inspiration Group

This exhibition space for Guangzhou Design Week attempts to explore "phenomenal and physical transparency through building the spatial dimension contradictions". The pavilion is enclosed by white, grey and transparent colour soft membrane. Fuzzy image is produced by the means of coated glass.

The pavilion's steel frame, mostly welded on site, juts out at extreme angles both at ground level and overhead. A translucent plastic membrane stretches over certain segments, while other panels are made of silvery glass that simultaneously reflected and revealed. Inside, photographs and video of the firm's projects, from tropical resorts to urban workplaces, play on a bank of monitors. Another wall, this one mirrored, catches the reflection of Chinese characters stenciled on the floor to convey a philosophical enigma: "Everything is nothing. Nothing is everything."

Fig. 4.9

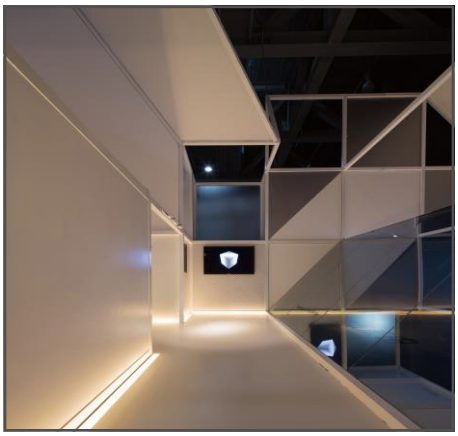


Fig. 4.10

This store façade for a clothing store in Shanghai is composed of two types of glass blocks. The combinations of the two types of glass block create a sculpted three-dimensional façade exhibiting cantilevered structures. By incorporating innovative structural engineering and inventing a new joining system in the block itself, an elaborate ornamental stepping canopy is achieved that naturally angles to the flow of pedestrian and allows for four bow windows to be visible from all directions.

During the day, the facade subtly reflects sunlight, while in the evening, the view is icy and crisp, and the surface illuminates with embedded LED lights integrated into the joints of the masonry. The differing geometries and changing perspectives of the facade expresses the transformative nature of the city and the people of Shanghai.

Fig. 4.11

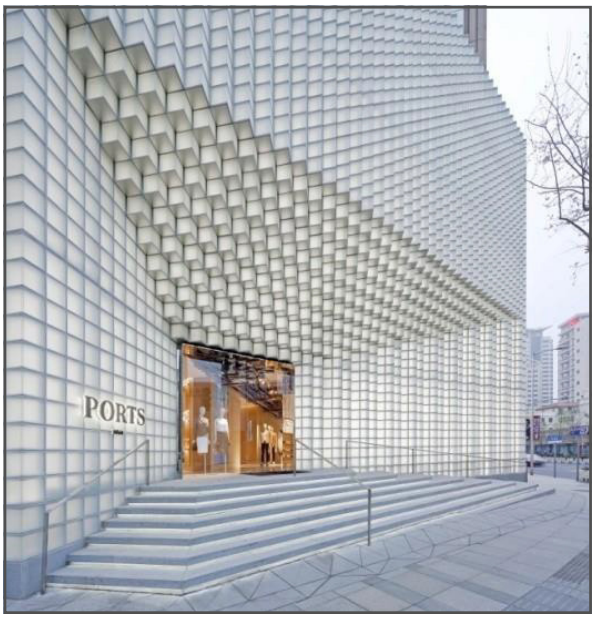


Fig. 4.12

CHAPTER 5

Metals - Strength and Durability
by Dr. Tris Kee

Metal and metal alloys have overall strength and durability that most other building materials lack, and are thus useful for many interior applications. Many types of metals and alloys are available in the market, and metal alloys can be used in a wide range of capacities such as wall panels, furniture, ceilings and decorative elements.

Aluminum

Due to its lightweight and corrosion-resistant properties, aluminum is one of the most widely used metals. Commonly used for making of airplanes components, eye wear and exterior façade cladding, aluminum is also seen in wall cladding and ceiling panels. Some interior designers have gone beyond the standard ceiling panel forms and have utilized the malleability of aluminum to create fluid forms, creating fabric-like ceiling panels.

Another aluminum product is the Alucobond® aluminum composite material, which is a composite panel consisting of two aluminum cover sheets and a plastic core. We see many Alucobond applications in transit stations interior as well as exterior storefront cladding. The sandwiched layers in Alucobond or similar products like Megabone possess durability and rust resisting properties, and they are suitable for exterior and interior applications. The widespread application of Alucobond has helped expand the designers' selection of interior cladding in recent years.

Fig 5.1

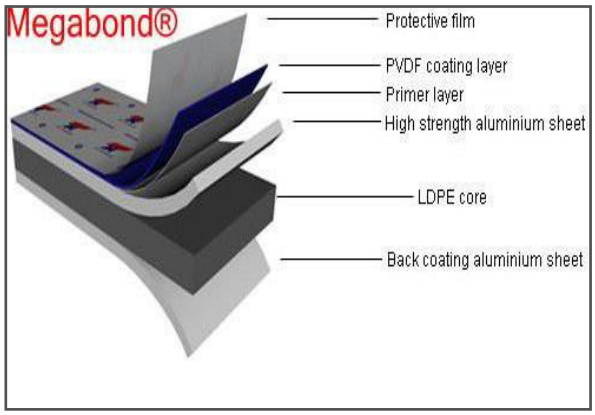


Fig 5.2

Copper

Copper has a long tradition of being used in interior design. The distinctive colours of copper and copper alloys make them prized for interior and product design use, such as copper lighting fixtures. Their natural metallic tones that range from reddish to silvery and a number of other colours can be obtained by chemical or electrochemical processing. Furniture and lighting designers David Derksen and Tom Dixon are known for their uniquely shaped copper lighting fixtures.

Although copper and its alloys are extremely resistant to corrosion, a discolouring tarnish will eventually form with prolonged exposure to moisture and air. Copper weathers naturally to a blue-green colour, or patina over time, but clear coatings can be applied to copper products to prevent tarnishing. These coatings consist of organic chemicals which harden at room temperature or with baking and are usually applied in a solvent vehicle.

Fig. 5.3 Copper lights by David Derksen

Corten Steel and Stainless Steel

Those who prefer the feel and texture of rust may consider corten steel – a metal that is known for its rusty texture if exposed to the elements over time. Richard Serra, an American minimalist sculptor whose works have been collected by major art galleries and museums, uses large pieces of welded corten steel to weave interesting internal spaces in his full-scale sculpture, playing with light and darkness, flow and folds architectonically.

Stainless steel is also a very common interior product, mostly used for ironmongery and kitchen counters. There are many grades of stainless steel, and the higher the numeric grade, the more rust resistant it is. Therefore, stainless steel 316 is better than stainless steel 314 in terms of corrosion resistance. The difference is that 316 stainless steel incorporates about 2 to 3 percent molybdenum, which increases corrosion resistance—particularly against chlorides and other industrial solvents. It is this unique corrosion resistance property that earned stainless steel its wide applications in surgical tables in hospitals, pharmaceutical products used in nursing or surgery rooms and kitchens counters.

Researchers at the University of Birmingham have successfully created antibacterial stainless steel. By introducing silver, nitrogen, and carbon to the surface of the metal, it not only wards off germs but is resistant to wear and tear. Such advance technology in material research can help broaden future interior applications, too.

Fig 5.4 One of Richard Serra's steel sculptures

Fig 5.5

Tips for interior designers in the use of metal

1) Anodizing metal for cladding

Anodizing is an electrochemical process that converts the metal surface into an anodic oxide finish to make it more durable and corrosion resistant. Aluminum is ideally suited to anodizing, although other nonferrous metals, such as magnesium and titanium, also can be anodized. Since aluminum oxide is not applied to the surface like paint or plating but is fully integrated with the underlying aluminum substrate, it will not chip or peel. Anodized metal has a highly ordered, porous structure that allows for secondary processes such as colouring.

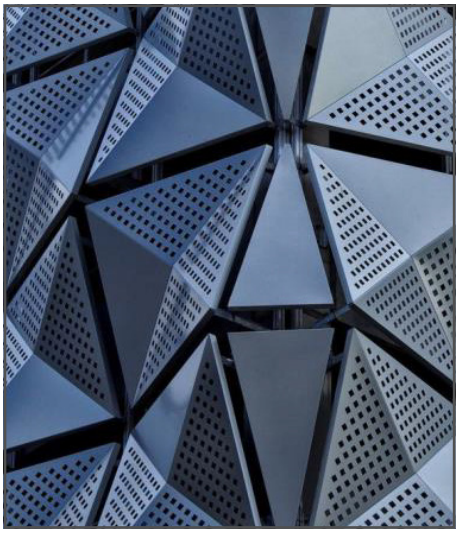


Fig 5.6

2) New Trends in Material Application Metal

New technologies such as 3D printing and new assembly methods can enhance how metal can be fabricated, twisted, rolled and be used in interior settings in the most innovative ways. Starting from form building, many 3D printers can now make free flowing forms that are not limited to geometric shapes. With advanced software such as Rhino, Solid Works and Grasshopper plug-ins, interior designers can easily formulate any shapes and forms that were impossible in the past. This has helped designers to bridge many technical elements, such as structure, connections and details to make fluid and artistic expressions.

Fig 5.7

3D printing, also known as additive manufacturing, is gaining popularly in the design field and is transforming the way designers create, produce and manufacture furniture. The technique – which “prints” objects from digital files by depositing material in layers – also signals an exciting change for consumers: from increasing the choices of available products to enhancing the ways they can customize their furniture. 3D printing can be used with various metals, including steel, stainless steel, titanium, gold and silver.

Fig 5.8

Laser cutting and 3D printing has also enabled designers to make prototypes much more easily. What was once a labour intensive and time-consuming task now can be executed in a matter of minutes. The ease of making prototypes allows more testing and research, thus permitting designers to have better means to understand the performance and outcome of their designs.

3) Parametric design in metal

Parametric design is a process based on algorithmic thinking. With new parametric software such as Rivet, interior designers are now better equipped with tools and software to help create conceptual and prototype models. This kind of software allows designers to have more command on dimensions such as width, depth and height, and other parameters. We see how this technology is applied to more advanced fabrication techniques to create a more versatile platform for future interior design thinking. Shenzhen Bao An International Airport's new Terminal 3, designed by Italian architect Massimiliano Fuksas, offers an example of the use of parametric design in interior spaces. The cladding is made of alveolus-shaped metal and glass panels of different sizes that can be partially opened.

Fig. 5.9 Shenzhen Bao An International Airport

Case Study 1
Project: Nana Tea Room
Firm: KAMITOPEN

Traditional Japanese tea rooms were usually constructed of wood logs, but the designer decided to reinterpret this concept and used metal logs as the main design element.

The metal logs were custom made and welded together without using bolts. These metallic logs give the tea room a clean, modern feel while maintaining a connection with tradition.

Fig. 5.10

Fig. 5.11

Case Study 2
Project: Issey Mikake Store, Tamagawa, Tokyo
Firm: MOMENT

The main theme of the store is to provide t-shirts for the 21st century. Interior designers designed metal screens that display the t-shirts. The screens consist of a simple system using just metal hooks so that the products can be displayed everywhere. This system functions as both hooks and walls, and creates a unique and intimate transparency to welcome customers.

Hooks are placed in the required position and joined with thin steel bars to make a big screen. Even though each single steel strand is weak, when joined together the structure gains strength and becomes self-sustaining. Steels strands are welded at points to make lightness stand out, while the surface is coated with powder coating with high strength.

Fig. 5.12

Fig. 5.13

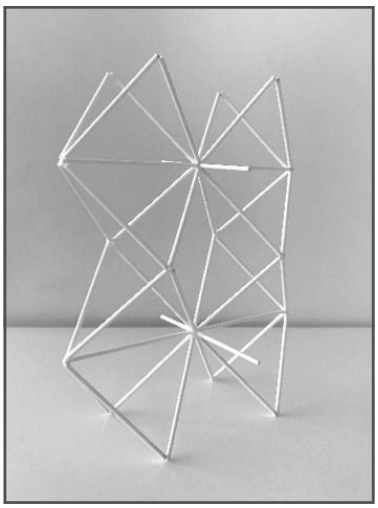


Fig. 5.14

CHAPTER 6

Plastics
by Alex King

The invention of plastic began in 1905 with the successful synthesis of a material which can bind powders to each other, forming thermosetting plastic. In 1916, the vehicle manufacturer Rolls Royce began to adopt phenol formaldehyde in the interior decoration of cars, creating multi-colour patterns that enhanced the user experience of driving. More inventions appeared in the commercial industry in the 1930s. For example, 3M Company brought the first transparent adhesive tape to the market as a result of the invention of new plastic. Other formation of new plastic materials included polyethylene (PE) and polystyrene (PS), which appeared in the next two decades. More sophisticated applications of plastics include silicone gel-filled breast implants and plastic beverage bottles made by polyethylene terephthalate that are now ubiquitous in the market place.

The development of plastics allows many products made by various large corporations. For example, Swatch watches are made of more than 50 high performance plastic components, while Smart Car is made of polycarbonate (PC) panels to create a lightweight and flexible outer appearance. Further innovation on polymer and plastic composites improved material properties in terms of strength and stiffness. In 2008, a double-deck four-engine jet airliner was made using carbon-fibre reinforced plastic. These are just some examples of the extensive application of plastic in contemporary society.

Fig. 6.1

Fig. 6.2

Main Plastic Materials

1. PVC

Polyvinyl Chloride (PVC) is synthetic plastic polymer that is oil-resistant and provides an excellent protective layer against gases. PVC was first introduced in 1929; because of its chemical stability and fire resistance, it has been used in many commercial applications. It is a thermoplastic that can be molded using simple techniques to produce clock cases, food containers, dolls and bottles in all kinds of shapes and sizes through injection-molding, blow-molding and extrusion. Because of its high resistance to adverse weather condition, public furniture such as fences, litter bins and road- signs are usually coated with PVC as protective layer. The first inflatable armchair, designed in 1967, was commercially produced thanks to PVC.

By 2020, it is expected that over 800,000 tons of products manufactured using PVC will be recycled every year across Europe. In the near future, super reflective PVC fabric with triangulated profile would be applied to create a stadium with zero carbon emission that provides comfortable playing condition for sports players

2. ABS

Derived from natural gas and petroleum, Acrylonitrile-Butadiene-Styrene (ABS) appears in a wide range of products in day-to-day living, including household appliances, camera bodies, cell phone cases and luggage. Due to its light weight, high impact resistance, stiffness as well as ease of surface painting and gluing, ABS materials have become ubiquitous in our daily lives. They can be molded into many sophisticated forms with excellent aesthetic qualities, and their costs are comparatively low, relative to Polycarbonate (PC). ABS has become popular with toy manufacturers due to its natural white colour, providing an excellent platform for artificial dyeing.

With the development of advanced injection molding, the first one-piece injection molded chair, Universale, was born in 1967. Manufactured by Kartell and designed by Italian designer Joe Columbo, this stacking side chair with an unfussy design is adaptable and durable, and can even be used outdoors.

Fig. 6.3 Universale chairs

3. PU

Flexible polyurethane (PU) is mostly applied as an insulating and cushioning material in furniture and bedding as its material property is more resilient than other plastic materials. PU foam can be molded into sculptural shapes, such as the Pratone seating unit, produced by the Italian company Gufram in 1972, aims at providing interactive and unconventional user experiences. Its form recalls oversized stalks of grass, and allows for various seating positions.

Fig. 6.4 Pratone seating unit

4. Corian

Developed by the American company DuPont in 1967, Corian is an acrylic polymer widely used in interior design. Due to its material consistency, stain resistance and nonporous nature, Corian is widely used for kitchen countertops, bathroom sinks and bathtubs. Because it is flexible when heated, Corain can be molded into a variety of shapes and forms, as well as custom-made to fit any interior space.

Fig. 6.5

In the manufacturing process, parts are clamped tightly together after applying acrylic epoxy adhesive, and when dried, the joints are sanded and polished to create a seamless appearance. Since it is non-porous stains can be easily removed with soapy water, ammonia-based household cleaner while scratches can be repaired with a sander.

Intelligent Plastics

Intelligent plastic materials have the ability to perceive different information from the external environment, such as temperature, light and external force, and can automatically change its shape corresponding to the change in environment. Intelligent plastics itself has intelligent sensing abilities to control and issue commands and complete actions. It can effectively achieve self-diagnosis, self-control and self-correction, and can even modify function by itself to cope with different purposes and potential barriers. Shape-memory plastics deform by responding to different parameters such as heating and electric field, and restore to its original form after the deformation and stimulation period is over. Furniture designers can now make use of these qualities to revisit their previous designs to see if they could apply such innovation to enhance the overall look and feel, functionality and ergonomics of the furniture.

Application of Plastics in Interior Design

Decorating our homes nowadays has become easier thanks to the numerous possible solutions made by vinyl or PVC, such as wallpaper and flooring with multiple colours and fine patterns that are durable and easy to install. Vinyl or PVC wallpaper is washable when it becomes dirty, leading to longer life cycles. Vinyl and PVC can also be used for ceilings in the form of panels. Since the materials are light for easy transport, fire resistant and sturdy enough for interior use, plastic panels offer replaceable, flexible and unique designs to fit different tastes and preferences of users. Vinyl has become a popular choice as flooring materials for high-traffic areas such as schools and hospitals due to its cleanability and durability. Vinyl composition tiles (VCT) are resistant to noise transmission and impact damage, and can be refurbished and replaced to maintain their attractive and glossy appearance, while vinyl upholstery fabric is well developed at affordable prices with high performance.

Recycling of Plastics

Environmental impact has become an important issue, and product designers are aware that they should minimize the emissions of hazardous substances. Plastic recycling mainly includes polyethylene terephthalate (PET) and high-density polyethylene (HDPE) from detergent bottles makes up a gigantic portion of plastic recycling market. Residential collection program of consumer electronics has been in place for the past decades in Western countries. About 20% of the solid waste now come from plastics, while over 90% of plastics are made of polyphenylene ether (PPE) and ABS, which are contained in many household appliances such as washing machines, air conditioners and refrigerators. These products are typically used for 10 to 18 years before being discarded. An increase in plastics recycling is needed to conserve the environment.

New Plastics Economy

Currently, around 30% of plastic packaging materials cannot be reused or effectively recycled. In addition, fewer than 4% of typically used plastic bags are recycled. Governments should take a leading role by proposing progressive policies in support of eco-friendly manufacturers and recyclers, and by simply imposing penalty on improper applications. The redevelopment of global plastics network will capture the true value of the material and contribute to favorable economic and environmental outcomes. Yet owing to the fact that consumption of plastic bags is estimated be up to 1 trillion per year across the world, recycling and reusing are not enough to solve this complex problem. Educating the masses to consume less is fundamental.

Emerging plastic materials – Bioplastics

Bioplastics are plastic materials designed to biodegrade, and are usually composed of starch, cellulose and biopolymers, as opposed to the commonly used fossil-fuel plastics derived from petroleum. Many disposable items such as cutlery, plastic packaging films, straws, fruit containers and egg cartons are already developed using bioplastics. The most commonly used in commercial market is starch-based plastics, which constitute more than a half of the bioplastics market. Bioplastics are either manufactured with native or slightly modified starches that are blended with natural or synthetic particles.

Polylactic acid (PLA), made from corn, is a good biodegradable replacement for plastic bags. One of the key benefits of PLA over other petroleum-based plastics is that no toxic fumes are emitted during the process of incineration. Its performance is similar to conventional plastics, having good colourability and antistatic behavior. However, its limited moisture resistance and mechanical properties narrow the application of starch-based plastics in food design and packaging.

However, there is some controversy regarding Polylactic acid use as corn is a foodstuff, and large-scale production of PLA may lead to a rise in food prices. There is also concern that the breakdown of biodegradable plastics will release harmful greenhouse gases like methane into the environment, while the carbon in conventional plastics stays inert and locked up in landfills.

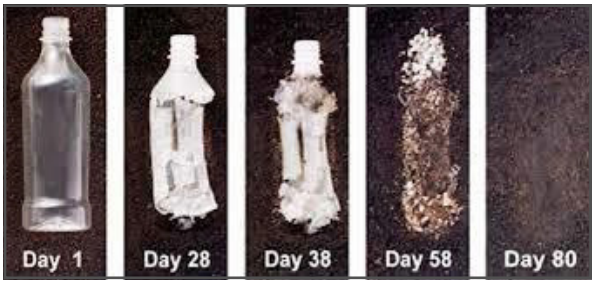


Fig. 6.6

Towards Sustainability: Future of Plastics

Developing innovative technologies in order to achieve a strategic shift towards new plastics economy will be a key development in future. This includes rethinking plastic usage, packaging and improving design, increase the percentage of plastics that are recycled or reused, as well as exploring alternatives such as biodegradable plastics and bio-based growing materials as alternatives to plastic.

CHAPTER 7

Biocomposite and Aerogel materials
by Sonny Choy

The development of advanced materials is a field of science and engineering that creates new and wonderful materials to meet a vast array of challenges. The innovations involved are usually concerned with improving a material's physical and chemical properties to provide solutions to practical problems. New materials are created to deal with extreme environmental situations, enhance sustainability and create new and advanced material behavior.

In this chapter, a number of new materials with innovative and advanced properties are explored. These materials, including biocomposites, aerogels and organic materials, have been developed to serve some very practical and novel applications, and benefit society in their own unique ways.

