Handbook of Design Professions

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Architect

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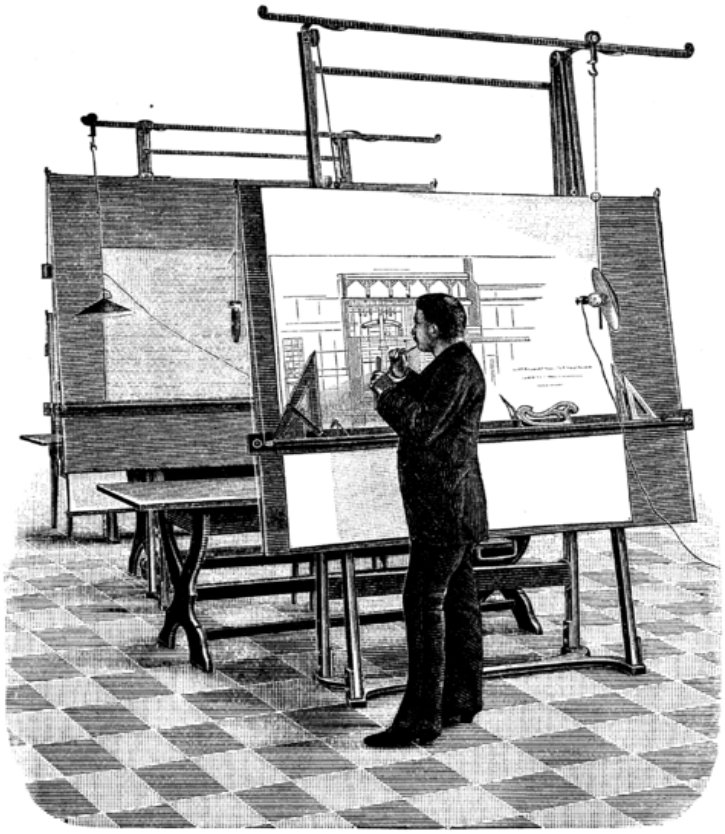


An architect at his drawing board, 1893.

Occupation	
Names	architect
Type	profession
	architecture
Activity sectors	real estate development
	urban planning

	construction
	interior design
	civil engineering
	Description
Competencies	technical knowledge, building design, planning & management skills

An **architect** is a person trained in the planning, design and oversight of the construction of buildings, and is licensed to practice architecture. To *practice architecture* means to offer or render services in connection with the design and construction of a building, or group of buildings and the space within the site surrounding the buildings, that have as their principal purpose human occupancy or use. Etymologically, *architect* derives from the Latin *architectus*, itself derived from the Greek *arkhitekton* (*arkhi-*, chief + *tekton*, builder), i.e. **chief builder**.

Professionally, an architect's decisions affect public safety, and thus an architect must undergo specialized training consisting of advanced education and a *practicum* (or *internship*) for practical experience to earn a license to practice architecture. The practical, technical, and academic requirements for becoming an architect vary by jurisdiction (see below).

The terms **architect** and **architecture** are also used in the disciplines of landscape architecture, naval architecture and information technology (for example a software architect). In most of the world's jurisdictions, the professional and commercial uses of the term "architect", outside of the etymological variants noted, is legally protected.

Architects in practice

The **practice of architecture** involves offering or rendering services that include pre-design services, programming, planning, providing designs, drawings, specifications and other technical submissions, the administration of construction contracts and the co-ordination of any elements of technical submissions prepared by others (such as by engineers) and technical designers.

Architecture is a business in which technical knowledge, management, and an understanding of business are as important as design. An architect accepts a commission from a client. The commission might involve preparing feasibility reports, building audits, the design of a building or of several buildings, structures, and the spaces among them. The architect participates in developing the requirements the client wants in the building. Throughout the project (planning to occupancy), the architect co-ordinates a design team. Structural, mechanical, and electrical engineers and other specialists, are hired by the client or the architect, who must ensure that the work is co-ordinated to construct the design.

Design role

The architect hired by a client is responsible for creating a design concept that meets the requirements of that client and provides a facility suitable to the required use. In that, the architect must meet with and question the client [extensively] to ascertain all the requirements and nuances of the planned project. This information, known as a program or brief, is essential to producing a project that meets all the needs and desires of the owner—it is a guide for the architect in creating the design concept.

Architects deal with local and federal jurisdictions about regulations and building codes. The architect might need to comply with local planning and zoning laws, such as required setbacks, height limitations, parking requirements, transparency requirements (windows), and land use. Some established jurisdictions require adherence to design and historic preservation guidelines.

Documentation role

The architect has the task and responsibility to document the design concept in such manner as to provide detailed drawings and information used by the various contractors, directly. In this, there is a transition that is required to convert design language to construction terms and information, directions and instructions. This work requires a large portion of the professional's fee and extensive time for production. The higher the quality of these documents the more the construction will be enabled and facilitated. This is work that is unavoidable and most necessary.