Hemp and Polypropylene Composite (Biocomposite)

Polymers have had a varied history since it was invented in the mid 19th century. The first synthetic polymer created was called 'styrolene' (Styrene) by the French chemist Marcelin Berthelot in 1866.

Early incarnations of synthetic polymers were preferred over their natural counterparts because of the new and improved performance properties. Synthetic polymers took precedence after the industrial revolution when mass production led to the increased demand and the opening of new markets around the world.

Today, petroleum-based polymers are being applied in excessive and frivolous ways to produce consumer products. Attempts to rein in this excess have led to innovations in composites that revisit natural and sustainably produced constituents.

Hemp and polypropylene composite is a strong, light weight and durable material composed of hemp pulp that is integrated into melted polypropylene during the molding process. The composite was developed as a response to the challenge of making more sustainable materials for large scale applications. It is now used in the automotive industry where this material's light weight and strength lends itself to use as interior molded panels and other car interior components. When compared to existing composite materials using glass fibres, hemppolymer combinations are much more sustainable.

Fig. 7.1 Car panel made of hemp composite

Various proportions of 'hemp to polypropylene' have been experimented with to achieve the best strength to weight ratio. For example, scholars looking into hemp composition found that the optimal percentage for best physical performance lies somewhere between 40-50% hemp fibers in the composite. They have also confirmed that laying the fibers in a direction that aligns with the direction of anticipated physical stress increases its strength and toughness performance.

More recently, designers have applied this polymer and plant fibre concept to other applications. Studio Aisslinger, a famous German design house, with the support of German chemical company BASF, developed a chair made of a composite with hemp, kenaf (Hibiscus cannabinus) and a water-based thermoset binder to produce the Hemp Chair.

Fig. 7.2 Chairs made of hemp composite

Borrowing the production process used in the auto industry, this chair is compression molded as a 'monobloc' part, and is the first stackable chair of its type to be produced this way. Sustainably planted hemp and kenaf are combined with BASF's water-based acrylic resin 'Acrodur', in a process which releases no harmful chemicals like phenol and formaldehyde during the polymer cross-linking process. In fact, the only by-product of the curing process is water, making the production process clean and environmentally friendly. Colouration is completed with eco-friendly pigments while the form stems from structural reinforcement through its curved and beaded design.

Aerogels – The Lightest Material on Earth

Invented in the 1930s by American scientist and chemical engineer Samuel Stephen Kistler, aerogels boasts some incredible properties that deserves a closer look. Aerogel is a category of material which typically is extremely low in density and exhibits no less than 50% porosity. The material is mesoporous, which means that its pores are so small that they range from between 2 to 50 nm in diameter. This category of material can be made from a number of different chemical compositions including silica, lanthanides and actinide metal oxides, organic polymers, biological polymers, semi-conductor nanostructures and carbon. However, their structure is basically similar across all compositions. Typically, aerogels are composed of 95-99% air, with the world's lightest aerogels made up of 99.98% air, making them extremely light in weight.

Contrary to what the name suggests, aerogels are not moist or gel like at all. They are dry and solid. However, their solid-like cohesive structure is derived from gels from which all liquid within its pores is vacated. As a result of this structure, an aerogel of a given material demonstrates physical properties that are very different from that of the material in its normal state.

The density of aerogels is very close to that of air and this gives the material some fascinating physical properties. Aerogels can be made even lighter than air itself by extracting the air out of the pores completely!

Aerogels have many different applications, and can be used in a variety of fields.

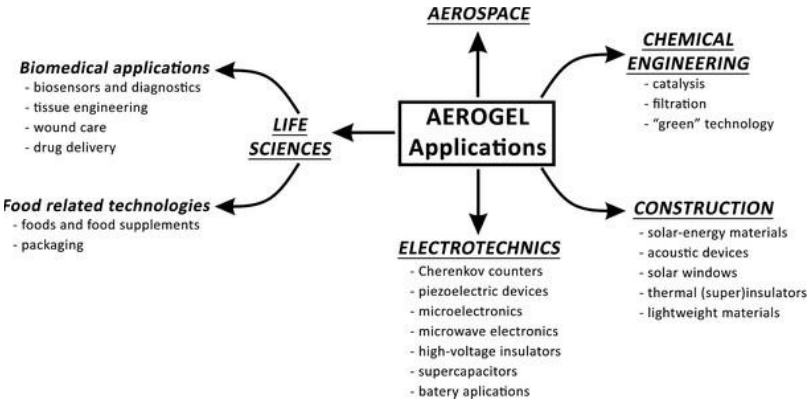


Fig. 7.3

Many aerogels are not strong. However, scientists at NASA have found innovative modifications to aerogels that can increase its strength while retaining its light weight. They created polymer coated aerogels that are stronger, and have even developed flexible aerogels that can be made into thin films.

Another property of aerogels is that it is an extremely good thermal insulator. The high air content means that if it is combined with flame resistant metal oxide or ceramic (silica), the physical form of the aerogel can take on a thin cross section and still offer excellent thermal insulation.

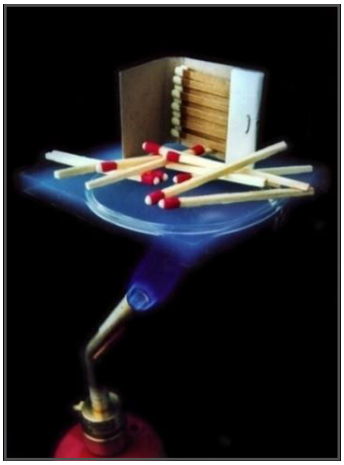


Fig. 7.4

As seen in Fig. 7.4, the thin layer of silica aerogel can protect the matches from the fierce flames of a Bunsen burner. Another application may be found for passive fire protection of industrial machinery where there is risk of flame damage. Temperatures of over 600 degrees Celsius is within the safe operating temperature of some aerogels like Pyrogel XTE. Finally, aerogel insulation products can even be used on personal applications in jackets and insoles to protect wearers from extremes in temperatures such as in high altitude mountains.

Mushroom® Packaging

Another excellent material that is totally bio-degradable is derived from mycelium of mushrooms. “Mushroom Packaging” is 100% renewable & compostable. It is a light weight packaging material which can be used for packaging anything from small consumer products to pumps and compressors. This material has a number of appealing properties which make it ideal for use as packaging material.

- High performing
- Has a premium, natural aesthetic
- Price competitive with most fabricated plastic foams
- Environmentally sustainable
- Home-compostable
- Non-abrasive
- Custom designed to fit any shape or thickness
- Not derived from petroleum or food

Some companies which have taken this bio-material on board as part of their product packaging include the US computer giant Dell, which uses it to package its high-end servers. Home furnishing company Crate and Barrel has also used it for some of the packaging on their selected product line. The advantage of producing mushroom packaging is that it does not compete with human food sources. The process of making it is simple and clean with little to no by-products of emissions or pollutants.

The production process of mushroom packaging involves securing agricultural waste products for the mushrooms to feed on. Such agricultural waste, including corn husks, for example, can be taken from a farm or a food processing plant where the organic material is of no further use to the food industry. The material is cleaned and prepared for the introduction of mycelium, and the mixture is left for a few days to allow the mycelium fibres to grow and digest the agricultural waste material. Afterwards, the mixture is taken and crushed into smaller loose particles, which are then placed into a mold and shaped into its final form. Finally, the piece is taken out of the mold and dried to achieve the final packaging product.

Mushroom material can also be applied to custom-made furniture. Below is a picture of the Tafl Table by Ecovative Designs. The table and chair set is completely made of mushroom material and is totally compostable.

Aside from furniture, mushroom material can be used to produce Myco-board, which addresses the need for a more sustainable building material for general usage.

Myco-board is an environmentally sustainable building material available in several dimensions: 3' x 6', 4' x 8' and 5' x 10'. It is free from urea-formaldehyde and VOC, and it is class B fire rated. Mycoboard's applications are endless. It has a pleasing all-natural surface finish which can be coated using conventional finishing systems or laminated.

Fig. 7.5 Tafl Table

Fig 7.6 Myco-board

All of these materials are examples of environmentally friendly materials. They are innovative materials that address both performance as well as sustainability. Through better use of limited resources and the smart application of technology, scientists pave the way for advanced materials that create a positive impact on the world.

CHAPTER 8

Concrete
by Dr. Tris Kee

Concrete is a composite material composed of coarse aggregate bonded with fluid cement which hardens over time. Prized for its strength and durability, it is a common material used in the building industry, both as structural support and interior decoration. Concrete is a versatile material that can be used in many constructions such as buildings, pavements and other structures. Although concrete is excellent in compressive strength, it has little tensile ability. The fact that concrete constructions are so durable is the combination with steel reinforcement bars (often called rebars) which are embedded in the material to provide tensile strength, yielding reinforced concrete.

Since ancient Roman period, engineers have used concrete technology in major infrastructural projects, such as the Colosseum and the world's largest unreinforced concrete dome at the Pantheon. In contemporary times, many interior designers opt for the bare and industrial look of concrete and have utilized the material for making wall panels, floor surfaces, and even office partitions. Concrete surface can be either fair faced or textured, and can bring dramatic shadow effects and a uniquely raw appearances to an interior space.

Fig. 8.1 The Pantheon in Rome.

For instance, Japanese architect Tado Ando's signature fair-faced concrete treatment is an effect that requires skillful craftsmanship to achieve. Plain concrete is used directly for its natural finishes, providing a smooth surface which is uniform in colour, producing a pure, solemn and Zen-like feel. Although the look may seem simple, in fact a great deal of skills went into making this flawless fair-face effect. The outcome is one that is true to the materials and a serene simplicity.

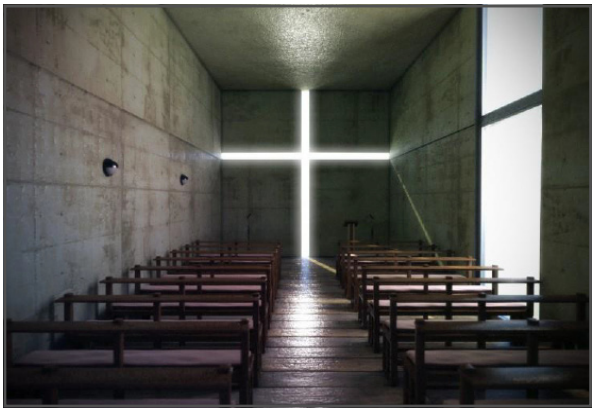


Fig. 8.2 Tado Ando's interior of Church of Light, in which concrete brings a sense of simplicity and solemnity

Concrete need not be plain and austere, but can also be highly decorative. For instance, casting molding, printed concrete and concrete blocks can come in various colours, patterns, shapes and forms. In addition, concrete surfaces can be scored, folded and curved, yielding endless possibilities with regards to surface treatment. With the availability of new technology, indoor and outdoor application of concrete can achieve dynamic and fluid forms.

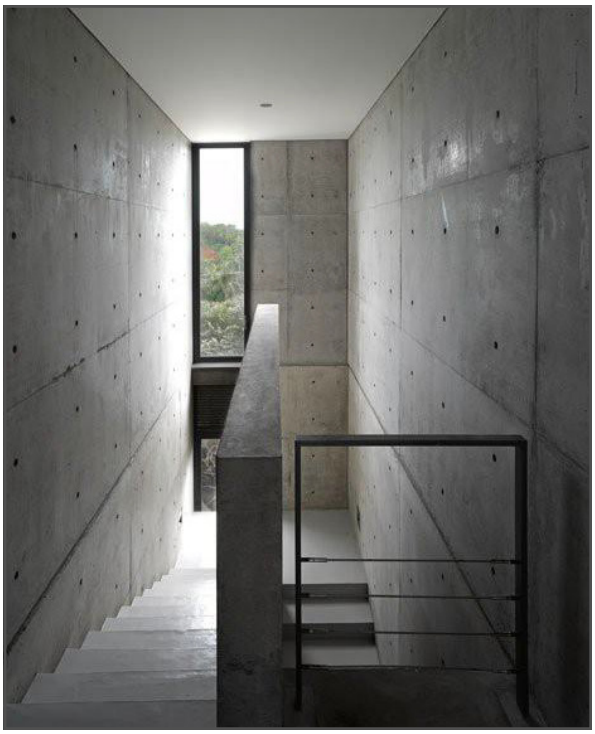


Fig. 8.3 Use of fair-face concrete in the interior

Fig. 8.4 Hall B, Turin Exhibition, Turin, 1947-1954

New Technologies in Concrete

To give an overview of the evolution of concrete, one can start with Pier Luigi Nervi, an Italian architect and constructor who blended the art and science of building using reinforced concrete in his design. Nervi based his work on sound design and construction experience, with an intense attention to the relationships between structure and shape. This design philosophy is clearly demonstrated in a stadium built in Florence in 1930 and a series of hangars built between 1935 and 1940.

Since then, many designers have also explored different possibilities of this material. Zaha Hadid became known for her skill in working with various concrete forms, often combined with the use of new technology. With her earlier work such as Vitra Fire Station to her masterful experimentation with curves and shells in the Roca London Gallery and ME Dubai Hotel atrium, Zaha Hadid pushes the limit to morph and bend a material that is not known to behave well in tension. The fluidity and dynamism of her forms are so outstanding that ceilings melt into walls which melt into the floors, and visitors feel completely enveloped by the material. Zaha Hadid was a trailblazer in many respects and serves as an inspiration to design.

Fig. 8.5 ME Dubai Hotel

Fig. 8.6 ME Dubai Hotel

Zaha's design was realized with the help of new technologies. New software such as Rivet and its supporting plug-ins can now make designing fluid forms a possibility. Such computer software is able to translate complex geometry into fabrication codes, making the construction and fabrication of concrete pre-cast available, allowing architects like Zaha Hadid to experiment with many innovative designs.

Recycled-content products can address the needs of architects and designers working on LEED® certified projects, and contribute to sustainable design and reduce life-cycle building costs. In addition, energy reduction and waste recycling efforts employed in concrete production can reduce the impact on the environment.

Tips for designers when using concrete

1) Designers using concrete for interior cladding should pay special attention to surface treatment and to ensure the surface of the concrete receives sufficient curing time.
2) Knowing the limit of concrete in terms of compression and tensile strength can help with the design of form for the interior. Reinforcement bars can be added to strengthen the tensile ability of concrete.
3) If curved forms and bent concrete is desired, designers can use new technologies to make curves possible and to add to the fluidity of forms.
4) Aside from poured concrete, concrete also comes in other forms such as blocks and other masonry products, and designers can consider utilizing recycled concrete to ensure the sustainability of their design.

Case Study 1

Project: Super Tomato Office
Firm: Super Tomato

Concrete is chosen as the main component of the space, providing it with texture and colour. The concrete gives the space a modern, airy feel. The office furniture is made out of old ship planks, bringing a sense of history to the space. The cool feeling of the concrete is balanced out by the textured wooden furnishings. All cabinets are built using wheat-straw board, an excellent sustainable material.

Fig. 8.7

Fig. 8.8

Fig. 8.9

CHAPTER 9

Fabric
by Dr. Tris Kee

Fig. 9.1

Fig. 9.2

Often forgotten as a material for interior design, fabric exists in almost every corner of an interior setting. From curtains and drapes to leather upholstery and cushion covers, fabric brings character to the hard surfaces in an interior. It is a very versatile material that can be cut and sewn to different shapes. Used smartly, fabric becomes the accent of the interior, adding colour and texture to the space.

Types of Fabric

Curtain

For most domestic or commercial interior, curtain is an essential element to block excess sunlight and to act as a screen for privacy. Although curtains come in many forms including blinds and drapery, the latter is more common in domestic settings and hotel interiors. Drapery fabric used for curtains should be selected for length, ability to shield off sunlight, as well as colour matched with other elements in the interior.

For instance, patterned drapery fabrics are best suited for window treatments, pillows, bedding and table skirts. There are millions of patterns from dots, checks, stripes, plaids and contemporary printing available, and interior designers can choose drapery based on the personality of the house residents or to match the overall theme of the design. For instance, in many hotels, heavy drapery such as velvet as both curtain and beddings are used to create privacy and shading from sunlight. To make sure the colour and pattern are long lasting and to minimize maintenance, designers often opt for simple and subdued patterns and avoid bold or aggressive colours as they tend to go out of style very quickly.

Fig. 9.3

To match the drapery with the bed covers, designers often choose either the same fabric or the same tone to create a holistic look. The same strategy can be applied to selected upholstery for the furniture inside the room setting, such as chairs, sofas or accent pillows. In the case of pillows and cushions, designers can adopt colour theory to play with contrast and select complementary colours to create a bold statement. Pillows or cushions are seen as decorative elements and therefore can come in different colours from the main furniture.

Carpet

Carpets often cover more interior space than other fabrics. Particularly in temperate climates, carpet is also chosen for its insulation property. Carpet design comes with various colours, patterns, synthetic and natural materials, as well as different weaves that can inspire endless imagination.

There are many carpet styles, including Plush, Saxony, Berber, textured and frieze. These terms refer to its pile, which is the surface you see, created from yarn tufts that are either folded over into loops, cut straight across or both. While each style has a distinctive look, designers should consider both the lifestyles of users and how it fits into the interior setting. Plush carpeting, for example, is made from tightly twisted pile, and is thick, soft and inviting and very suitable for hotel floors. However, it often shows footprints and vacuum tracks, and can have patches which are called “pooling”--areas that appear shaded because the normal direction of the carpet fibers has been reversed.

Fig. 9.4 Plush carpet

Saxony is the most common type of carpeting. For areas which are low-traffic areas like formal living rooms and master bedrooms, Saxony is often the preferred choice.

Berber carpeting is crafted from continuous fiber loops and is flat and dense. Varying from level loop, cut-and-loop or multi-level loop design, Berber is extremely durable and does not show tracks, soil and stains. It can be used for high traffic areas or places such as children’s play room. Some interior designers like to use textured carpet as it is made from fibers cut to different heights, which causes them to reflect light. Since it is difficult to show tracks and dirt, textured carpet is good for high traffic areas too.

Fig. 9.5 Berber carpeting

Leather

Fabric also includes upholstery such as leather or other covers that provide furniture with padding, springs, webbing, and fabric. Similar to other fabric treatment in the interior setting, upholstery selection can be of complementary colour with the overall tone of the interior, or be of a contrasting factor. There is a wide range of synthetic or natural leather in the market. Some designers prefer to use natural leather, but for humane reasons, synthetic leather, which can have the same texture and appearance as natural leather, can be chosen.

Fabrics not only give an extra touch to the otherwise hard surfaces of the interior, but can also act as an acoustic moderator. Many restaurant interiors that lack soft surfaces that fabrics can provide often have acoustic resonance issues, making the environment noisy. Therefore, for most interior settings where noise is an issue, fabric becomes an essential element.

Fig. 9.6

To conclude, fabric comes in a wide range of materials that can be applicable to the interior. From the most common fabric such as curtain drape, pillow covers, bedding, to the extensive coverage of carpet flooring, leather or upholstery for furniture, fabric functions as a colour moderator and a sound absorber. If designers are tactful with the selection of fabric, very interesting effects can be created.

CHAPTER 10

Lighting Design
by Louisa Young

What is lighting?

Lighting is an important aspect of interior design as it enhances the aesthetic appeal of a design and creates the mood and ambiance of a living, working, dining and relaxing space. Lighting fixtures that illuminate a space create a safe and comfortable environment as well as add style to the interior décor. Light is the main element that gives the spatial design a special look and transforms it into a seamless combination of functionality and style. Besides playing a practical role, it also contributes to a visually dynamic space, and lighting can make or break the ambiance of a space.

Importance of lighting in interior design

Without proper lighting, interior design cannot be experienced to the fullest. Good lighting assures a warm, inviting and functional atmosphere in the design. The way in which designers incorporate lighting into the interiors defines the mood for the user of the space. Selection of proper lighting is the key element in interior design as it augments everything in a space - from the furniture, flooring, fittings to the finishes and textures. Creative use of different types of lighting can give the space uplift and focus, and the light fittings and lamps chosen to compliment the style provides stimulation to the space. In many interior design projects, specially trained interior lighting designers are employed to enhance the space and create ideal mood sets.

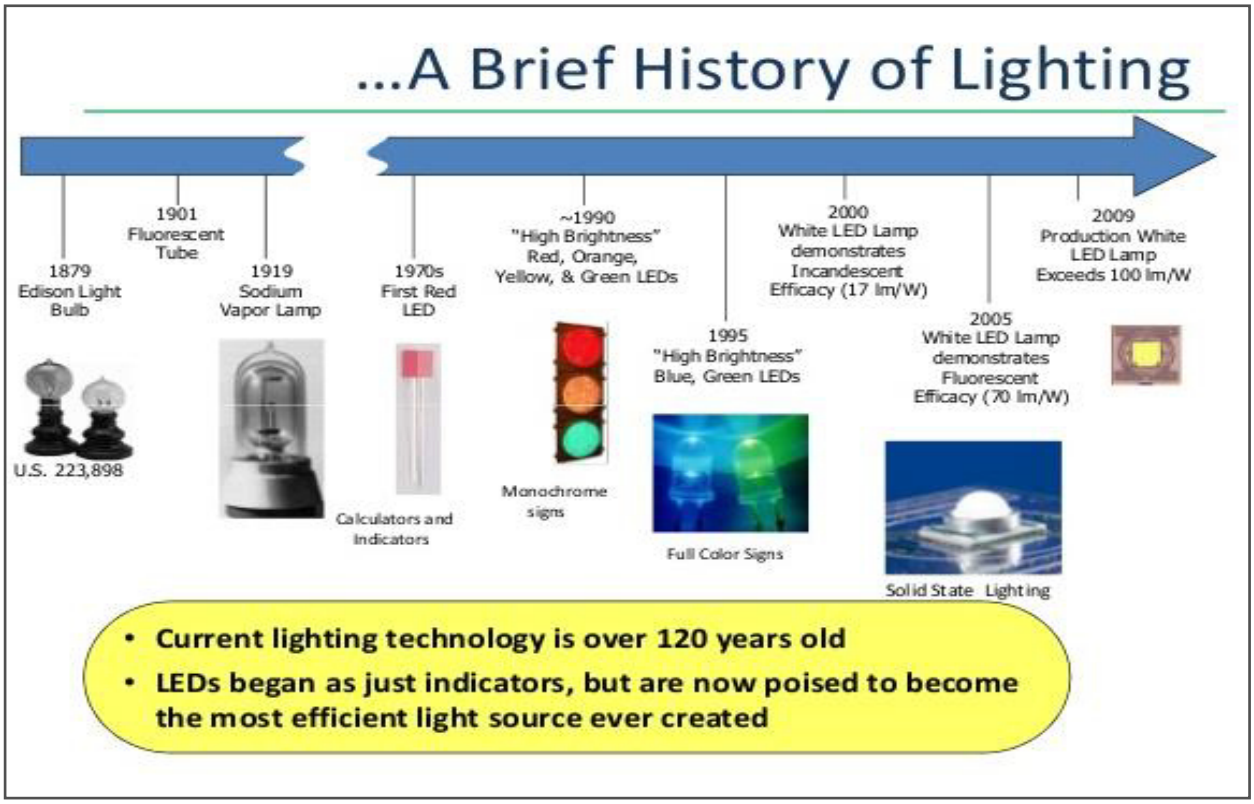


Fig. 10.1 A brief history of lighting

Designing with Light

Design is as much a process of intellect and intuition as it is the product delivered at the end of that process. Also, design is exploratory and iterative. Some iterations lead to dead ends or undesirable outcomes. Others lead to refining the design and moving toward a beautiful solution to a problem.

There is not a one-size-fit-all lighting design process. Some designs require careful attention to technical aspects of a lighting system, some designs have very strict illumination or energy consumption criteria, while other designs are exclusively about creating an evocative mood, atmosphere, or environment. Designers should understand a variety of design methods and apply the most appropriate method or approach to each project.

Finally, the goal of every design is to create, in collaboration with the rest of the design team, an environment that is appropriate to the use and the user, and meets the clients' requirement of cost, project timeline, efficiency, etc.

To achieve a design's goals, architectural and interior designers must have a thorough understanding of both the art of design and the technology used to create and control light. Some aspects of the design process can be organized into checklists, making them easy to address. Others aspects require a lighting designer to understand architecture, interior design, and/or electrical engineering to integrate the lighting with the work of the rest of the team.

The biggest challenge a designer faces is to connect a variety of elements into a comprehensive whole: to see beyond what is to what can be or to connect abstract ideas to real world conditions and, in the process, add layers of intention or meaning to a design. In doing so, we transition from being illumination engineers to lighting designers and artists working with light.

There are many paths that a design may take. Each new project begins with exploring and understanding the requirements and expectations for the project and then adopting an appropriate strategy to develop and execute the design.

A good tip to help in any design process is to gather relevant information so we can understand the requirement of the design. General questions will lead to more specific ones until we have a thorough knowledge of those aspects of the design that are required, including those that are expected and those that are desirable but optional.

Thinking about Light

A lighting designer selects lighting fixtures and lamps, and determines luminaire placement and quantity so as to control the light in each space to achieve the desired effects. In order to achieve the results, designer needs to evaluate the "Controllable Principles and Elements of Light".

<u>Lighting Principles and Elements</u>

Human needs

We experience our environment first and foremost through our eyes. 80% of the sensory impressions we receive are visual. Too much or too little light, glare or distorted colours impact on what we perceive, distract our attention and cause visual fatigue.

In all areas of life and throughout the working environment, good and appropriate lighting is a prime requirement that enabes us to see clearly, enjoy a sense of well-being, perform concentrated fatigue-free work and perceiveand interpret important information and our surroundings correctly.

Illuminance

The brightness of an object is the strength of the light reflected from it. The greater the luminance, the stronger the visual stimulation, and the easier the object is to see.

In daylight, the illuminance of an illuminated surface is between 10,000 lux (overcast sky) and 100,000 lux (bright sunlight). Indoors, we need to make do with much less light. For writing and reading, it is generally enough if artificial lighting provides 500 lux illuminance; for drawing or other visually demanding tasks, illuminance should be at least 750 lux.

Brightness Distribution

Brightness is a complex factor that can be defined as an illuminance of a surface as perceived by a human eye. Such a definition of brightness can be expressed as a ratio of luminous intensity of a surface under certain angle to the surface area of its projection. Brightness is a directional unit and is determined by luminous intensity in different directions and directional reflectiveness of a surface and the projected area of a surface in a given direction.

Harmonious distribution of brightness is important for sharpness of vision and sensitivity to contrast, contrast being relatively small differences in brightness. Setting the brightness too low can cause strain, decrease visual stimulation and therefore work performance. Darker surfaces in the room can work against the harmonious distribution of brightness and can cause feelings of oppression and anxiety.

Glare

Glare is one of the most disturbing side-effects of lighting. Direct glare caused by marked contrast differences between very bright and very dark surfaces or due to unshielded lamps in our line of vision place strain on people's eyes and lead to fatigue and mistakes through loss of concentration. To avoid direct glare from lamps, attention should be placed on glare limitation and shadowing.

Glare limitation

Being dazzled by a general-diffuse lamp or the reflection of a window on a computer screen can affect visual acuity and impedes work performance. Direct and reflected glare can be largely avoided by good room and lighting design.

Shadowing

Where there is light, there is also shadow. To ensure that shadows do not impede people's view when writing, the light should fall, for a right-handed person, from the left and vice versa for a left-handed person.

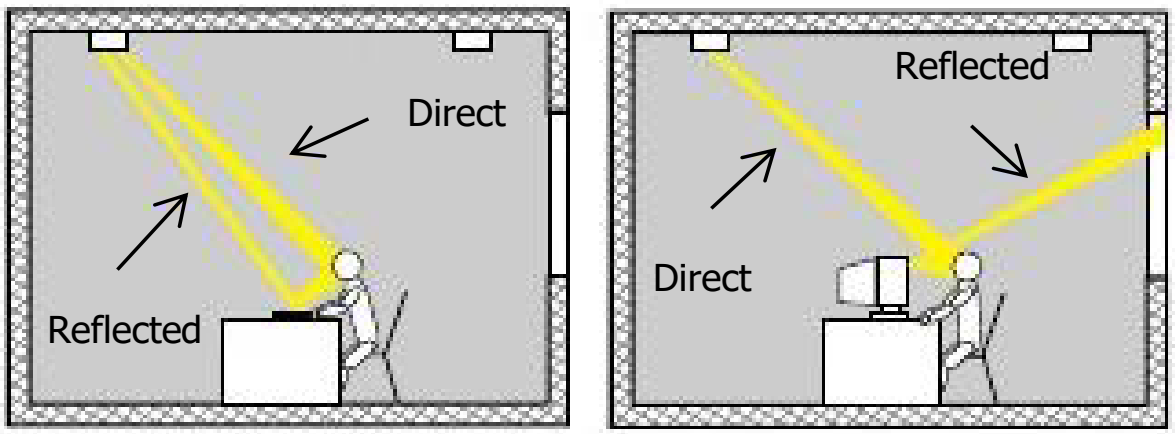


Fig. 10.2 Possible sources of direct & reflected sources of glare

Light and colour

The way people perceive colours under artificial light depends on the colour rendering properties of the lamps. Lamps with good colour rendering properties produce natural colours while lamps with poor colour rendering properties cause colour distortion.

For human vision performance and revealing the world around us, we are usually concerned with “white” light, but white is a subjective experience (like all “colour”) and our definition is constantly changing. Two issues are of note, namely, the completeness of spectrum and the balance of spectrum.

1. Completeness of Spectrum:

The completeness of spectrum / CRI means that the more wavelengths come out of a light source, there are more opportunities for surfaces to reflect light. We measure the complexity / completeness of a light source by the COLOUR RENDERING INDEX or CRI. It is a numeric value ranging from 0-100, with the value of 100 being a light source identical to standardized daylight. CRI is an indication of the average shift of eight standard colours. Two different light sources may have identical CRI values, but colours may appear quite different under these two sources.

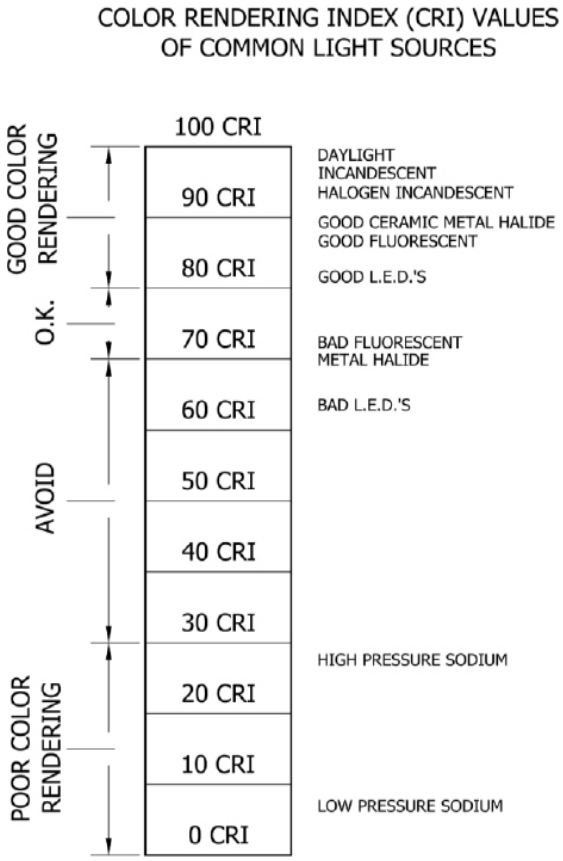


Fig. 10.3

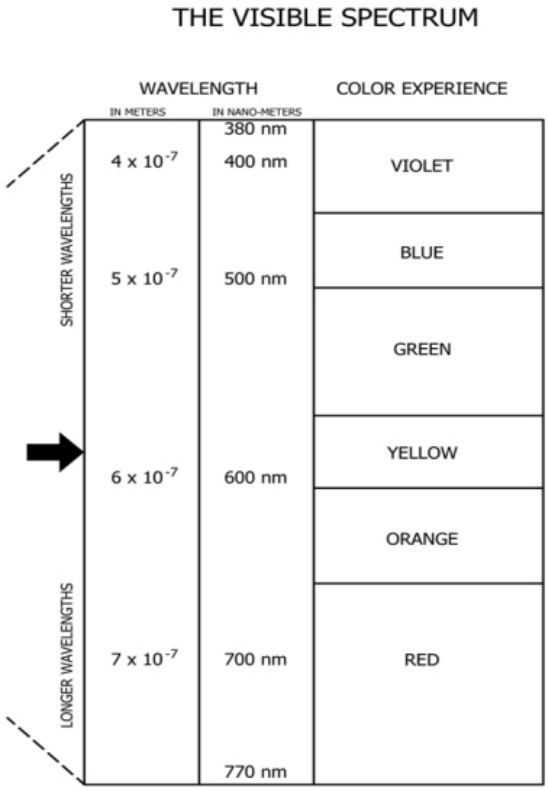


Fig. 10.4

2. BALANCE OF SPECTRUM / COLOUR TEMPERATURE

If a light source gives of more of one wavelength than another, our brains' translation of the light is a slight colour experience. We have devised a numeric description of the colour produced by the imbalance called CORELATED COLOUR TEMPERATURE or CCT. Expressed as a temperature in degrees Kelvin K or "Kelvins".

By convention, we think of yellow-red colours (like the flames of a fire) as warm, and blue-green colours (like light from an overcast sky) are considered cool. However, lights with higher Kelvin temperatures (3600–5500 K) are blue-green lights while those with lower colour temperatures (2700–3000 K) are yellow-red lights. Cool light is preferred for visual tasks because it produces higher contrast than warm light. Warm light is preferred for living spaces because it is more flattering to skin tones and clothing. A colour temperature of 2700–3600 K is generally recommended for most indoor general and task lighting applications.

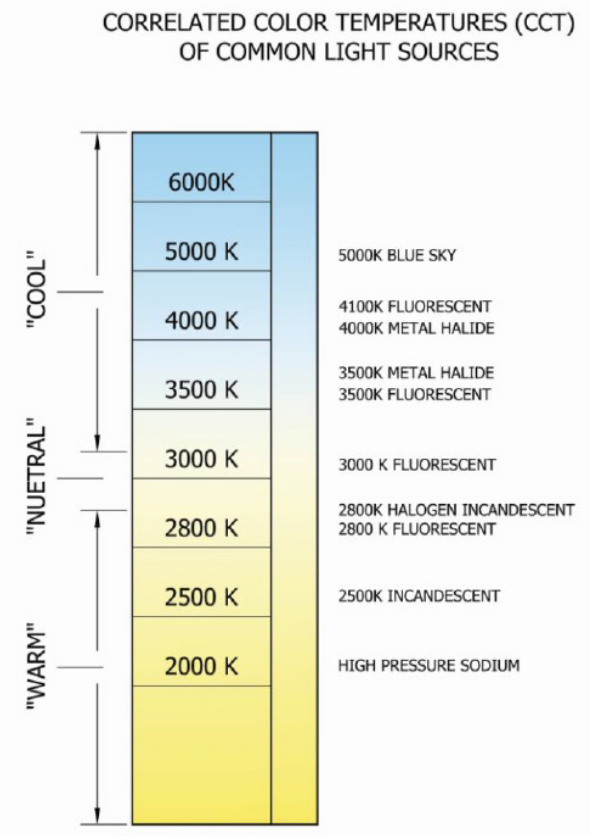


Fig. 10.5

Direct/Indirect lighting

Luminaries with direct and indirect lighting components permit free arrangements of furniture, reduce the risk of reflected glare and create a more agreeable lighting atmosphere.

Direct lighting casts an illumination from the fixture onto a desired subject or area. As a straightforward radiation, it acts as task lighting that functions to help daily tasks (e.g., reading, cooking, drawing and studying). Because it radiates powerful illumination, it is best used for detailed tasks and productive activities and providing light to a subject that needs more focus. However, when using an overly powerful fixture, the light may appear too harsh and designers can consider dimmers for adjustability.

Indirect lighting utilizes a fixture as a source to spread light outside just one target object. This is to create ambient lighting, also known as general lighting, which helps people navigate their ways around a space. It also accentuates a space or provides reflective light. Designers should opt for indirect lighting so as to illuminate a room without casting a harsh light beam. Commonly used to create ambiance, indirect lighting usually adds overall brightness of a space or used in areas to create softer light and to set a mood.

The primary factors affecting the distribution of illumination are the shape of the luminaire, its materials and finishes, the location and size of the aperture, as well as the mounting position. The location of the aperture, materials, and mounting position determine the primary ways in which light is distributed: (a) direct, (b) indirect, (c) semi-direct, (d) semi-indirect, (e) direct-indirect and (f) diffused.

a. Direct Lighting:

Lighting in which luminaires distribute 90% to 100% of the emitted light downward on the surface or area to be illuminated.

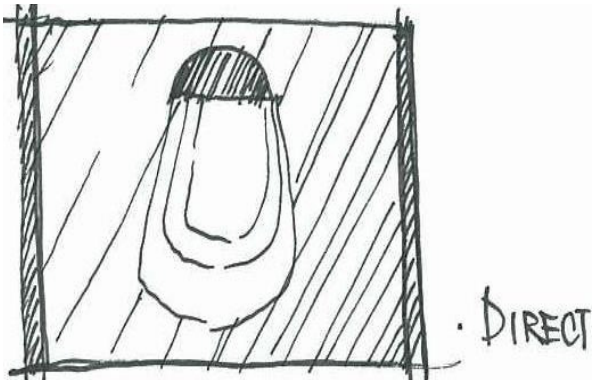


Fig. 10.6

b. Indirect lighting:

Lighting in which luminaires distribute 90% to 100% of the emitted light upward, especially to avoid glare or prevent shadows.

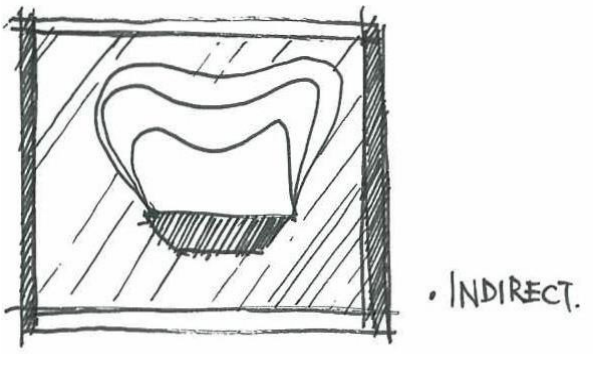


Fig. 10.7

c. Semi-direct lighting:

Lighting in which luminaires distribute 60% to 90% of the emitted light downward

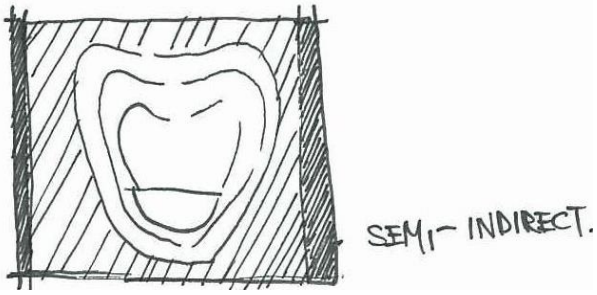


Fig. 10.8

d. Semi-indirect lighting:

Lighting in which luminaires distribute 60% to 90% of the emitted light upward.

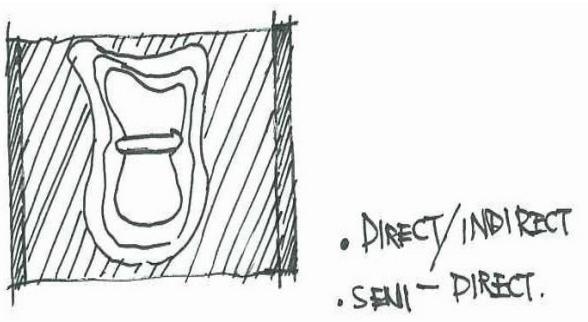


Fig. 10.9

e. Direct-indirect lighting:

General diffused lighting in which little light is emitted in the horizontal plane of the luminaires.

f. Diffused lighting:

Lighting from luminaires that emit an approximately equal distribution of light upward and downward.

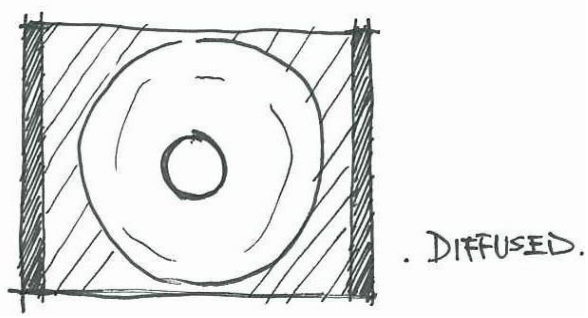


Fig. 10.10

Visual Hierarchy

During the day, it is easy to think that the natural world has one principal light source in the shape of the sun. However, our surroundings are always illuminated by a combination of direct light from the sun and sky and light that comes from a multitude of directions and reflected by clouds, plants, ground, water and rocks. Each light source or source of reflected light has its own qualities of intensity, direction, colour and diffusion, and each source and reflection adds something, however small, to our visual environment.

Light can be a powerful medium to establish visual hierarchy in interior spaces. The simple choice of whether to illuminate a surface or object directly affects the way it is perceived by the viewer. Designers can choose to conceal less attractive areas by concentrating light where they want people to look and make an area advance or retreat visually with the subtle use of colour. Intensity and direction of light can also provide subtle signals about what is most visually important in a space.

To be able to use the visual hierarchy of light successfully, designers need to get into the minds of the users of different kinds of space. Imagining or visualizing the scene from both the users' point of view and their mindset that makes it possible to create the most appropriate lighting solution.

Fig. 10.11 Morning: warm tones and low light intensity

Fig. 10.12 Midday: bright white light, high intensity

Fig. 10.13 Late evening: warm tones and low light intensity

Understanding Qualities of Daylight

To create a space with a legible and familiar feel, designers can work with the qualities of natural daylight. By endeavoring to replicate or reinforce the direction, colour, intensity and variation of natural light, designers can shape an environment that has the familiar quality of the exterior world.

On the other hand, it is easy to produce surprising and discordant environments by working against the patterns of light and colour that people may expect to see in the outside world. This can be used to attract people's attention, or to subtly discourage them from entering a space by lighting it in an uninviting manner.