In addition, the working drawings must be accompanied by suitable construction specifications. The two sets of documents must be closely coordinated, supplementary and complementary, so as to be inseparable [i.e., the project cannot be built using just one set of the documents. The reason for this is that some information is easily [and better] depicted graphically, while other data is incapable of being depicted and must be produced in written form.

Architects prepare the technical or "working" documents (construction drawings and specifications), usually coordinated with and supplemented by the work of a variety of disciplines [i.e., with varied expertise like mechanical, plumbing, electrical, civil, structural, etc.] engineers for the building services and that are filed for obtaining permits (development and building permits) that require compliance with building, seismic, and relevant federal and local regulations. These construction drawings and specifications are also used for pricing the work, and for construction.

Construction role

Architects typically put projects to tender on behalf of their clients, advise on the award of the project to a general contractor, and review the progress of the work during construction. They typically review subcontractor shop drawings and other submittals, prepare and issue site instructions, and provide construction contract administration and

Certificates for Payment to the contractor. In many jurisdictions, mandatory certification or assurance of the work is required.

Depending on the client's needs and the jurisdiction's requirements, the spectrum of the architect's services may be extensive (detailed document preparation and construction review) or less inclusive (such as allowing a contractor to exercise considerable design-build functions). With very large, complex projects, an independent construction manager is sometimes hired to assist in design and to manage construction. In the United Kingdom and other countries, a quantity surveyor is often part of the team to provide cost consulting.

Alternate practice and specializations

Recent decades have seen the rise of specializations within the profession. Many architects and architectural firms focus on certain project types (for example, health care, retail, public housing), technological expertise or project delivery methods. Some architects specialize as building code, building envelope, sustainable design, historic preservation, accessibility and other forms of specialist consultants.

Many architects elect to move into real estate (property) development, corporate facilities planning, project management, construction management, interior design or other related fields.

Professional requirements

Although there are variations from place to place, in most of the world architects are required to register with the appropriate jurisdiction. To do so, architects are typically required to meet three common requirements: education, experience, and examination.

Educational requirements generally consist of university degree in architecture. The experience requirement for degreed candidates is usually satisfied by a practicum or internship (usually two to three years, depending on jurisdiction). Finally, a Registration Examination or a series of exams is required prior to licensure.

Professionals engaged in the design and supervision of construction projects prior to the late 19th century were not necessarily trained in a separate architecture program in an academic setting. Instead, they often trained under established architects. Prior to modern times, there was no distinction between architects, engineers and often artists, and the title used varied depending on geographical location. They often carried the title of master builder, or surveyor, after serving a number of years as an apprentice (such as Sir Christopher Wren). The formal study of architecture in academic institutions played a pivotal role in the development of the profession as a whole, serving as a focal point for advances in architectural technology and theory.

Professional Title Distinctions

According to the American Institute of Architects, titles and job descriptions within American architectural offices might be as follows:

- **Senior Principal / Partner**: Typically an owner or majority shareholder of the firm; may be the founder; titles may include president, chief executive officer, or managing principal/partner.
- **Mid-level Principal / Partner**: Principal or partner; titles may include executive or senior vice president.
- **Junior Principal / Partner**: Recently made a partner or principal of the firm; title may include vice president.
- **Department head / Senior Manage**r: Senior management architect or non-registered graduate; responsible for major department(s) or functions; reports to a principal or partner.
- **Project Manager**: Licensed architect, or non-registered graduate with more than 10 years of experience; has overall project management responsibility for a variety of projects or project teams, including client contact, scheduling, and budgeting.
- **Senior Architect / Designer**: Licensed architect, or non-registered graduate with more than 10 years of experience; has a design or technical focus and is responsible for significant project activities.
- **Architect / Designer III**: Licensed architect or non-registered graduate with 8–10 years of experience; responsible for significant aspects of projects.
- **Architect / Designer II**: Licensed architect or non-registered graduate with 6–8 years of experience, responsible for daily design or technical development of projects.
- **Architect / Designer I**: Recently licensed architect or non-registered graduate with 3–5 years of experience; responsible for particular parts of a project within parameters set by others.
- **Intern-Architect**: Unlicensed architecture school graduate participating in defined internship program; develops design or technical solutions under supervision of an architect.

Architect's Fees

Architects' fee structures are typically based on a percentage of construction value, hourly rates or a fixed lump sum fee. Combinations of these structures are also common. Fixed fees are usually based on an a project's allocated construction cost and can range between 2 and 12% of new construction cost, depending on a project's size and complexity. Renovation projects typically command higher percentages, as high as 15-20%.