Day

Evening

Night

Fig. 10.14 Museum at Prairiefire, architecture by Verner Johnson

Understanding Layers of Light

Light in the natural world is all about the layering of light from multiple directions - strong directional light mingling with softer diffuse light, white light with subtle tints picked up from the sky and reflecting surfaces. This mixture changes constantly, providing a new pattern of light and shade every time people look.

However, most artificially lit working environments have uniform lighting; the light tends to come from only one direction and any reflected light is accidental and dependent on the furniture and fittings in the space below the lights. This is in sharp contrast to the lighting conditions of the natural world, so it is no wonder that many workplaces still feel uninspiring, cold and clinical.

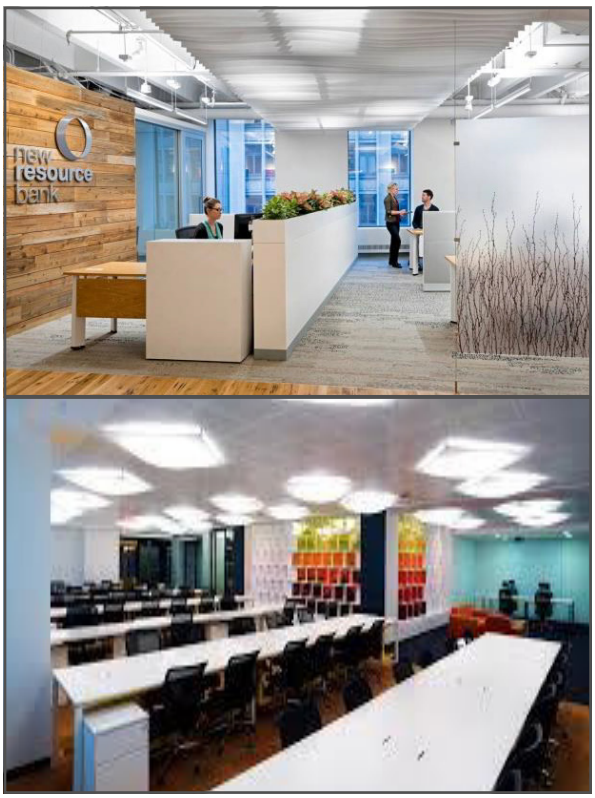


Fig. 10.15-16

Change and Variation

When designing lighting for interior environments, designers need to remember that change andvariation in light are expected. They may not always have to involve sophisticated control systems to achieve suitable changes in artificial worlds. In most types of building these may be unnecessary because people move from one space to another within a building. Designers should never underestimate the richness of experience this adds to the visual world.

Creating areas with subtly differing qualities of light adds a visual richness to the experience of being within a space. Small and deliberate changes in light colour, colour temperature, intensity, direction and focus in different parts of the space are easy to implement and can transform an otherwise drab experience. To achieve the best possible design outcome, designers should use light and colour to carefully plan the visual experience for the user rather than simply using light to illuminate 'task areas'.

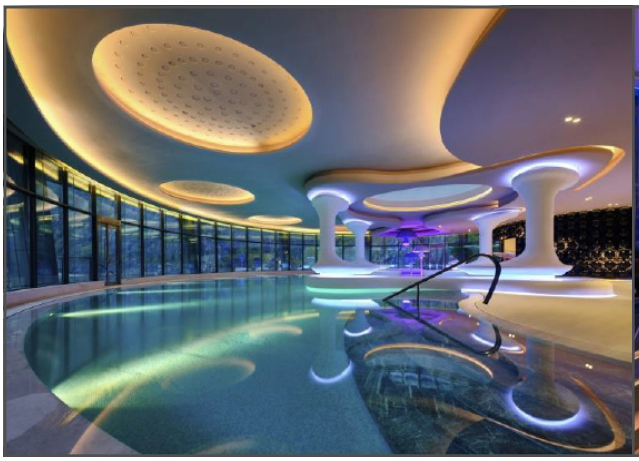


Fig. 10.17 InterContinental Shanghai Wonderland Hotel- Martin Jochman by JADE+QA architect

Fig. 10.18 Woobar at W Kuala Lumpur

Creating Drama through Lighting

Creating drama means avoiding the ordinary, the common place and the predictable. It means being striking, unusual and completely unexpected. By this definition, what people experience on a daily basis is not dramatic. Designers can make conscious decisions about what should be visually important and what should recede into the background and design the lighting accordingly. To make an object or surface stand out does not necessitate using very bright light sources - all that is needed is a good control of contrast. Creating a hierarchy of visual importance and working with layers of light ensures that the significant features of a space are not lost among uniformly illuminated surroundings.

Dramatic lighting can come from the choice of lighting directions, colour combinations, the patterns of light and shade or the changing nature of any of these elements. Drama requires novelty, so the more an effect is used the more commonplace it becomes. Spectacular lighting demands innovation and careful choreography to maintain the element of surprise.

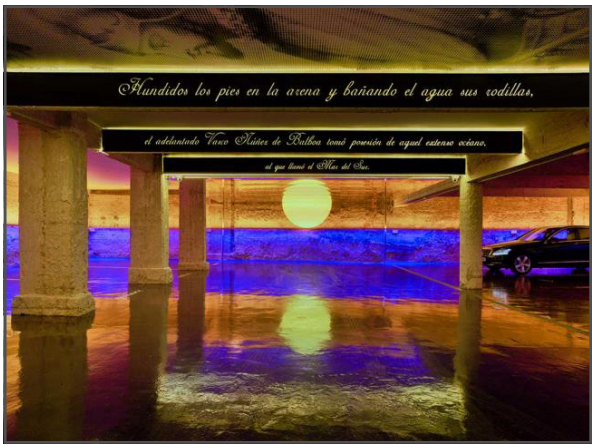


Fig. 10.19 First Sunset in the Pacific, Madrid – Clavel Architects

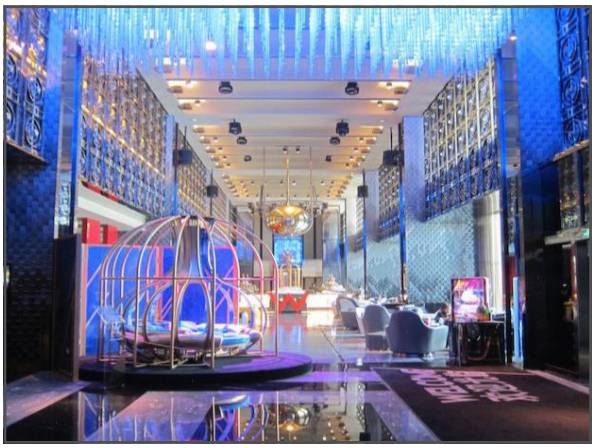


Fig. 10.20 The W Beijing Chang'an

Fig. 10.21-22- AMMO Restaurant, interior design by Joyce Wang, is Inspired by Jean-Luc Godard's classic science fiction film noir Alphaville.

Light on Surfaces and Texture

Materials add interest to a project, but achieving the right effect depends on how lighting is applied. Many architects and interior designers believe that the selection of materials and finishes is among the most important decisions made during a project. Without illumination, people cannot perceive the aesthetic characteristics of any material, so it stands to reason that the appropriate lighting is essential to maximize the impact of architectural finishes. Several characteristics of materials should be understood when determining the lighting approach.

Characteristics to consider - Texture shadows caused by variation in surface texture create contrast that allows the viewer to perceive depth in a material. The position of the light source determines the length of shadow, rendering the surface with varying degrees of definition.

a. **Surface Reflectance:** How an opaque material reflects light determines the viewer's perception of the illumination present at its surface. While a mirrored, or highly specular, surface is most able to reflect, it will appear dark if the environment seen in reflection is not illuminated, even if light is present on the surface. Matte or diffuse materials reflect light equally in many directions, resulting in a similar light quality from many points of view.

Fig. 10.23-24

Reflection occurs when light strikes a shiny opaque surface, or any shiny surface, at an angle. Reflection can be classified in three general categories:

- Specular reflection
- Spread reflection
- Diffuse

Specular Reflection occurs when light strikes a highly polished or mirror surface. The ray of light is reflected or bounced off the surface at an angle equal to that at which it arrives. Very little of the light is absorbed, and almost the entire incident light leaves the surface at the reflected angle.

Spread Reflection occurs when a ray of light strikes a polished but granular surface. The reflected rays are spread in diverging angles due to reflection from the facets of the granular surface.

Diffuse Reflection occurs when the ray of light strikes a reflective opaque but non-polished surface, such as flat white paint.

Absorption occurs when the object struck by the light ray retains the energy of the ray in the form of heat. Some surfaces, like flat black paint, absorb nearly all of the incident light rays. These surfaces, such as those of a solar collector panel, tend to get very hot when placed in the sunlight.

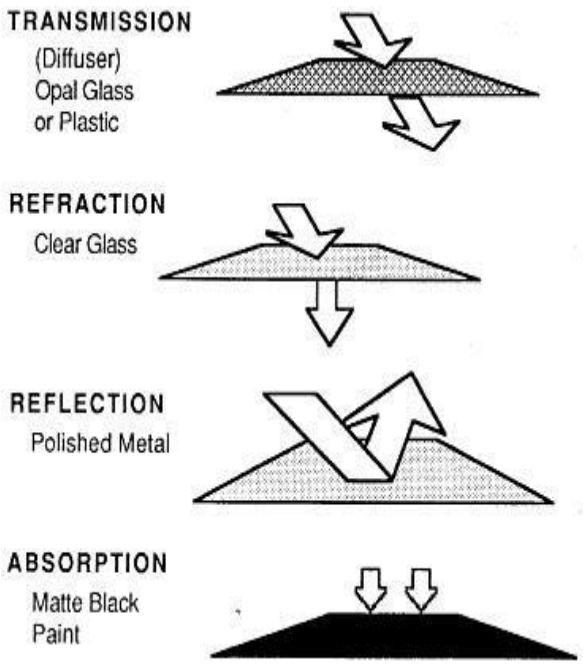


Fig. 10.25 Types of Light Reflectance (F. H. Jones)

b. Colour

Every object absorbs some of the light that strikes it. The pigment within a surface determines how much and which components of the visible spectrum reach the eye. Generally speaking, dark colours absorb more illumination than their lighter counterparts.

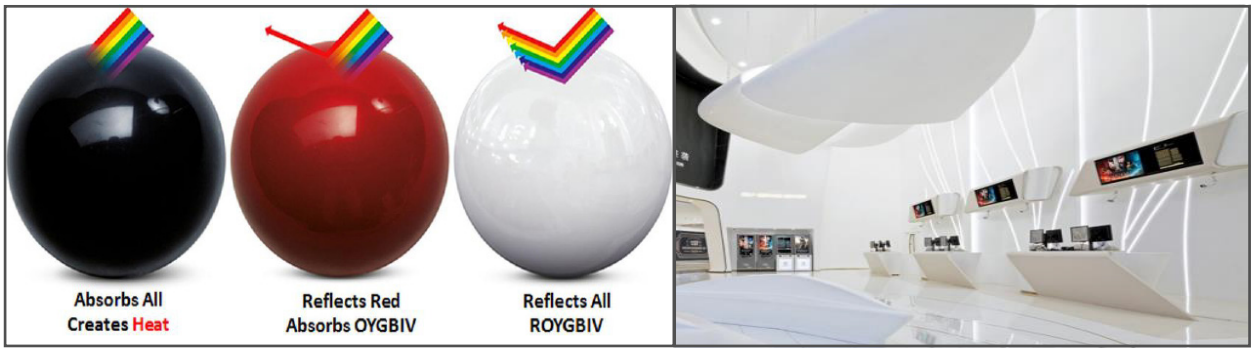


Fig. 10.26-27

c. Light Transmission

Transparent and translucent materials allow light to pass through them. The internal composition of these materials influences the amount and quality of light transmitted.

Fig. 10.28-29

Physical factors of Light

In addition to colour, the four factors which determine the visibility of an object are size, contrast, luminance, and time. Of the four, luminance, that is, the brightness or the strength of the light falling on the rods and cones cells in the eye, is the underlying dominant factor.

Size is considered because the larger or nearer an object, the easier it is to see. A larger object, of course, reflects more total light, and offers a stronger stimulation of the rods and cones cells.

Contrast is the difference in brightness of an object and its background. Distinct contrast allows the brain to differentiate easily between areas of strong and mild visual stimulation.

Luminance is the brightness of an object, or the strength of the light reflected from it. The greater the luminance, the stronger the visual stimulation, and the easier the object is to see.

Time: refers to how long it takes to see an object clearly. Under the best conditions, it takes slightly less than one-sixteenth of a second for the eye to register an image.

Quality Of Light

Good quality illumination is that which provides a high level of visual comfort, and allows people to view tasks clearly and easily. This affects people's psyche in a positive way. On the other hand, poor visual comfort Illumination is irritating.

Fig. 10.30

Illumination

The distribution of light on a horizontal surface. The purpose of all lighting is to produce illumination.

Efficacy

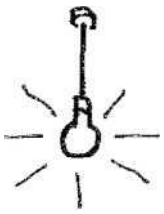
The ratio of light produced to energy consumed. It is measured as the number of lumens produced divided by the rate of electricity consumption (lumens per watt).

LUMINAIRE TYPES

While it may be possible to categorize all luminaires as either dispersive or directional, there are many useful subcategories. There are thousands of lighting manufacturers worldwide, each of whom may have hundreds or thousands of products. At some point in the design process, it is necessary to decide exactly which products will be used for a project, but at the early stages it is much more helpful to set aside specifics and focus on general principles. At concept and schematic design stage, designers will often work with generic luminaire types rather than any specific product.

This allows the design to evolve, with the final product selected to fit the completed design proposal rather than the other way around. Any project designed around a particular product is unlikely to be as successful as one where the product is selected to match the particular requirements of the project.

There is no real limit to the number of categories of luminaire, but the following generic list is a useful start.

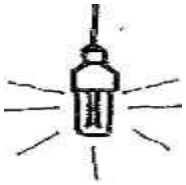


Incandescent lamp:

A luminaire can be as basic as a lamp in a lamp holder suspended from a ceiling with rods or wires. In this illustration, this luminaire does not affect the spread of light from the lamp. A bare lamp such as a domestic incandescent produces a fairly equal distribution of light in
all directions.

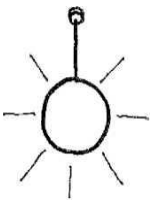
Fluorescent Batten:

A linear fluorescent lamp also has a 360- degree distribution of light. Most of the light is produced at right angles to the tube, with less light directed parallel to the length of the tube. The back box containing the control gear blocks some of the light coming from the back of the lamp, but modern fluorescent gearboxes are slim enough to occlude only a little light.



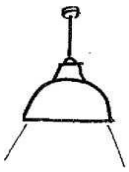
Compact fluorescent:

A compact fluorescent lamp, basically a bent and folded linear fluorescent. Domestic compact fluorescent lamps are designed as retrofit replacements for incandescent lamps and come as a complete package with the control gear housed in the large lamp-holder end of the lamp. This shape means most compact fluorescent lamps do not produce light in all directions as an incandescent lamp does. With little light getting past the control gear housing, their use as replacements in some small domestic table lamps can produce very unsatisfactory spread of light, possibly significantly reduces the light output ratio of the luminaire.



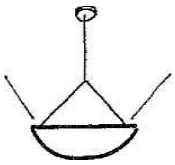
Dispersive pendant:

A simple frosted or oval glass globe luminaire produces a very soft light that is fairly equally spread in all directions. This kind of luminaire can help to disguise tine lack of upward light from a suspended, compact fluorescent lamp. With this kind of dispersive luminaire, how brightly a surface Is illuminated depends on how far away the surface is from the light source and whether it is facing towards the luminaire.



Downlight pendant:

The light source used for the dispersive pendant can be fitted into a simple metal shade that redirects the light in one direction, giving control over which surfaces receive most light.

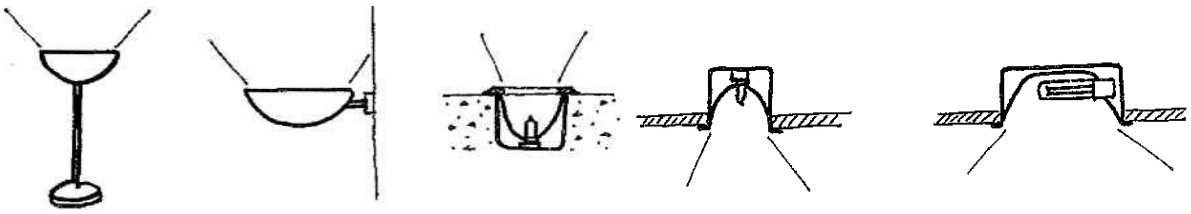


Uplight Pendant:

Suspending the kind of reflector used for the downlight pendant the other way round creates an uplight, which illuminates the soffit to produce a very soft, indirect qualify of light.

Floodlights and spotlights:

A directional luminaire can use any combination of simple shades, polished reflectors or lenses to control the light, and the available range of beam spreads is almost infinite; some luminaires even have an adjustable beam spread. In basic terms, it is enough to describe directional luminaires as wide-beam (also known as floodlights) or narrow-beam (spotlights). The terms 'floodlight' and 'spotlight' are generally applied to discrete, surface mounted luminaires. A floodlight may be used to evenly illuminate a large area; the narrower spread of light from a spotlight allows small areas and objects to be picked out from their surroundings. Although there is no definition of how wide a spotlight beam has to be before it becomes a floodlight, in normal usage anything above 40 degrees would be too wide to highlight small areas effectively. One definition of beam spread would describe a narrow-beam luminaire as being less than 20 degrees and a medium beam between 20 and 40 degrees. Anything above 40 degrees would be described as a wide beam.



Uplights:
As with downlights and downlight pendants, uplights can be used in different locations for specific purposes, Floor standing ones can uplight a soffit where suspended luminaires are not suitable (perhaps because ceiling height is too low). Wall-mounted uplights allow soffits to be illuminated without cluttering the ceiling with pendants. Ground-recessed (or in ground) uplights can be used with a diffusing glass as a low brightness marker or can be used with precision reflectors to illuminate columns or walls from the ground up. Given our natural tendency to look down slightly as we walk, it is good practice to ensure that inground uplights are not in locations where people are likely to walk over them, as they can easily dazzle people.

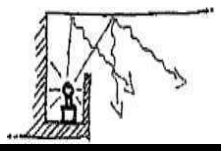
Downlights:
One of the most common uses of directional luminaires in architectural situations is as downlights recessed into ceiling surfaces. Properly known as ceiling-recessed downlights, this is usually shortened to just downlights. Endless options exist for different light sources, luminaire sizes, shapes and light distributions. The terms 'spotlight' and 'floodlight' are not generally used for recessed luminaires; rather, they tend to be described as medium-, wide- or narrow-beam.

Reflector shape

Floodlight reflectors are usually designed to produce a symmetrical spread of light, but special reflector shapes can produce different spreads of light. Asymmetrical floodlights direct more light to one side than the other. This can be useful where a design calls tor wall-mounted uplights to evenly illuminate a soffit from the edges of a room. Asymmetrical reflectors can also be used in groundrecessed uplights to help to evenly illuminate vertical surfaces.

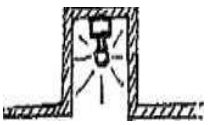
Ceiling planes:

Concealed fluorescent battens mounted above a suspended soffit can create a visual separation between the ceiling planes and make the lowered soffit appear to float below the main ceiling plane. Turn this whole arrangement through 90 degrees and the backlight will make vertical panels float off the wail surface behind.



Concealed ceiling coves

a fluorescent batten concealed in a ceiling cove can produce a very soft, indirect light that can help to make a low space feel much higher.



Ceiling slots

A concealed fluorescent batten mounted in a ceiling slot uses the architecture as a luminaire to produce controlled and directional light.

Source: www.laurenceking.com

Luminaires

Luminaire type		Typical polar curve	Mounting possibility	Typical spacing/ height	Typical utilisation factor range	Application examples
	Fluorescent batten		S, P	1.75	0.21-0.82	Industrial, high mounting height, could be glaring
	Fluorescent trough reflector		S, P	1.5	0.37-0.81	Industrial, storage areas, DIY retail
	Fluorescent prismatic diffuser		S, P	1.5	0.13-0.65	Industrial, commercial, retail
	Fluorescent specular louvre		S, P, R	1.25	0.34-0.7	Industrial, commercial, retail, low glare
	Fluorescent diffuser louvre		S, P, R	1.75	0.3-0.6	Industrial, commercial, retail
	High bay reflector		S, P	1.0	0.5-0.8	Industrial, warehouse, high mounting height
	Downlight		S, P, R	0.75	0.3-0.75	Commercial, retail, low glare
	Diffusing sphere		S, P	1.75	0.23-0.6	General illumination, retail
	Uplight		P, W, F	3.0	0.1-0.5	Commercial, retail

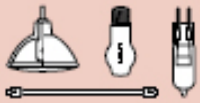
S = Surface, P = Pendant, R = Recessed, W = Wall, F = Floor mounting

Source: www.energy-efficiency.gov.uk

Typical luminary types and characterizes:

An indication prototype, actual manufacturers' data should be used for design purposes

Lamps

Lamp types	Luminous efficacy (lm/W)	Average life (hours)	Colour appearance group	Colour rendering group	Run-up time (mins)	Restrike time (mins)
 **Tungsten filament**	8-18*	1000	Warm	1A (excellent)	Prompt	Prompt
 **Tungsten halogen**	18-24*	2000-4000*	Warm	1A (excellent)	Prompt	Prompt
 **Tubular fluorescent**	55-100*	5000-15 000*	Warm, intermediate and cold*	1A-2 (excellent-moderate)*	Prompt	Prompt
 **Compact fluorescent**	50-75*	5000-10 000*	Warm and intermediate*	1B (good)	Prompt	Prompt
 **High-pressure sodium**	70-125*	14 000-30 000*	Warm	1B-4 (good-very poor)*	1.5-6*	1-3*
 **High-pressure mercury**	40-60*	14 000-28 000*	Intermediate	3 (poor)	2-5*	4-7*
 **Metal halide**	70-110*	6000-13 000*	Warm, intermediate and cold*	1A-2 (excellent-moderate)	1-2*	5-15

* Depending on type

Source: www.energy-efficiency.gov.uk

Typical Luminaires types and characterizes: Chart 2

An indication prototype, actual manufacturers' data should be used for design purposes

Colour rendering			
Colour rendering performance	**Colour rendering identification group**	**Colour rendering index (Ra)**	**Typical applications**
Excellent	1A	=>90	Wherever accurate colour matching is required, eg colour inspection
Good	1B	80-89	Wherever accurate colour judgements are necessary, eg shops and offices
Moderate	2	60-79	Wherever moderate colour rendering is sufficient
Poor	3	40-59	Wherever colour rendering is of little significance
None	4	20-39	Wherever colour rendering is of no importance

Colour appearance		
Colour appearance class	**Correlated colour temperature (CCT)**	**Typical applications**
Warm	Below 3300 K	Domestic-type situations
Intermediate	3300-5300 K	Combined daylight and electric light
Cold	Above 5300 K	Situations where a cool appearance is required

Source: www.energy-efficiency.gov.uk

Lamp Colour Performance

All about Lighting

We need light to see the world around us, and the advent of a wide range of electric light sources means people are now less dependent upon light from the sun and flames from combustible fuels. The quality, quantity and intensity of light around us greatly affect people's visual appreciation of their surroundings. It is important to understand the relationship between light, colour, what we see and how we see it.

Artificial lighting would not be required if buildings were not occupied or visited by human beings. The sole purpose of lighting installations is to allow people to adequately perform physical or visual tasks, and the effectiveness of performing these tasks correlates to the quantity and the quality of the lit environment.

- Lighting installations should be designed primarily for the comfort of the occupants within. The task efficiency, energy efficiency and aesthetic value of the lighting installation a secondary consideration. However, the importance of energy efficiency is greatly increased with issues such as climate change and energy pricing, which have become more pressing with each passing year.

- The major aim of lighting is to provide correct lighting solution for the installation to attain the highest quality results whilst realizing the need for energy efficiency. The quality of the lighting system is paramount - the quality of output, morale of the employees and perceived working conditions are all directly related to the lighting system installed.

- The most important thing to remember is that lighting is based on 50% fact and 50% psychology. The needs of the site and the occupants, or potential customers, are critical.

Fitness for Purpose

It is important that any lighting system is fit for purpose: it should provide a quality and quantity of light that is appropriate for the environment in which it is being used; enable tasks to be performed efficiently and effectively; be perceived as comfortable and give people a high level of satisfaction. The aim is to achieve this whilst providing a good balance of cost and energy consumption through good design and optimum selection of products.

Energy Efficiency

Energy efficiency is defined as optimization of energy consumption with no sacrifice in lighting quality. It is a combination of thoughtful design and selection of appropriate lamp, luminaire and control system selection, made in conjunction with informed choices of the illumination level, requiring integration and awareness of the environment or space which is being lit.

- It is very easy to produce an inefficient lighting installation with efficient equipment.
- The most common cause of an inefficient lighting system in the home is the excessive use of low voltage tungsten halogen downlights that produce extremely high lighting levels in some sections of the residence.

Categories of Lighting

There are 6 major categories of luminaires designed to distribute light. These luminaires are designed primarily for incandescent, fluorescent, and HID lamps, and are available in variety of sizes, shapes, and materials, and most of them can be used for general, task, accent, or decorative lighting. The 6 categories are:

1. Recessed
2. Surface-mounted
3. Suspended
4. Track
5. Structural
6. Furniture-integrated units

1. Recessed Luminaires

Recessed downlight luminaires are fixtures that are installed above a sheetrock or suspended-grid ceiling. New developments in the design of recessed allow a flangeless installation so that the ceiling surface is flush with the aperture of the recessed fixtures. The installation has a clean appearance and helps to conceal the fixtures.

Characteristics

- The most common shapes for recessed downlights are round and square;
- The finish applied to the rim affects the efficiency of the luminaires, with white and aluminum finishes providing the highest luminaire efficiency;
- The type of device used at the aperture affects the photometric distribution from downlights.

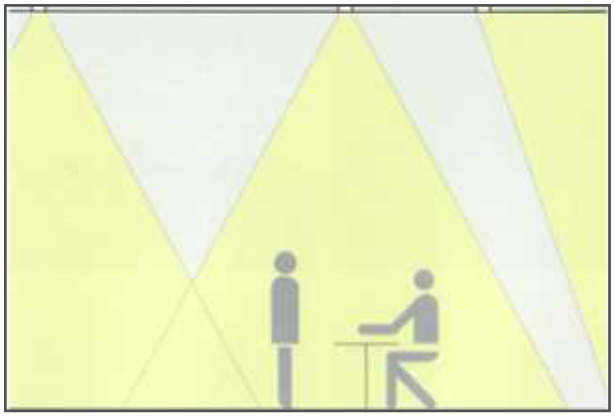


Fig. 10.31-32 Recessed ceiling-mounted luminaire

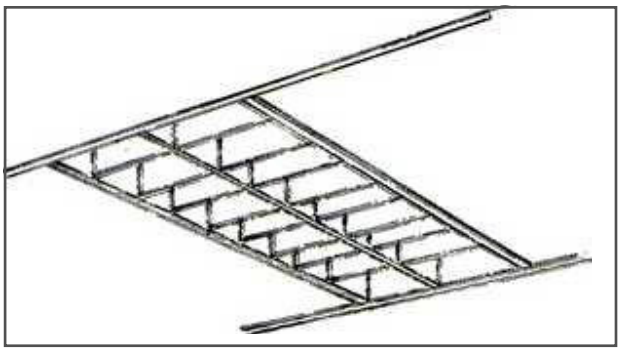


Fig. 10.33 Recessed downlight

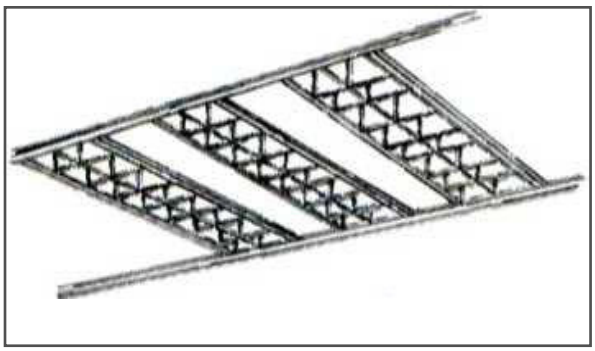


Fig 10.34 High Hat

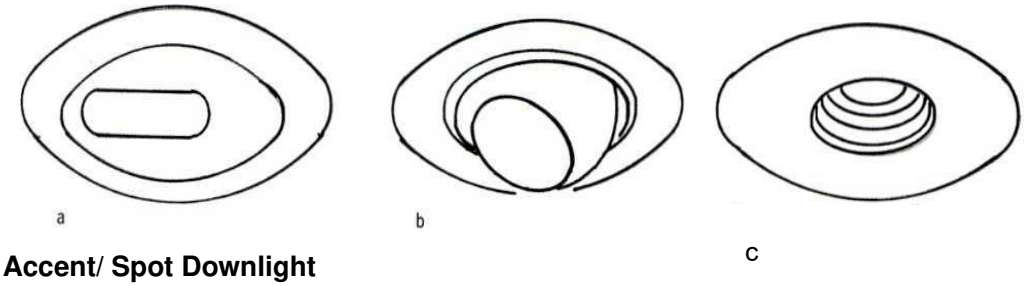


Fig. 10.35

Recessed Accent/ Spot Downlight

Emits a narrow beam of light with an aiming angle of 30◦to 45◦, and are either fixed or adjustable. Common directional trims for recessed accent downlights include: a) Slotted, b) Eyeball, and c) Baffle pinhole.

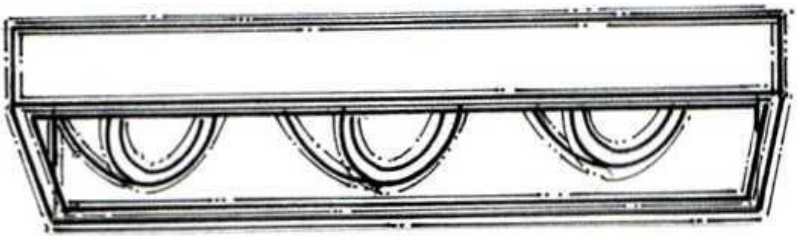


Fig. 10.36

Multiple recessed downlight has two to six spots in one rectangular opening, enabling them to spotlight three different points of emphasis with only one opening in the ceiling, and is able to provide a washer effect or spotlight objects.

2. Surface-Mounted Luminaires

Surface-mount luminaires are fixtures that are installed on a ceiling, wall, floor and under a shelf or cabinet. They are designed for direct, indirect, semi-direct, and diffused lighting. The most common surface mount luminaires for ceiling are troffers, downlights, wraparound lens luminaires, and HID high-bays.

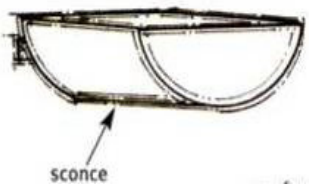
Characteristics

- A decorative luminaire that also provides illumination;
- Offers direct and diffuse light that provides flexibility in addressing the multiple lighting requirements in an environment;
- Easy to install;
- Revamping at the ceiling level can be difficult.

Fig. 10.37-38

Fig 10.39 HID high-bay luminaire includes metal halide and high-pressure sodium lamps. Aluminum reflector has optical controls and is often used in commercial locations with high ceilings.

Fig. 10.40 Scone: Decorative light sources that provide direct, indirect, semi-direct, semi-indirect and diffused lighting. To help prevent glare, some scones need to have diffusers, louvers, baffles or lenses, especially if illumination level is high.



3. Suspended Luminaires

Suspended luminaires are fixtures that are installed on the ceiling and extended by cords, chains, poles, or wires. Some luminaires have a mechanism that allows for easy cord length adjustments. Suspended luminaires can emit direct, indirect, semi-direct and diffused lighting. Most common types include pendants, chandeliers, ceiling fans, and linear fluorescent fixtures (indirect and bidirectional).

Characteristics

- Mostly decorative purpose;
- An appropriate distance is determined by the height of the ceiling and the scale of the room and the luminaire;
- Can serve as focal points in an interior and can visually divided the space;
- Reflect the design concept of the space and adhere to the principles of design;
- The mounting should avoid glare and prevent collision with people moving through the space.

Fig. 10.41

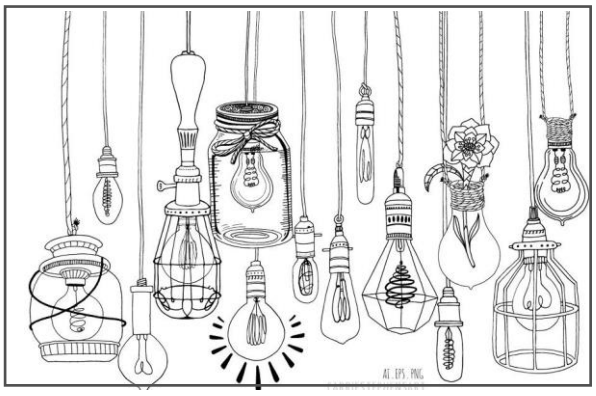


Fig. 10.42 Suspended Luminaire: light fixtures suspended from ceiling

Fig. 10.44 Chandelier: A decorative lighting fixture suspended from a ceiling, usually having branched supports for a number of lamps.

Fig. 10.43 Droplight: a light fixture suspended from a ceiling or wall by a flexible cord that can be raised or lowered

4. Track Luminaires

Track luminaires are fixtures that have multiple heads and are mounted on an electrical raceway, which are available in a variety of lengths, and connectors are used to create shapes. Generally, one end of the track connects to the main circuit wiring while the other end is dead. Track systems can be suspended from the ceiling by cables, recessed into the ceiling plane or surface-mounted on the ceiling or wall. Track-mounted luminaires, known as track heads, are available in a variety of styles, colours, sizes, lamp types, and materials; they come with built-in transformers and low-voltage cable and rail systems. Some track heads are connected to the long flexible cable that enable them to aim light in numerous directions.

Characteristics

- The primary advantage of track system is flexibility, in that it is relatively simple to re-aim and reposition the heads;
- Excellent for highlight items on display;
- Flexibility of having different types of illumination from one fixture;
- Difficulty to reach the track heads, seldom re-aimed or repositioned;
- Have potential for glare, therefore avoid track locations where users can see the lamps, or add a shielding device to the head;
- Rated specifically for one manufacturer and one product line;
- Adding heads to a track increases the likelihood of exceeding sum wattage for the system.

Fig. 10.45

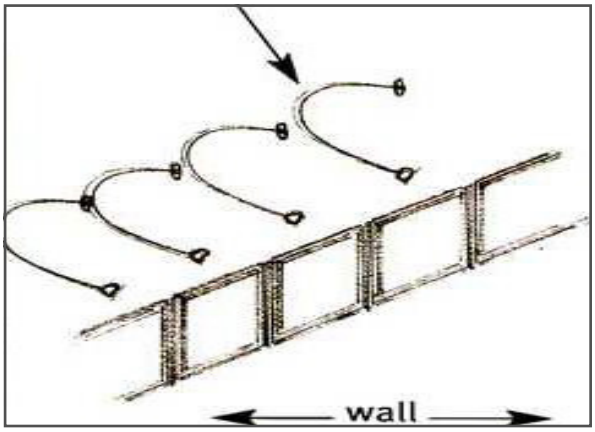


Fig. 10.46 Monopoint luminaire with a flexible cable

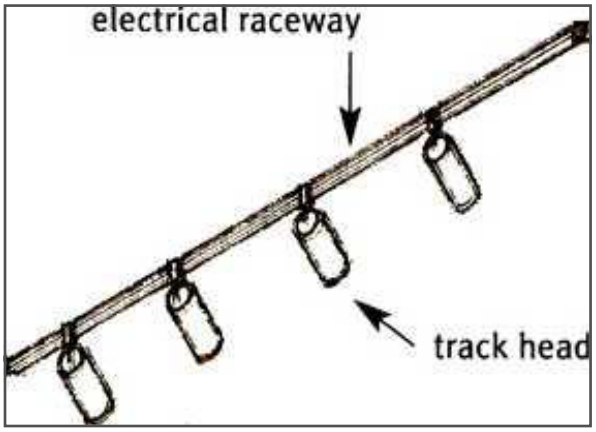


Fig. 10.47 Track luminaires with multiple heads mounted on an electrical raceway

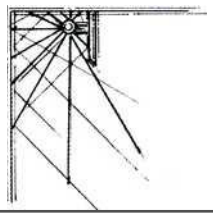
5. Structural-Integrated Luminaries

Structural luminaries are those that form an element of the architectural interior. The major types of structural luminaries include: 1. Cove, 2. Valance, 3. Cornice, 4. Soffit, 5. Wall Brackets and 6. Wall slot. The most common materials used for structural luminaries are wood, metal and gypsum board. To achieve the maximum amount of light from structural luminaries, the interior surfaces should be painted white and the Fascia board (the board shielding the light source) should have angled cut-off. Generally, linear fluorescent lamps are used to ensure consistency in colour and intensity level, all lamps installed in a unit should be from the same manufacturer. To reduce glare, a device may be included to shield the light source, such as baffle, lens or louver.

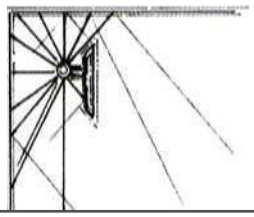
Characteristics

- The size of the unit and its location are vital factors for achieving successful ambience;
- Improper placement of luminaries will create reflectance, inappropriate illumination levels and the potential for glare;
- Basic dimension criteria for some structural luminaires are:
  45cm from the ceiling, 15cm to 30cm from the wall, with lamps at least 10cm from the wall and 5cm from the Fascia;
- Well integrated with the interior architecture;
- Outlining the shape and size of an interior, and can make a space appear larger as well as following the rhythm of the structure;
- Even distribution of light and excellent general lighting purposes;
- Be aware of the potential for glare and difficulties associated with cleaning as well as re-lamping.

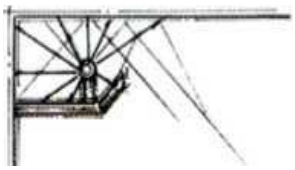
Fig. 10.48-49



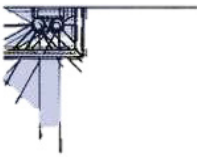
Cove Lighting
Luminaire mounted on a wall or ceiling, directing the lighting up towards the ceiling



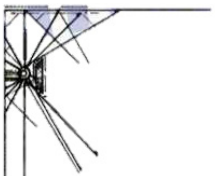
Valance Lighting
Luminaire mounted above a window, directing the lighting up and down



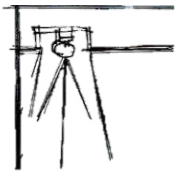
Cornice Lighting
Luminaire mounted on a wall or above a window, directing the lighting down



Soffit Lighting
Luminaire that is a built-in wall element close or next to the ceiling; directs the lighting down onto a task



Wall Bracket Lighting
Luminaire is mounted on a wall and directing the light up and down



Wallslot
A structural lighting system integrated in the ceiling and distributing light down onto vertical surfaces

6. Furniture-Integrated Luminaires

Furniture-integrated luminaires are mounted in a cabinet and generally hidden from view. The most common furniture pieces that have integrated lighting are office systems, curio cabinets, bathroom cabinets, kitchen cabinets and bookcases.

Characteristics

- Provide excellent light for intended purpose;
- Mainly used as task lighting and create an ambient atmosphere;
- Highlighting objects as downlights or spot lights;
- Be aware of the amount of heat that collect in the cabinets;
- Difficulties associated with re-lamping.

Fig. 10.50-51 Furniture-integrated Luminaire:
Fixture mounted in a cabinet and generally hidden from view

Specifying Luminaires

To specify luminaires, an interior designer must be knowledgeable about the products offered by various manufacturers such as luminaires, lamps, and devices used to control fixtures.

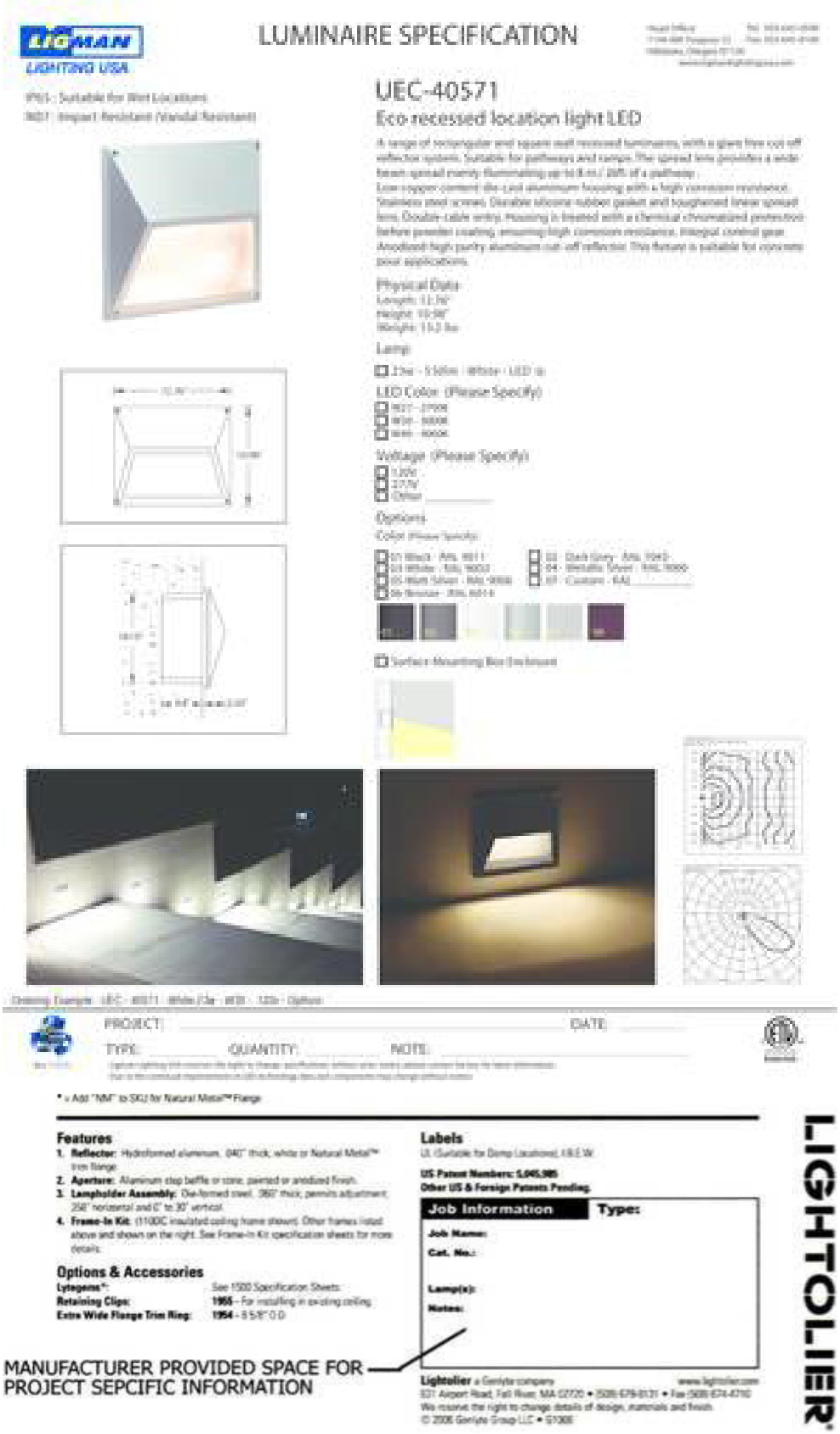


Fig. 10.52-53 Lighting specification

Manufacturers' Specifications

The process of specification is product categories driven, and involves searching current products and seeking resources for identifying and comparing products. Specification details list several product categories, such as type of fixture, lamps, and application.