Overall billings for architectural firms range widely, depending on location and economic climate. Billings have traditionally been dependent on the local economic conditions but, with rapid globalization, this is becoming less of a factor for larger international firms. Salaries also vary, depending on experience, position within the firm (staff architect, partner or shareholder, etc.) and the size and location of the firm.

Professional organizations

Refer to the international list of professional architecture organizations for groups created to promote career and business development in architecture. A wide variety of prizes are awarded to architects to acknowledge superior buildings, structures and professional careers.

Prizes, Awards, and Titles

The most lucrative award an architect can receive is the Pritzker Prize, sometimes termed the "Nobel Prize for architecture." Other prestigious architectural awards are the Aga Khan Award for Architecture, the Richard H. Driehaus Prize for Classical Architecture, the Alvar Aalto Medal (Finland), the Carlsberg Architecture Prize (Denmark), and the Governor General's Awards (Canada). Other awards for excellence in architecture are given by national professional associations such as the American Institute of Architects (AIA), the Royal Institute of British Architects (RIBA), and the Royal Architectural Institute of Canada (RAIC).

Architects in the UK who have made contributions to the profession through design excellence or architectural education, or have in some other way advanced the profession, are elected Fellows of the Royal Institute of British Architects and can write FRIBA after their name if they feel so inclined. Architects in the USA who have made contributions to the profession through design excellence or architectural education, or have in some other way advanced the profession, are elected Fellows of the American Institute of Architects and can write FAIA after their name. Architects in Canada who have made outstanding contributions to the profession through contribution to research, scholarship, public service or professional standing to the good of architecture in Canada, or elsewhere, may be recognized as a Fellow of the Royal Architectural Institute of Canada and can write FRAIC after their name.

Chapter- 2

Stonemasonry

Stonemason working on a fountain with pneumatic tools

The craft of **stonemasonry** has existed since the dawn of civilization - creating buildings, structures, and sculpture using stone from the earth. These materials have been used to construct many of the long-lasting, ancient monuments, artifacts, cathedrals, and cities in a wide variety of cultures. Famous products of stonemasonry include the Taj Mahal, Cusco's Incan Wall, Easter Island's statues, the Egyptian Pyramids, Angkor Wat, Borobudur, Tihuanaco, Tenochtitlan the Iranian Persepolis, the Greek Parthenon, Stonehenge, and Chartres Cathedral.

Definition

Typical Aberdeen city street showing the widespread use of local granite

19th Century Colonial Secretary's Office in Sydney, Australia constructed of typical Sydney sandstone

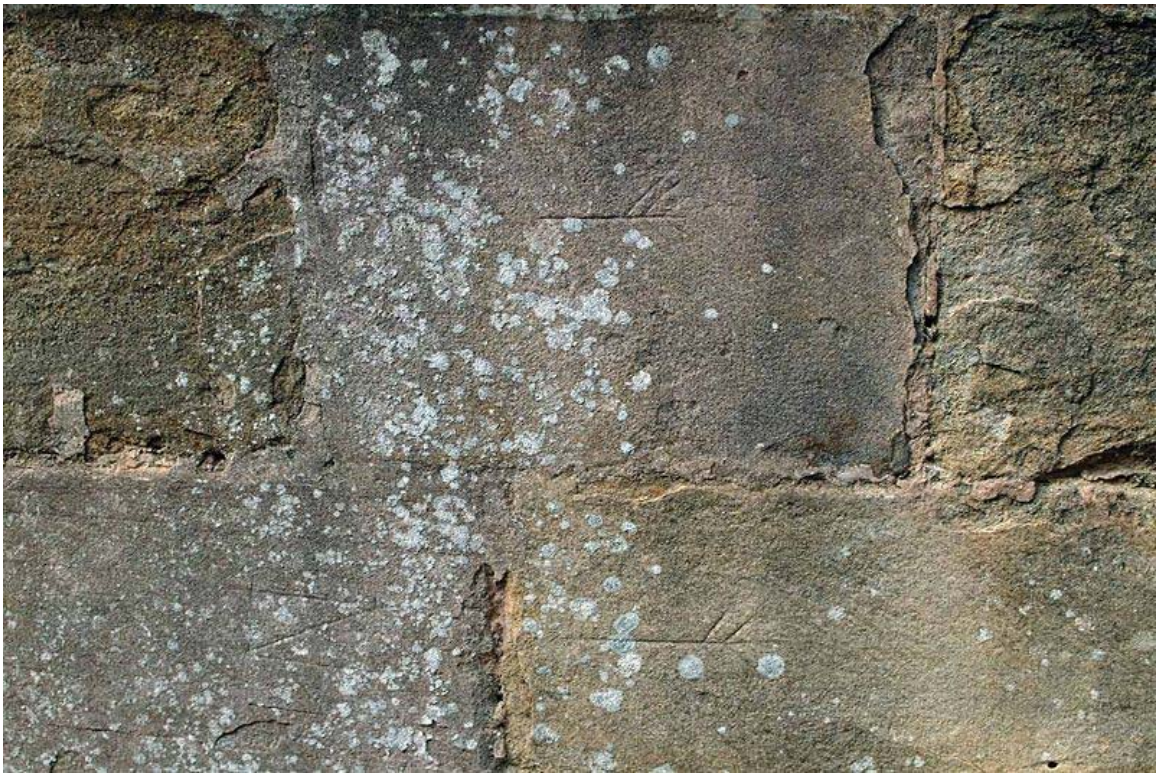
Stonemasonry is the craft of shaping rough pieces of rock into accurate geometrical shapes, mostly simple, but some of considerable complexity and then arranging the resulting stones, often together with mortar, to form structures.