Characteristics

- Data supplied by the manufacturer are critical for designers and contractors when selecting and installing products. Such data includes installation instructions and costs;
- Also includes photometric data such as spacing criterion and tables;
- Designers need this information in order to select and specify luminaires and lamps;
- Data is used to perform calculations and provide maintenance recommendations to clients.

Fig. 10.54-56 Lighting specification sheets for various lamps

A-lamp: Common incandescent "light bulb" used throughout most homes in North America. An A-lamp can have a clear glass bulb or a white coating or an etched frost on the inside of the glass bulb.

accent lighting: A technique that emphasizes a particular object or draws attention to a particular area. Accent lighting usually utilizes the tight beam control of PAR-lamps and MR-lamps. Also called highlighting.

accent luminaire: A type of luminaire that includes ceiling-mounted track and directional luminaires and recessed accent luminaires. Accent luminaires provide directional lighting to accent an object or an area within a space.

adjustable head: An adjustable luminaire that is surface-mounted, or that inserts into a linear track and provides directional lighting.

ambient lighting: Lighting that is designed to provide a substantially uniform light level throughout an area, exclusive of any provision for special local requirements.

annual energy savings: A term used in the Economics chapter to refer to the difference per year in kWh between the energy used for lighting Design 1 and Design 2.

annual energy use: A term used in the Economics chapter to refer to the energy used per year in kWh by a lighting system.

annual lamp replacement costs: A term used in the Economics chapter to refer to the cost per year of replacement lamps, excluding labor.

annual operating cost savings: A term used in the Economics chapter to refer to the difference between the annual operating cost of Design 1 and that of Design 2.

annual operating cost: A term used in the Economics chapter to refer to the cost per year of electricity and replacement lamps.

aperture: An opening, usually in a recessed luminaire, through which light enters a space.

architectural luminaire: A luminaire that is integrated into the structure of the room. Architectural luminaires are mounted horizontally on a wall or ceiling with a shield to hide the lamp(s) from view. See also cove, soffit, and valance luminaires.

average rated lamp life: The average rated life of a lamp is the number of hours when 50 percent of a large group of lamps have failed. For fluorescent lamps, the operating conditions include operation at nominal line voltage at 3 hours per start. For high-intensity discharge lamps, the lamps are operated at 10 hours per start. The average rated life of an electric lamp is a median value of life expectancy. Any individual lamp, or group of lamps, may vary from the published average rated life.

baffle: A single opaque or translucent element that shields a light source from direct view at certain angles or that absorbs unwanted light.

ballast: A device that is used with a fluorescent or high-intensity discharge lamp to provide the necessary circuit conditions (voltage, current, and wave form) for starting and operating the lamp.

beam spread: The width of a light beam, expressed in degrees. The beam of light from a reflector-type lamp (PAR, R, ER, or MR) can be thought of as a cone. The beam spread is the angular width of the cone. The edge of the beam is defined as "50 percent of center beam intensity (candlepower)" or "10 percent of center beam intensity," depending upon the lamp type.

bi-pin base: A base with two pins that is used for some tungsten-halogen reflector lamps, low-voltage tungsten-halogen lamps, and fluorescent lamps.

bollard: A low, pole-mounted luminaire, usually for outdoor use. Bollards commonly are used to light pathways.

brightness: Subjective impression of light reaching the eye. Subjective brightness does not correlate exactly with luminance, which is measured with an instrument.

bulb: The outer envelope of a light source, usually quartz glass or other varieties of glass.

candle lamp: A decorative incandescent lamp with a bulb shaped like a flame. The lamp designation is usually "F" or "C."

candlepower: See luminous intensity.

cans: Square or round recessed downlight luminaires. These are also called "high-hats." Also, a surface-mounted luminaire, usually a downlight, that has a cylindrical shape.

capsule compact fluorescent lamp: A screwbase compact fluorescent lamp product whose lamp(s) is covered by a diffusing glass or acrylic lens. Capsule compact fluorescent lamps commonly are available in three shapes: globe, bullet, or jar.

ceiling-mounted luminaire: See surface-mounted luminaire.

center beam candlepower (CBCP): The luminous intensity (in candelas) of a reflector lamp measured at the center of its beam.

central controls: Lighting controls systems that control many luminaires from one or two locations.

chandelier: A decorative, often branched, luminaire suspended from the ceiling.

circline lamp: A fluorescent lamp bent in a circle so that the ends meet at the socket.

color: The color appearance of a lamp, and how the lamp makes other colors appear. See correlated color temperature and color rendering index.

color rendering index (CRI): A technique for describing the effect of a light source on the color appearance of objects being illuminated, with a CRI of 100 representing the reference condition (and thus the maximum CRI possible). In general, a lower CRI indicates that some

colors may appear unnatural when illuminated by the lamp. CRIs of two or more lamps should only be compared if the lamps have the same correlated color temperature. See also correlated color temperature.

color temperature: See correlated color temperature.

commodity-grade luminaire: A commonly available luminaire that is constructed of less-expensive materials, with lower-quality construction standards. It is usually lower in price than a specification-grade luminaire. Commodity-grade luminaires commonly are used in homes and are available at discount stores and some electrical suppliers.

common incandescent lamp: See A-lamp.

compact fluorescent lamp: A small fluorescent lamp, usually with one or more bends in the tube.

contrast: The relative brightness (luminance) of an object against its immediate background.

control: A mechanism to turn lamps on and off, or dim lamps. Controls include switches, dimmers, timing devices, motion detectors, photosensors, and central control systems.

cornice luminaire: See soffit luminaire.

correlated color temperature (CCT): Describes the color appearance of the light that is produced, in terms of its warmth or coolness. The CCT relates the color appearance of the lamp to the color appearance of a reference source when the reference source is heated to a particular temperature, measured on the Kelvin (K) temperature scale. A low color temperature (3000 K and lower) describes a warm source, such as a typical incandescent lamp and a warm fluorescent lamp. A high color temperature (4000 K and higher) describes a cool source, such as a cool white fluorescent lamp.

cove luminaire: An architectural luminaire that directs light from sources that are mounted in a cove to the ceiling or upper wall. A cove is a ledge or shelf on the wall, or a recess in the wall.

current: A flow of electric charge, measured in amperes or amps.

daylight: Light produced by solar radiation. Daylight includes direct sunlight, sunlight scattered by the atmosphere, and sunlight reflected from clouds or other surfaces.

Design 1: A term used in the Economics chapter to refer to an existing lighting system, a common-practice lighting system, or any other lighting design that serves as a point of reference for comparison to another lighting design, Design 2.

Design 2: A term used in the Economics chapter to refer to a new lighting system that is being compared to Design 1.

diffuse lighting: Lighting provided on the work plane or on an object that does not come from any particular direction. Diffuse lighting produces less-distinct shadows than directional lighting.

diffuser: A device to redirect or scatter the light from a source, primarily by the process of diffuse transmission.

dimmer: A device used to control the intensity of light emitted by a luminaire by controlling the voltage or current available to it.

dimming power reduction factor: See power reduction factor.

direct glare: Glare resulting from very bright sources of light in the field of view. It usually is associated with bright light from luminaires and windows. A direct glare source may also affect performance by reducing the apparent contrast of objects in the field of view, especially those near the source of light.

directional lighting: The lighting produced by luminaires that distribute all, or nearly all, of the light in one direction.

directional luminaire: A luminaire that provides directional lighting, including downlights, accent luminaires, and the like.

distribution: See light distribution.

downlight: A directional luminaire that directs light downward.

efficacy (of a light source): The total light output of a light source divided by the total power input. Efficacy is expressed in lumens per watt.

efficiency (of a luminaire): The ratio of luminous flux (lumens) emitted by a luminaire to that emitted by the lamp or lamps used therein. Luminous efficiency is a dimensionless measure, expressing the percentage of initial lamp lumens that ultimately are emitted by the luminaire.

electromagnetic interference (EMI): The impairment of a wanted electromagnetic signal by an electromagnetic disturbance.

electronic ballast: A ballast that uses electronic circuitry to provide the voltage and current that are needed to start the lamp(s) and to maintain its operation. Electronic ballasts weigh less than magnetic ballasts and operate more quietly. Electronic ballasts operate lamps at a higher frequency than magnetic ballasts (20,000 to 60,000 hertz compared to 60 hertz), which eliminates flicker and increases efficacy. See also ballast.

ellipsoidal reflector lamp (ER-lamp): An incandescent lamp with an internal reflector that has a focal point a few inches in front of the lamp face. ER-lamps are used in grooved-baffle recessed downlights or track heads to reduce the amount of light absorbed by the baffle trim.

energy: The product of power (watts) and time (hours). Energy used for lighting can be saved either by reducing the amount of power required or by reducing the amount of time lighting is used.

ER-lamp: An ellipsoidal reflector lamp.

exterior lighting: Lighting for the outside of a building, including decorative and functional lighting.

"eyeball" luminaire: A recessed luminaire with a partially recessed sphere that can be rotated to provide adjustable, directional lighting.

facade lighting: Floodlighting the exterior of a structure for security or for illuminating architectural features.

filament: A fine wire heated electrically to incandescence in an electric lamp.

fitting: See luminaire.

fixture: See luminaire.

flood lamp: A lamp that produces a relatively wide beam of light.

fluorescence: The ability of some materials, such as phosphors, to convert ultraviolet energy into visible light.

fluorescent lamp: A lamp containing mercury under low pressure, relative to high-intensity discharge lamps. The mercury is ionized by an electric arc, producing ultraviolet energy which, in turn, excites phosphors coating the inside of the lamp to fluoresce.

footcandle: Imperial unit of illuminance equal to one lumen per square foot. One footcandle equals 10.76 lux.

footlambert: Imperial unit of luminance equal to $1/\pi$ candelas per square foot. One footlambert equals 3.426 candelas/m^2 (nits).

four-way switch: One of three switches that controls the same luminaire or group of luminaires. The luminaire(s) may be turned on or off from any of the three switches. It is called a four-way switch because it contains four contact points: the luminaire and the three switches.

G-lamp: A globe-shaped incandescent lamp, usually having a spherical bulb.

general lighting: See ambient lighting.

glare: The loss of visibility and/or the sensation of discomfort associated with bright light within the field of view. See also direct glare and reflected glare.

globe: A spherical transparent or diffusing enclosure that is intended to protect a lamp, to diffuse its light, or to change the color of the light.

globe lamp: An incandescent lamp with a globe-shaped bulb or a compact fluorescent lamp with a globe-shaped diffusing cover. See also capsule compact fluorescent lamp.

globe luminaire: A luminaire with a spherical diffuser, typically used for ambient lighting.

grazing light: Directional, usually downward, light that emphasizes the texture of surfaces by creating contrast between highlights on raised portions and shadows beyond them. Heavily textured surfaces, such as stucco, are complemented by grazing light.

halogen incandescent lamp: An incandescent lamp whose filament is encapsulated; the capsule contains a halogen gas that reacts with tungsten evaporated from the filament to redeposit it on the filament. Halogen incandescent lamps have higher efficacies than common incandescent lamps. They are sometimes referred to as quartz lamps because the capsule is made from quartz glass.

halophosphates: The class of phosphors that commonly are used in fluorescent lamps. Halophosphates are limited in their ability to provide a high color rendering index without sacrificing light output. See also rare-earth phosphors.

HID lamps: High-intensity discharge lamps.

"high-hat" luminaire: A square or round recessed downlight luminaire. Also called a "can."

high-intensity discharge (HID) lamps: A group of electric discharge lamps operating at relatively high pressures (compared to fluorescent lamps). This group includes the lamp types known as mercury vapor, metal halide, and high-pressure sodium.

highlighting: See accent lighting.

high-pressure sodium lamp: HID light source in which radiation from sodium vapor under high pressure produces visible light. High-pressure sodium lamps are orangish in color appearance, take a few minutes to achieve full light output on lamp startup, and require several minutes to restart if power to the lamp is interrupted, even briefly.

"Hollywood" lights: A luminaire that uses a strip of multiple globe lamps mounted on one or more sides of a mirror. They are common in bathrooms.

"hot spot": An area of higher illumination than that on the immediate surrounding area, often resulting from a lamp being placed close to a surface. Hot spots also can occur due to improper optical design of a luminaire.

human factors: The study of the interaction of people and lighting.

illuminance: The density of luminous flux incident on a surface. Illuminance is the luminous flux divided by the area of the surface when the surface is uniformly illuminated. Illuminance is calculated as the amount of lumens per unit area. Two common units used to measure illuminance are footcandles (lumens/square feet) and lux (lumens/square meter). For conversion purposes, 1 footcandle is equal to 10.76 lux. The IESNA recommends illuminance levels for a variety of lighting applications in which visual performance (for example, speed and accuracy) is important. These recommendations are a function of the visual task being performed, the adaptation level of the observer, and the age of the observer.

incandescent lamp: A lamp producing visible radiant energy by electrical resistance heating of a filament.

incentive: A reimbursement of a portion of the cost of a product. Incentives commonly are offered by electric utilities and manufacturers on some energy-saving lighting products. Also known as rebates.

incremental cost: The difference between the cost of two items that perform similar functions.

indirect lighting: Light arriving at a point or surface after reflection from one or more surfaces (usually walls and/or ceilings) that are not part of the luminaire.

infrared-reflecting lamp (IR-lamp): A halogen lamp with an infrared-reflecting coating on the capsule that surrounds the filament. The coating redirects infrared energy onto the filament, which increases the temperature of the filament without additional input power, thereby increasing efficacy.

initial cost: The original cost of equipment, lamps, and installation, exclusive of operating costs such as energy, maintenance, and lamp replacement.

input power: The active power that is used by a lamp or lamp/ballast combination, measured in watts.

intensity: See luminous intensity.

interval timer: A lighting control that automatically switches the luminaire off after a selected time interval. An interval timer can be either electronic or mechanical.

IR-lamp: See infrared-reflecting lamp.

IR PAR-lamp: An infrared-reflecting PAR-lamp. See infrared-reflecting lamp.

kelvin (K): The standard unit of temperature that is used in the Système Internationale d'Unités (SI) system of measurements. The Kelvin temperature scale is used to describe the correlated color temperature of a light source.

kilowatt (kW): One thousand watts. See also watt and watt-hour.

kilowatt-hour (kWh): Measure of electrical energy consumed; 1 kilowatt-hour is equal to 1000 watts used for 1 hour. See also watt and watt-hour.

lamp: A manufactured light source. For electric lamps, it includes the bulb, the base, and the internal structure that produces light, either a filament or an arc tube. Lamps are often referred to as light bulbs. The term lamp also is commonly used to refer to plug-in luminaires (see desk, floor, and table lamps).

lamp life multiplier: A factor used in the economic analyses in this book to adjust the average rated lamp life to reflect the effects of hours per start and dimming of lamps.

lamp life: See average rated lamp life and service life of a lamp.

LED: See light-emitting diode.

lens: A glass or plastic element used in luminaires to refract, that is, to control, the distribution of light. Lenses can be flat and fitted into the aperture, or cup-shaped or spherical to fit over a lamp.

light: Radiant energy that is capable of producing a visual sensation. The visible portion of the electromagnetic spectrum extends from about 380 to 770 nanometers.

light distribution: The pattern of light that is produced by a lamp or a luminaire, or the patterns of light created in a room.

light-emitting diode (LED): A semiconductor diode that radiates in the visible region of the spectrum. LEDs are used as indicator lamps on some lighting controls, and are used in some emergency exit signs.

light output: Luminous flux, measured in lumens. The light output rating of a lamp is a measure of its total integrated light output. See also lumen.

light source: The object that produces the light. For electric lighting, a lamp; for daylighting, the sun.

lighting design: The planned application of lighting systems to an indoor or outdoor space.

lighting system: The set of equipment that is used to produce light, including a luminaire and control.

lighting technique: A way to light a space to achieve a desired effect.

linear fluorescent lamp: Any of the family of straight tubular fluorescent lamps. Lamps are available in 6-inch to 8-foot lengths, with the most-common length being 4 feet.

louver: A series of baffles or reflectors that is used to shield a light source from view at certain angles, absorb unwanted light, or reflect light.

low-voltage lamp: A lamp that nominally operates at 6, 12, or 24 volts. A transformer must be used to convert the 120-volt line voltage to the lower voltage.

lumen: The unit of luminous flux. The lumen is the time rate of flow of light.

lumens per watt (LPW): See efficacy.

luminaire: A complete lighting unit consisting of a lamp or lamps, together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply. Also referred to as a light fixture, fitting, or unit.

luminance: (footlamberts, candelas/m², or nits) The luminous intensity of a surface of a given projected area. Luminance is closely related to the brightness of an object. One candela/m² = 1 nit = 0.2919 footlamberts.

luminance ratio: See brightness ratio.

luminous ceiling: A dropped ceiling containing lamps above translucent panels. Luminous ceilings provide bright, diffuse lighting.

luminous flux: The time rate of flow of light, measured in lumens.

luminous intensity: Total luminous flux within a given solid angle, in units of candelas, or lumens/steradian.

luminous intensity distribution data: Curve, generally plotted on polar or rectilinear coordinates, which represents variation in luminous intensity (in candelas) from a bare lamp or from a luminaire. Distribution data can also be presented in tabular format.

lux: Standard international unit of illuminance equal to 1 lumen per square meter. One lux equals 0.0929 footcandles.

magnetic ballast: A ballast that uses a magnetic core and coil to provide the voltage and current that are needed to start the lamp(s) and to maintain its operation. Magnetic ballasts are heavier than electronic ballasts. See also ballast.

matte surface: A surface from which the reflection is predominantly diffuse.

mercury vapor lamp: HID light source in which radiation from mercury vapor produces visible light.

metal halide lamp: HID light source in which radiation from a mixture of metallic vapor and additives of halides (e.g., sodium, thallium, indium) produces visible light.

modular compact fluorescent lamp: In this book, the replaceable lamp in a two-piece compact fluorescent lamp product. It is a single-ended fluorescent lamp with a two- or four-pin base. When used with a modular compact fluorescent lamp ballast, the combination can replace an incandescent lamp.

modular compact fluorescent lamp ballast: In this book, the ballast in a two-piece compact fluorescent lamp product. It has a medium screwbase with a socket for the modular compact fluorescent lamp. The ballast and lamp connect together using a socket-and-base design that ensures compatibility of lamps and ballasts.

motion detector: Also called an occupancy sensor, a device that detects the movement of people, animals, and objects using a passive infrared and/or ultrasonic sensor. Motion detectors are used to control other devices, such as alarm systems and luminaires, so that these devices are activated when motion is detected. Some motion detectors offer manual on and/or manual off override capabilities. See also passive infrared and ultrasonic.

motion detector factor: A factor that is used in the economic analyses of this book to adjust the hours of lighting use to account for a motion detector that turns off lamps when no motion is detected.

mounting height: The distance from the floor to the lamp center of the luminaire or to the plane of the ceiling for recessed equipment. Motion detectors also have a recommended mounting height.

MR-lamp: A multi-faceted reflector lamp.

multi-faceted reflector lamp (MR-lamp): A low-voltage halogen reflector lamp that is used in lighting applications where precise beam control is required, such as accent lighting. Some MR-lamps, such as projection lamps, are designed for line-voltage operation.

multiple-level switching: A switching technique wherein the individual lamps, or groups of lamps, in a luminaire are switched independently to achieve multiple light outputs. For example, an architectural luminaire that contains two rows of lamps may have each row controlled by a separate switch, so that the two rows of lamps may be turned on and off independently.

occupancy sensor: See motion detector.

operating cost: See annual operating cost.

PAR-lamp: A parabolic aluminized reflector lamp.

parabolic aluminized reflector lamp (PAR-lamp): An incandescent or tungsten-halogen incandescent lamp with a hard glass bulb and an interior reflecting surface, a precisely placed filament, and a lens to control beam spread. The lens is hermetically sealed to the reflector. Metal halide PAR-lamps are also now available.

parabolic reflector: A reflector with a parabolic shape that usually is used to concentrate the light in the direction parallel to the axis of the reflector. The location of the light source relative to the reflector is crucial to the design of the reflector.

passive infrared (type of motion detector): Passive infrared motion detectors sense the motion of infrared energy (heat) within a space. A detector is located behind an infrared-transmitting lens, which is usually vertically segmented with multiple smaller lenses etched within each segment. This lens design results in horizontal and vertical "fan" pattern detection zones. When a passive infrared sensor detects motion from one zone to another, it activates whatever device it controls (usually an alarm system or one or more luminaires). See also motion detector.

pendant luminaire: See suspended luminaire.

phosphors: Chemical compounds that are used to coat the inside of fluorescent and some HID lamps. See also fluorescence.

photosensor: A device that converts light to electrical current. Based on the amount of incident light, a photosensor can switch a lamp on or off or regulate a lamp's light output to maintain a preset light level.

plenum: The space between the ceiling and the floor or roof above.

point source: A source of radiation, the dimensions of which are small enough, compared with the distance between the source and the lighted surface, for them to be neglected in calculations and measurements.

power reduction factor: A factor used in the Economics chapter that accounts for the reduction in power that is drawn by lamps when they are dimmed to a specified level (expressed as a fraction of full power), or when they are operated by multiple-level switching. The power reduction factor also accounts for the use of multiple-level lamps (e.g., 50-100-150 watts) at various levels.

pull-cord: A string or chain that is attached to a switch that is mounted in a luminaire. Pull cords typically are used to control individual ceiling-mounted luminaires, as in an attic or basement.

quartz-halogen lamp: See halogen incandescent lamp.

R-lamp: A common reflector lamp.

radio frequency interference (RFI): Direct radiation from lamps or wiring, or conducted interference through wiring, that can affect the operation of other electrical devices.

rare-earth phosphors: A group of phosphors containing rare-earth elements. Rare-earth phosphors are used in fluorescent lamps to achieve higher efficacy and better color rendering than can be achieved with halophosphates. Rare-earth phosphors each produce light in a very narrow wavelength band. Although collectively they are more efficacious than halophosphates, they are more expensive. Thus, to reduce manufacturing costs, lamps often are coated first with halophosphates and then with a thin layer of rare-earth phosphors. RE designates a lamp containing rare-earth phosphors.

rated life: See average rated life.

receptacle: An electrical outlet.

recessed luminaire: A luminaire that is mounted above the ceiling (or behind a wall or other surface) with the opening of the luminaire flush with the surface.

reduced-wattage lamp: A lamp that is of slightly lower wattage than the lamp it is intended to replace. A reduced-wattage lamp also provides less light.

reflectance: A measure of how effectively a surface will reflect light, that is, the ratio of lumens reflected off a surface to lumens falling on it. Pale surfaces have a higher reflectance than dark ones.

reflected glare: Glare resulting from bright reflections from polished or glossy surfaces in the field of view. Reflected glare usually is associated with reflections from within a visual task or areas in close proximity to the region being viewed.

reflector: A surface of mirrored glass, painted metal, polished metal, or metalized plastic that is shaped to project the beam from a light source in a particular direction. Reflectors may be an integral part of a lamp or they may be part of the luminaire.

reflector lamp (R-lamp): An incandescent filament or electric discharge lamp in which the sides of the outer blown-glass bulb are coated with a reflecting material so as to direct the light. The light-transmitting region may be clear, frosted, or patterned.

reflector lamps: A class of lamps that have reflecting material integrated into the lamp to direct the light. Types include common reflector (R), parabolic aluminized reflector (PAR), ellipsoidal reflector (ER), and multi-faceted reflector (MR) lamps.

sconce: A decorative and/or functional wall-mounted luminaire.

screwbase compact fluorescent lamp: A compact fluorescent lamp with a ballast that has a medium screwbase that fits into the standard incandescent lamp socket. A screwbase compact fluorescent lamp may either be modular, in which the lamp and ballast are separate pieces, or self-ballasted, in which the lamp and ballast are inseparable. Both types are designed to replace incandescent lamps. See also modular compact fluorescent lamp and modular compact fluorescent ballast.

self-ballasted compact fluorescent lamp: A one-piece screwbase compact fluorescent lamp.

service life (of a lamp): The total time that passes, including time that the lamp is on and time that it is off, before the lamp must be replaced.

shade: A device on a luminaire that is used to prevent glare (by hiding the light source from direct view), control light distribution, and sometimes diffuse (and perhaps color) the light emitted.

simple payback: A term used in the Economics chapter to define the time required to save enough in operating costs by using Design 2, compared to Design 1, to pay back the incremental cost of Design 2.

single-pole switch: Single-location on-off switch that controls one luminaire, or group of luminaires.

skylight: A clear or translucent panel set into a roof to admit daylight into a building.

socket: The fitting on a luminaire that electrically connects the luminaire to the lamp.

soffit luminaire: An architectural luminaire that directs light downward from the cornice or soffit between the wall and ceiling to light the wall surface below.

specification-grade luminaire: A luminaire that is produced with high-quality construction and materials. See also commodity-grade luminaire.

specular surface: A surface from which the reflection is predominantly directional. Specular surfaces are mirror-like or shiny, as opposed to diffuse.

spot lamp: A lamp that provides a relatively narrow beam of light.

surface-mounted luminaire: A luminaire mounted directly on the ceiling or other surface.

suspended luminaire: A luminaire hung from a ceiling by supports. Also called a pendant luminaire.

switch: A device that turns a lamp or lamps on or off by completing or interrupting the power supplied to the lamp(s). See also single-pole switch, three-way switch, and four-way switch.

task lighting: Lighting that is directed to a specific surface or area. Task lighting provides illumination for visual tasks.

three-level lamp: Incandescent lamp having two filaments. Each can be operated separately or in combination with the other, which provides three different light outputs. A special socket is required to use the three levels of this lamp.

three-way switch: One of two switches that control the same luminaire or group of luminaires. The luminaire(s) may be turned on or off from either of the two switches.

timer: See interval timer.

torchiere: An indirect floor lamp sending all or

three-way switch: One of two switches that control the same luminaire or group of luminaires. The luminaire(s) may be turned on or off from either of the two switches.

timer: See interval timer.

torchiere: An indirect floor lamp sending all or
nearly all of its light upward.

track head: An adjustable luminaire that connects to the track in a track lighting system.

track lighting: A lighting system with an electrically fed linear track that accepts one or more track heads. The track heads can be easily relocated along the track.

trim: Baffles, cones, rims, and other treatments for apertures of downlights. Trim is usually the part of the luminaire that is visible from below the ceiling.

trim ring: A plastic or metal ring used to cover and seal the edges of holes that are cut into ceilings to install recessed luminaires.

triphosphor: See rare-earth phosphors.

troffer: A recessed luminaire that is installed in the plenum with the opening flush with the ceiling. Typically rectangular or square in shape, as in a 2-foot by 4-foot luminaire.

tungsten-halogen lamp: See halogen incandescent lamp.

twin-tube lamp: A single-ended fluorescent lamp with the tube bent into a very tight "U" or "H" shape.

U-shaped lamp: A fluorescent lamp with the tube bent in the middle so that the ends fit into the same side of a luminaire.

UL: Underwriters Laboratories; conducts safety and materials tests. UL-listed products have passed UL's tests.

ultrasonic (type of motion detector): Ultrasonic motion detectors emit high-frequency sound waves (too high for the human ear to hear), which are reflected by objects and room surfaces to a receiver located in the detector. The reflected waves set up a static wave pattern; any disturbance in this pattern alters the frequency of the reflected wave, which is detected by the receiver. The receiver then activates whatever device the detector controls (usually an alarm system or one or more luminaires). See also motion detector.

set up a static wave pattern; any disturbance in this pattern alters the frequency of the reflected wave, which is detected by the receiver. The receiver then activates whatever device the detector controls (usually an alarm system or one or more luminaires). See also motion detector.

ultraviolet (UV) radiation: Any radiant energy within the wavelength range of 10 to 380 nanometers.

under-cabinet lighting: Luminaires mounted on the underside of cabinets to provide task lighting, typically in a kitchen.

uplight: A luminaire that directs the light upward onto the ceiling and upper walls of a room.

valance luminaire: An architectural luminaire with a longitudinal shielding member mounted across the top of a window or along a wall and usually parallel to the wall, to conceal light sources giving both upward and downward distributions. See also architectural luminaires.

vanity light: A wall-mounted luminaire located next to a mirror. See also "Hollywood" lights.

voltage (V): The electric potential difference that drives the current through a circuit.

wall washing: A technique that lights a wall fairly evenly from top to bottom without spilling or wasting light away from the wall into the room.

watt (W): Unit of active electric power; the rate at which electric energy is used.

watt-hour: Unit of electric energy. One watt-hour is the amount of energy consumed at the rate of 1 watt during a 1-hour period.

wattage: The active electrical power consumed by a device.

wavelength: The distance between two similar points of a given wave. Wavelengths of light are measured in nanometers (1 nm = 1 billionth of a meter, or 1×10^{-9} meters)

Glossary - Lighting Research Center
https://www.lrc.rpi.edu/resources/publications/lpbh/091Glossary.pdf

CHAPTER 11

Furniture
by Alex King

Furniture design has been a part of the human experience since the beginning of history. Evidence of furniture survives from as far back as the Neolithic Period in the form of paintings, wall murals discovered at Pompeii and in sculptures. Furniture has also been excavated inside Egyptian Pyramids and have been found in tombs in Ghiordes (modern day Turkey). The furniture design timeline below outlines just some of the different periods of furniture design in the West, and includes the following periods:

- Ancient Egyptian Furniture (3000 - 2000 BC)
- Ancient Greek Furniture (2000 - 300 BC)
- Medieval Furniture (500 - 1450 AD)
- Renaissance Furniture (1350 - 1550)
- Jacobean Furniture (1567 -1625) - 1775)
- Colonial Furniture (1500 - 1754)
- Rococo Furniture (1725- 1775)
- Revival Furniture (1800 - 1900)
- Art Nouveau Furniture (1890 - 1914)
- Bauhaus Furniture (1919 - 1933)
- Art Deco Furniture (1925 - 1940)
- Modern Furniture (1930 - 1945)
- Contemporary Furniture (1980 - 2000)

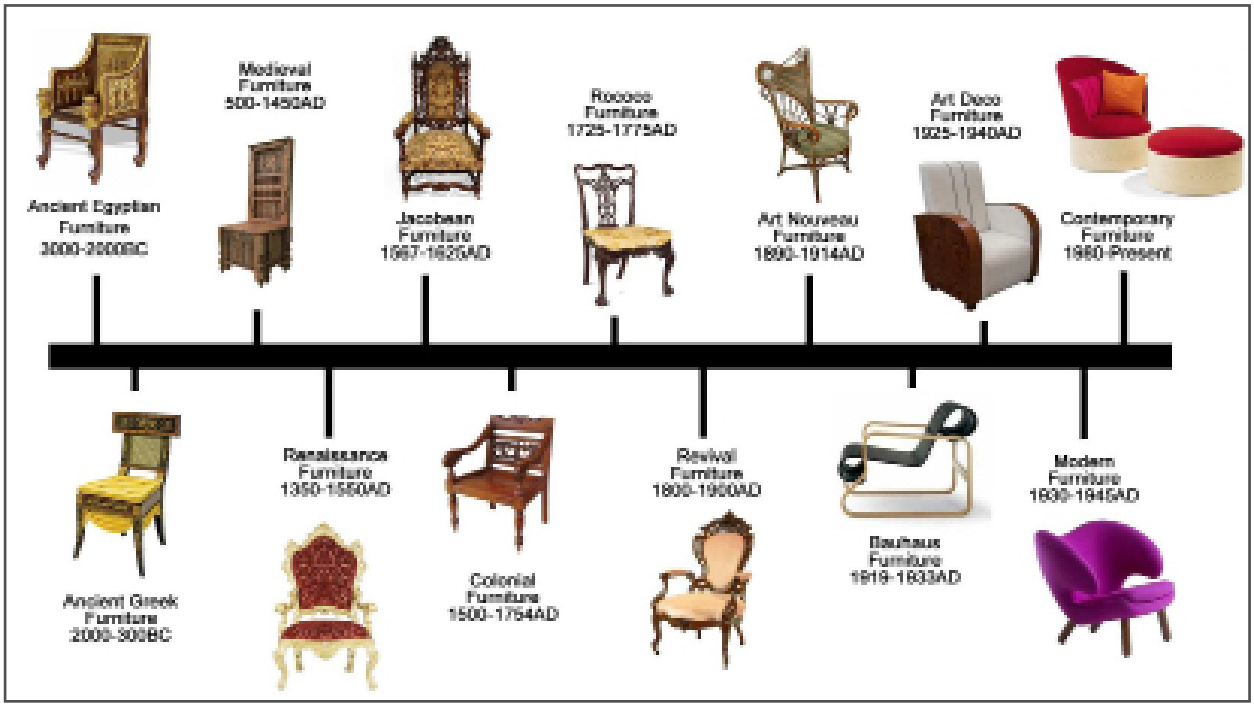


Fig. 11.1 Timeline of furniture development in the West

Modern Movement

Beginning in the 19th century, there came to be fundamental changes in the style of design of furniture and home accessories in the Western world. The Belgium architect Victor Horta first introduced the decorative arts into the style of architecture in 1892. The Hotel Tassel, commissioned by Prof. Emile Tassel, and Maison Horta, the architect's private residence, included stained glass mosaic patterns with serpentine shapes of furniture and door handles developed down to the last detail.

The Viennese architect and designer Josef Hoffmann embodied the progressive attitudes of the 20th century, using simple geometry as the foundation of design. His signature design included applying apparent grid pattern with leather cushions instead of traditional upholstery to embody modern expression. In 1917, the American architect Philip Johnson initiated what became known as the international style of design, which shifted from solely decorative to machine-like minimalist principles. Johnson's work with Marcel Breuer and Mies van der Rohe came to be seen as proponents of modern architecture and furniture design.

Fig, 11.4 Interior of Philip Johnson's Glass House

Fig 11.5 Chaise Longue designed by Le Corbusier, Pierre Jeanneret and Charlotte Perriand

Fig, 11.2 Joseph Hoffman's geometric design

Fig, 11.3 Chairs designed by Joseph Hoffman

In the 1920s, the Swiss-French architect Le Corbusier, together with Charlotte Perriand, designed a luxurious lounge using tubular steel, which became part of their unique style. The first president and the founder of Bauhaus School, Walter Gropius, expressed the theory of "form follows function" to his students in furniture through endless experimentation with materials. Modern furniture pieces like Marcel Breuer's Cesca chair, designed in 1928, celebrated the beauty of tubular steel, which became one of the most successful pieces of machine-produced furniture of its time, and is still commercially available today.

With the tremendous technological advancement in the 20th century, high quality furniture including lounges, working tables and couches became mass-produced. Geometric and minimalist structure prevailed over the expressive curvilinear styles found in Art Nouveau.

Functional Flexibility

In the contemporary world, flexibility plays a significant role in daily living, in particular for people who live in small living spaces and working in SOHO (small office, home office.) Flexible design allows people to change their furniture types in terms of composition, supporting structure, volume and overall expression to fit the needs of individuals. In today's furniture industry, designers should possess the ability to research and understand the changes in the functional and emotional requirements of modern furniture. Typical furniture pieces such as office tables should be as flexible as possible and with a high degree of inclusivity so that it can accommodate a greater variety of requirements, as different users may have different size appropriateness.

Fig. 11.6 Home office

For instance, a well-developed wooden chair should be stackable for easy storage and put to use when necessary to enhance users' quality of life. Nowadays, consumers demand a sense of modularity as they require furniture to serve multiple purposes.

Universal design principles require furniture designers to pay attention to movable components, handles and foldable hinges that need low physical effort to operate. In universal design, the overall design language aims to be simple and intuitive, maximizing the flexibility in use.

Sustainability Consciousness

The term "sustainability", which emerged over the past two decades, has become overused and may be misinterpreted in the process of design development. Many consumers are now more conscious in material selection and are aware of the concept of carbon footprint, and make efforts towards sustainability and eco-living when making their choices. Sustainable furniture design process involves the consideration of re-use and recyclability, design for disassembly, utilization of recycled materials, weight reduction and durability.

Fig 11.7 Elemento Diseno Bi Chairs can be stacked one upside-down on the other to produce a table and storage system

National strategies for promoting sustainable living are key to nurturing eco-consciousness. In Hong Kong, the Environmental Protection Department (EPD) offers sustainable development funds for "Making Hong Kong an Ideal Home" by promoting public participation in the discussion and implementation of long-term sustainable development of the city. The cultivation of Cradle to Cradle (C2C) design approach in the past decade has brought us a total concept in choosing sustainable furniture. This approach advocates the removal of dangerous substances such as certain synthetic materials and harmful chemical dyes, and also considers clever design for disassembly so that every single component can be easily separated for future use.

Designers in the twenty-first century should pay more attention to the environmental performance of materials. For example, in terms of manufacturing energy usage, titanium consumes more than five times the energy needed to produce an equivalent amount of stainless steel. Another consideration is the choice of paint finishes free of volatile organic compounds (VOCs) and using water-based paint finishes to minimize negative environmental effects.

Aesthetics, Emotion and Individuality

Aesthetics is an abstract concept and relates to judgments about beauty, taste, culture and the nature of art. A sense of aesthetics in itself is a foundation for the formation of human personality. We appreciate the beauty of furniture according to our ability to judge sentiments and tastes. Taste is the awareness of cultural values learned through exposure to mass culture and differs among people according to their education backgrounds. In contemporary interior design, furniture forms an immediate connection between people, carrying emotional depth and narratives. In addition, consumers expect the furniture they choose to express what they want and feel, as well as embody their individuality. Individuality is the key to enhancing customer satisfaction by tailoring a product, furniture or solution to accommodate specific personalities. It provides opportunities for users to discover and express their unique qualities.

Ergonomic Considerations

There is no doubt that ergonomic factors in furniture design that give a sense of comfort to end users have become an essential part of furniture design. For example, in designing a handle for a drawer, designers may need to collect data on the average sizes of the human hand and pay attention to the difference between various ethnic and racial groups. The judgment of human factors is an assessment of usability and how successfully human beings interact with an object.

Fig. 11.8 Universal design

Quality ergonomic design aims at improving physical experience of users, eliminating any fatigue or injury induced by improper design. Furniture should be well designed and developed, ergonomically correct and functionally fit for its purposes for all people. When designing a tasking chair, for example, the size and location of control knobs, the curvature of backrest and armrest as well as the softness of upholstery should be taken into account in the process of development testing. Human gestures like sitting, moving around, gripping and even the degree of legibility on graphics over the control knobs are key ergonomic indicators.

Furniture of the Future

Designers should explore the latent needs of people rather than their expressed needs, and try to look for bigger living patterns on how people with different cultural backgrounds interact with furniture. The beauty of co-creation in furniture design allows users to work with creative people in developing the future possible solution for all. The process of design is now shifting from “design for people” to “design with people”. Future designers should have the ability to drive the force of change towards social and environmental issues, making our world a better place to live.

CHAPTER 12

Nanotechnology in Interior Design - a Driving Force for Sustainable Buildings by Sylvia Leydecker

Nanotechnology is a quiet revolution. Regarded as one of the key technologies of the 21st century, nanotechnology plays a role not only in construction but also in fields ranging from aerospace to medicine and automotive to architecture and interior design. In the design of interiors, however, its potential has yet to be fully exploited. Interior designers are in the special position of being able to contribute inspiration as well as develop initial ideas for new product developments in this field due to their ability to connect product development with specific usage requirements.

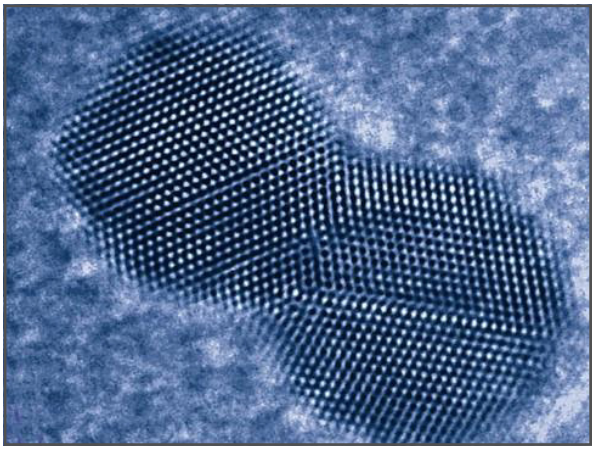


Fig. 12.1

But why "nano" anyway? Nanotechnology as an innovation is neither an aim in itself nor a flagship topic for political backing; it offers a variety of concrete and practical uses. Whether optimisations or entirely new creations, nano products and nano materials consume fewer resources, have a smaller CO2 footprint and make things more comfortable to use. In both the field of new construction as well as the renovation and modernisation of existing buildings, a traditional domain of interior design, the days in which investment costs were the sole concern are behind us.

Today, the life-cycle costs (LCC) are gaining greater focus. So why is the pace of development of nano materials and nano products from the laboratory to the market so difficult and slow? Aside from the cost, a primary reason would seem to be the lack of communication between the realms of science, industry, design and architecture. For this reason, this chapter takes a look at nanotechnology and interiors-related products and materials.

What is nanotechnology?

The word "nano" derives from the Greek word nanos (νάνος) meaning "dwarf". A nanometre (nm) is a millionth of a millimetre and 1 metre is a billion nanometres (1,000,000,000 nm). Generally speaking, nanotechnology describes the analysis and manipulation of materials with particles where at least one dimension is smaller than 100 nm. This threshold reflects the fact that at this point there is a "kink in nature" where the properties of materials begin to change, for example their colour or conductivity. Compared to their volume, nano-particles have a very large surface area, which makes them potentially highly reactive.

The specific exploitation of these properties began long before these phenomena were explained by nanotechnology: nano-particles are responsible, for example, for the ruby-red colouring of stained glass in historical church windows and for the extreme hardness of Damascene blades. Nano-technology applies to all manner of materials. The term refers not to a specific material but to the size of its particles and the properties they have at this scale as well as how these can be used.

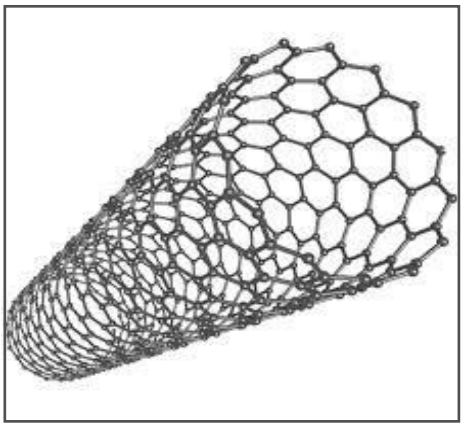


Fig. 12.2

Nano-particles are invisible to the human eye because they are smaller than the wavelength of visible light. A good example of how the dimensions of particles affects visibility can be seen by looking at two solutions each with a 50% proportion of suspended solids. When the particle size measures just a few nanometres, the solution looks transparent despite containing the same percentage of solids. [1]

The ability to impart specific functional qualities to surfaces with the help of nanotechnology can make materials exhibit properties that are quite different to their own. Surfaces can also be given multifunctional properties.

Fig. 12.3

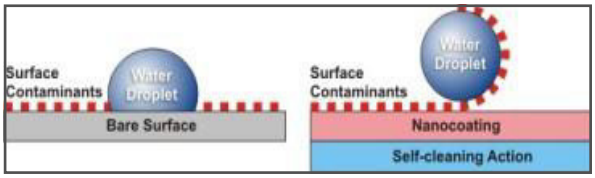


Fig. 12.4 Water-repellent nano coating

So, what is available on the market? The majority of the many currently available applications are surface coatings that make surfaces easy to clean or reduce soiling. Other functional coatings used to optimise materials include scratch-resistant coatings, thermochromic surfaces, tribological coatings for reducing friction, or antibacterial coatings. Insulation materials are a further interesting area of application with much potential in the context of green building. Similarly, nanotechnology-optimised concrete has the potential to become the lightweight building material of the future. Because the value chain in the construction industry is long, it can take a correspondingly long time for the finished product to reach the market, and eventually the consumer or client. Many applications, such as fire-retardant hemp-straw insulation boards, are already possible but not yet in production. Some materials and products that are already available do not achieve market penetration due to a lack of appropriate marketing and market visibility.

(Almost) self-cleaning

Nano-materials can be used to make materials easy to clean and reduce the frequency of cleaning. This in turn lowers maintenance costs, minimises the use of environmentally harmful cleaning agents, which conserves resources and reduces staffing costs and material wear and tear.

The most popular nano-related function is the Lotus Effect® , a term often used synonymously to mean “nanotechnology” although it is actually only licensed for a select group of applications on the market. This effect is used on surfaces, such as the painted facades of buildings, so that rainwater simply runs off the surface due to the hydrophobic (water-repellent) properties of the coating, taking any dirt deposits with it. At a microscopic scale, the surface is not smooth but rough and covered with tiny protuberances so that there is little contact surface for droplets of water to settle on. However, if the nano coating is damaged by mechanical abrasion, it may lose its effectiveness. As a result, they are not suitable for many uses and are rarely used in interiors.

Water-repellent surfaces are also often used for sanitary facilities such as shower screens, toilets, washbasins or similar, although these are called Easy-to-Clean (ETC) surfaces. These have a diminished surface attraction and exhibit both hydrophobic (water-repellent) as well as oleophobic (oil-repellent) properties. They are more resilient than artificial lotus surfaces, but only to a limited degree and can be damaged by abrasive cleaning agents. Easy-to-Clean surfaces are relatively widespread, easy to maintain and help to ensure general cleanliness.

Fig. 12.5

Photocatalytic self-cleaning is another variant already in use around the world, and especially in Japan. Water falling on one of these surfaces spreads to form a film of water that washes off loose dirt deposits, cleaning the surface in the process. While this does not replace the need for cleaning, it reduces the cleaning interval significantly. This variant is most commonly used for smooth surfaces such as membranes, glass and ceramics in outdoor areas. Self-cleaning tiles are, however, also used in interiors, for example for bathrooms or operating theatres. In contrast to hydrophobic surfaces, photocatalytic surfaces have hydrophilic (water-attracting) properties: rather than running off, water falling on such surfaces spreads out in a fine film. In combination with UV light, a catalyst is activated that decomposes organic dirt on the surface allowing it be washed off by the film of water. In most cases the active compound is titanium dioxide (TiO2).

Tiles with photocatalytic properties are also available in combination with additional antibacterial properties that are particularly effective at improving hygiene. Silver has historically been prized for its antibacterial properties, and nanoscale silver particles are that much more effective in preventing bacteria due to their large surface area. Silver ions have a triple effect, destabilising the bacteria's cell walls, inhibiting their reproduction and halting their metabolism. This antibacterial function can be used for surfaces and textiles – curtains, upholstery, work surfaces, light switches and door handles – in kitchens or in healthcare environments, such as hospitals and care homes, where hygiene is especially important. To prevent the build-up of resistance, antibacterial silver nano-applications should not be used for end consumers but rather only in healthcare environments.

Fig. 12.6

Fig. 12.7

Fingerprints are generally regarded as unsightly. With the help of nanotechnology, their visibility can now be inhibited using surfaces with anti-fingerprint coatings that alter the refraction of light, rendering them invisible to the eye. As such, building material concepts using glass and steel can also be employed in the interior of buildings without fear of aesthetic or functional impairments. In the same way, anti-fingerprint coatings can be applied to especially smudge-prone materials in interiors, such as stainless steel and frosted or coloured glass, to achieve a consistently lasting appearance and also to integrate these materials in a holistic interior design concept.

Improved indoor air quality

How comfortable we feel in an interior also depends more and more on the quality of the indoor air, both in terms of smell as well as freedom from pollutants. The quality of indoor air can be improved by using airpurifying materials, which can range from plasters and building boards to textiles such as curtains and carpets. To be effective, there must be sufficient unobstructed material surface for the volume of air in the room. In a catalytic process, unpleasant odours as well as pollutants in the air such as formaldehyde or nicotine are broken down into their constituent parts and destroyed. This represents an especially interesting option for tackling the widespread sick building syndrome (SBS), although it only combats the resulting conditions and not the root causes. This method does not obviate the need for adequate ventilation with fresh air and cannot remedy high levels of relative humidity and related problems such as mould formation. The products of the catalysis, such as carbon dioxide (CO2) also need to be extracted from the interior.

Air quality has long been the focus of environmental protection initiatives. More recently, various pilot projects have examined the use of nanotechnology-enhanced road surfaces and facade paints in inner cities areas subject to heavy traffic, as the process of catalysis is reportedly even more effective outdoors.

High-performance low-thickness thermal insulation

In the context of energy conservation initiatives and building certification by organisations such as the DGNB, LEED or BREEAM, the use of nano-technologically optimised thermal insulation materials offers very promising results. These include vacuum insulation panels (VIP), renders or plasterboard panels with integrated latent heat accumulators or phase change materials (PCM) as well as insulation panels and glazing filled with aerogels.

Vacuum insulation panels exhibit extremely efficient thermal insulation properties and are very thin, making it possible to build very compact constructions. VIPs achieve the same insulation effect as normal insulation materials at a tenth of the material thickness. Put another way: the effect of VIPs is ten times greater than traditional insulation materials. For new construction, VIPs are especially attractive as they maximise the amount of lettable space. In the renovation of existing buildings, they enable the insertion of narrow constructions that would not be possible in the available space when using conventional materials.

Thermal nanomaterials for reducing heating and cooling requirements

Indoor room temperature can be maintained at a comfortable level with the help of phase change materials (PCM) as a means of latent heat storage. Using PCMs, a room stays cool or warm for longer without the need for additional energy input in the form of cooling or heating – offering a further means of saving energy. The PCM consists of minute paraffin-filled globules, each encapsulated in a sealed plastic sheathing, that change their state from solid to liquid or from liquid to solid at a predefined switching temperature, for example 24°C. During this phase change period warmth is given off or absorbed and the wax stores this “latent heat” until the material changes its state again. The paraffin PCM therefore acts as a temperature buffer. PCMs are available as additives for plasterboard panels or plasters and even out temperature fluctuations. The material is easy to work with and can be sawn and drilled without damaging it.

Aerogel is another thermal material that is as visually fascinating as it is functionally impressive. It consists of 99% of air, is ultra-lightweight, appears to float with a cloud-like quality and has a translucent quality that seems out of this world. This association is not as far flung as it might sound, as aerogel was originally developed by NASA to protect people and equipment from the extreme temperatures of outer space.

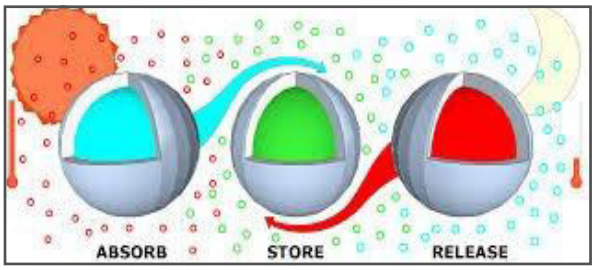


Fig. 12.8

The pores are so small that molecules are unable to pass between them and therefore to conduct or give off heat. The excellent insulation properties of aerogel are not limited to heat: it is an equally effective acoustic insulator and can be used for noise insulation. Aerogel-based products include glass panels with aerogel filling or innovative insulation panels, both of which have mass market potential.

Fig. 12.9 Aerogel has a wide variety of applications.

New architectural forms for spatial enclosures are now possible using especially lightweight and slender concrete constructions made of Ultra High Performance Concrete (UHPC). This nanotechnologically optimised high-density concrete also offers other means of construction. It can be glued, which makes it much easier to handle. UHPC concrete enable the realisation of complex 3D geometries, including decorative perforations, and has the potential to change both the aesthetics and construction systems of buildings.

In this context, UHPC represents a perfect material for parametric design. In the realm of interiors, UHPC is used for flooring, wall panelling or other fittings or furnishings such as tables or planting containers. Compared with conventional concrete, UHPC is more environmentally friendly as it reduces the quantity of material needed and therefore the CO2 footprint of its production, as well as the lifecycle costs due to reduced need for maintenance and repair.

Energy-efficient light: super flat and flexible

Light emitting diodes (LED) are today a widely used modern source of artificial light and are extremely energy efficient. The next generation – organic light emitting diodes (OLED) – is, however, already in sight and has the potential to give rise to completely new products. Using OLEDs, light can acquire another dimension: lighting will not come from a single tangible light source but from large surfaces made of lightweight, flexible illuminated foils. Paper-thin, super-flat, large format OLED foils can, for example, function as screens in conference rooms. While this vision is still a little way off, it is no longer science fiction: OLED displays are within reach and are able to interact with the help of sensors. These thin foils give off a warm light strong enough to illuminate a room. The materialisation of light in the form of surface leads to the dissolution of the boundaries of spaces. Light is fused with the boundaries of spaces, lending architecture a new quality. In future, light may also be used in three dimensions: three-dimensional OLEDs have already been created in laboratories. Currently the available formats are still small – more suitable for a mobile phone or TV than an entire façade or wall. Different lighting manufacturers are currently experimenting with OLEDs for relatively traditional uses such as desk, floor or ceiling lamps.

Fig. 12.10 Paints and light

Without light there is no colour. Light is essential for us to perceive colour but it can also have a detrimental effect: UV light can accelerate degrading, which is why many wood surfaces, for example, are coated with a transparent UV protection varnish. Conventional varnishes consist of organic particles that sooner or later degrade of their own accord. With the help of nanotechnology, transparent varnishes can be made of inorganic particles that do not degrade and provide lasting protection.

Fig. 12.9 Aerogel has a wide variety of applications.

Paints can be given new qualities using inspiring effect pigments. So-called flip-flop effect paints employ special effect pigments to create new variants or painted surfaces. The colour changes with the angle of view, shifting from pink to green and blue. Thermochromic paints, on the other hand, respond to changes in temperature and were originally developed for military purposes – in the realm of interiors there are as yet no specific areas of application.

Information technology

Information technology (IT) and interior design are becoming more and more intertwined. IT systems and components are increasingly miniaturised, which would not be possible without nanotechnology. Their sensors are being integrated into textiles, RFID (Radio Frequency Identification) systems are used to allow access to particular rooms and track operating processes, computers make it possible for the user to control energy consumption and IT is increasingly being used to communicate with the building as well as with the outside world. IT is changing the design of interiors, whether they are in office workspaces, healthcare environments, restaurants and hotels or private houses.

True progress consists of useful innovations that improve on what we already have. Today and in the future, we will need to carefully weigh up the benefits and risks of such progress. Interdisciplinary teams of scientists, industry, architecture and interior design are called upon to push forward the development of energy-efficient buildings, and politicians need to create the necessary conditions to make this possible. Good interior design should likewise address the challenges facing society and help to conceive new solutions for the future. The application of smart nanomaterials will no doubt shift the interior world of innovation into a sustainable future.

Fig 12.12 Myto Chair for Plank in collaboration with BASF, Konstanin Grcic. The use of nano technology means the moulding process can be conducted at a lower temperature, saving energy.

CHAPTER 13

Pre-Modernism
by Eisuke Tachikawa (Nosigner)

Please close your eyes and image the most beautiful place you have been. It does not matter where, as long as it makes you feel soothing and relaxed. It can be a café in the city, a seaside hotel or a small chapel in the woods. Now, try to picture the detailed furnishings of that place.

Now you are ready to answer the next question, which has to do with that place.

“Does it have any plastics?”

I believe you will answer “no”. If I were to ask you further questions, I believe that extruded aluminum, stainless steel, flashing LEDs, plywood and artificial leather will also not be present. These kinds of new materials that surround us are not things that make us feel soothing and relaxed.

On the other hand, the place you imagined will probably contain the following materials: wood, glass, iron, brass, leather, tiles, stone and paper, as well as natural surroundings. These timeless materials have been with us for hundreds and thousands of years. Even though we live in the post-modern age, we long to return to pre-modern times. That’s why I will name the current sense of aesthetics as Pre-modernism.

Pre-modern design is not limited to space design.

In the realm of graphic design, such fonts as Plantin, Cochin, Baskerville are all influenced by late 19th century movable type publishing. The newly popular minimalist Geometric Sans-serif font is descended from the Bauhaus school. On the other hand, fonts that emerged in the latter part of the 20th century, such as Bank Gothic, has been increasingly abandoned and seen as being old fashioned. In publishing, people are switching back to traditional methods such as movable type, flat-bed press and silk screen.

Fig. 13.1

These changes are also seen in industrial design. In automobile design, for example, the market is already weary of sleek, super-fast sports cars, while reengineered classic models such as MiniCooper and Ford Mustangs have made a resurgence. Even electric car powerhouse Tesla trades on an anti-fossil fuel primitive image, which has resonated with consumers.

Pre-modern aesthetics has also become lifestyle choices. For example, in culinary culture, sales of McDonald’s has been declining as people favor pesticide-free organic foods. Also, micro-brewed craft beer and home-roasted craft coffee are all the rage these days. These trends indicate that we now desire things that were taken for granted 100 years ago.

Modernism and its design philosophy of simplicity is still being upheld today, but the cheap imitations that it bred, along with the aesthetic flaws of economic essentialism, led to a deep skepticism of modernism and the rise of pre-modernist aesthetics.

The past few decades of economic essentialism had stressed market monopoly, unequal trade, disregard of environmental consequences, low-cost production, instant gratification, constant development, planned obsolescence, disposable culture and buying the same item repeatedly. Over the past few decades, these marketing trends have left us feeling strongly skeptical, and engendered a deep-seated sense of disgust for these kinds of material. That is why Pre-modernism, which seeks to revive the aesthetic sense of 100 years ago, has found an audience.

In the realm of design and society, Pre-modernism can bring about many changes. Below, I would like to share some of my treasured viewpoints:

Minimalism and Real Materials

In the information age, the relationship between information and material will become more distant. Decorations that contained information in the past, such as church paintings, will lose their value, while simple geometric aesthetics will gain in importance. At the same time, as mentioned previously, artificial materials will be abandoned in favour of primitive materials formerly associated with church buildings such as stone and wood. One example of this pre-modernist aesthetics is the minimalist Barcelona Pavilion, designed by Ludwig Mies van der Rohe, which uses marble as the main material.

From the Individual to the Community

In this irrational and unsettled age, people chase after convenience, but in the end they become lonely. Yet people long to return to the community. How to make small community become more important and to connect with like-minded individuals will become an important issue in the future.

From Ownership to Sharing

People's mindsets have gone from "gaining satisfaction from ownership" to "owning as little as possible yet feeling content". Co-sharing culture such as renting out one's home, co-working spaces and car-pooling are becoming increasingly popular.

Fig. 13.2 A co-working space in Hong Kong

Repair and recycle

In a pre-modern world, old things and natural materials are valued, and there is a growing trend for repairing. The repairing trade will be more popular in the future, and recycling will be an important issue. Even waste categorization and management will become more innovative.

Live a life of necessity

Living in small homes or transforming old busses into living spaces is a growing trend, and people will live with fewer material possessions. At the end of his life, the world-renowned architect Le Corbusier lived in a log cabin by the sea at Cap Martin, leading a life of quiet meditation. Only by reducing life to the bare essentials can we truly enjoy a rich life.

Fig. 13.3-4 Le Corbusier's log cabin at Cap Martin

A Lifestyle based on Hippie Ideas

With the rise of the small house movement, one can expect to see the revival of a lifestyle based on a hippie sense of exploration. This kind of mindset is closely akin to IT startups, which can become the giant corporations of tomorrow. After all, it was a former hippie who started the Apple brand.

What the pre-modern aesthetics seeks is a kind of lifestyle that had been forgotten in the age of post-war economic miracle. I call on designers not to focus on superficial stylistic considerations and forget the true meaning of design. We have to explore ways to situate ourselves in the 21st century and elevate design to the next level.

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Mr. Tachikawa obtained his Master's of Architecture degree from Keio University's Department of Science and Technology, where he focused his studies on architecture, product design, and revitalizing local communities through design. In 2006, while still in school, he established NOSIGNER, a design firm aimed at "designing the invisible." Specializing in a multi-disciplinary approach that traverses two-dimensional, three-dimensional, and spatial design, his conceptual planning, innovative product development and branding has been recognized through global awards like Design for Asia Award 2011, NY ADC Young Guns 7, PENTAWARDS PLATINUM, Good Design Awards, and many others. His activities extend beyond commercial work to encompass science and technology, education, local industries, and support for developing nations. Mr.Tachikawa is also the founder of "OLIVE PROJECT," an initiative to provide meaningful design during times of disaster.

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The Interior Design School, London invited Anna Whitehead to prepare the chapter on the British Standards as she informs the sustainable research at the school. Anna is a sustainable interior design consultant based in Buckinghamshire, UK, providing design and consultancy for interior environments that are resource, energy & water efficient using ethically sourced sustainable materials & products. As a qualified LEED-AP ID&C and with a BSc (Hons.) degree in Human Physiology, her specialty is designing holistically healthy interior environments to enhance clients' health and wellbeing. Ms. Whitehead is a founding head of the environment committee for the BIID, and had organised the inaugural BIID Retrofit Conference. She is a USGBC Educational Session Reviewer for Health and Wellbeing seminars and educational sessions for USGBC's annual Greenbuild Conferences, and writes and presents Sustainability Module lectures for Interior Design Students in the UK. She has published articles and delivered industry presentations on designing for health & wellbeing including at Ecobuild, Grand Designs Live, RIBA Guerilla Tactics and Green Sky Thinking.

Louisa Young
Louisa Young has been the Program Leader of Interior Architecture at the Faculty of Design of Caritas Bianchi College of Careers since 1995. Her extensive experience in the industry and her years-long service at the Hong Kong Interior Design Association (HKIDA) are a synergy to her teaching. Louisa has been actively involved in HKIDA since 2003 and is presently the Vice Chairman. Louisa holds a bachelor degree in Interior Design at Southern Illinois University at Carbondale, U.S.A. in 1985, a post graduate diploma in Education in The Chinese University of Hong Kong in 1997, and a master degree in Lighting in Queensland University of Technology, Australia in 2011. In 2019, she was appointed a Specialist by the Hong Kong Council for Accreditation of Academic & Vocational Qualification (HKCAAVQ).

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