- **Quarrymen** split the rock, and extract the resulting blocks of stone from the ground.
- **Sawyers** cut these rough blocks into cubes, to required size with diamond-tipped saws.
- **Banker masons** are workshop based, and specialize in carving stones into intricate geometrical shapes required by a building's design. They can produce

anything from stones with simple chamfers to tracery windows, detailed mouldings and the more classical architectural building masonry. When working a stone from a sawn block, the mason ensures that the stone is bedded in the right way, so the finished work sits in the building in the same orientation as it was formed on the ground. The basic tools, methods and skills of the banker mason have existed as a trade for thousands of years.

- **Carvers** cross the line from craft to art, and use their artistic ability to carve stone into foliage, figures, animals or abstract designs.
- **Fixer masons** specialize in the fixing of stones onto buildings, using lifting tackle, and traditional lime mortars and grouts. Sometimes modern cements, mastics and epoxy resins are used, usually on specialist applications such as stone cladding. Metal fixings, from simple dowels and cramps to specialised single application fixings, are also used. The precise tolerances necessary make this a highly skilled job.
- **Memorial masons** or **monumental masons** carve gravestones and inscriptions.

An apprentice carving a block



Three different stonemason's marks, which can be seen in the Chapter House of Fountains Abbey

The modern stonemason undergoes comprehensive training, both in the classroom and in the working environment. Hands-on skill is complimented by intimate knowledge of each stone type, its application and best uses, and how to work and fix each stone in place. The mason may be skilled and competent to carry out one or all of the various branches of stonemasonry. In some areas the trend is towards specialization, in other areas towards adaptability.

Types of stone

A stonemason at Eglinton Tournament bridge with a selection of tools of the trade

A stonemason's stone workbench from the 1845 Eglinton Tournament bridge construction

Stonemasons use all types of natural stone: igneous, metamorphic and sedimentary; while some also use artificial stone as well.

Igneous stones

Granite is one of the hardest stones, and requires such different techniques to sedimentary stones that it is virtually a separate trade. With great persistence, simple mouldings can and have been carved into granite, for example in many Cornish churches and the city of Aberdeen. Generally, however, it is used for purposes that require its strength and durability, such as kerbstones, countertops, flooring, and breakwaters.

Igneous stone ranges from very soft rocks such as pumice and scoria to somewhat harder rocks such as tuff and hard rocks such as obsidian, granite and basalt.

Metamorphic

Marble has traditionally been used for carving statues, and for facing many Byzantine and Renaissance Italian buildings. The traditional home of the marble industry is the area around Carrara in Italy, from where a bright white marble is extracted in vast quantities.

Slate is a popular choice of stone for memorials and inscriptions, as its fine grain and hardness means it leaves details very sharp. Meanwhile, its tendency to split into thin plates has made it a popular roofing material.

Typical French chisels with wooden hilt, used for soft limestone

A French stonemason using a straightedge and chisels

Sedimentary

Many of the world's most famous buildings have been built of sedimentary stone, from Durham Cathedral to St Peter's in Rome. There are two main types of sedimentary stone used in masonry work, limestones and sandstones. Examples of limestones include Bath and Portland stone. Yorkstone and Sydney sandstone are well-known sandstones.

Types of stonemasonry

Types of stonemasonry are:

- Rubble Masonry

  When roughly dressed stones are laid in a mortar the result is a stone rubble masonry.

- Ashlar Masonry

  Well arranged and cut stones set in mortar.

Splitting a block of marble with plug and feathers

Stonemason's mallets of plastic, beechwood and steel

Training

Traditionally medieval stonemasons served a seven-year apprenticeship. A similar system still operates today.

A modern apprenticeship lasts four years. This combines on-site learning through personal experience, the experience of the tradesmen and college work where apprentices are given an overall experience of the building, hewing and theory work involved in masonry. In some areas colleges offer courses which teach not only the manual skills but also related fields such as drafting and blueprint reading or construction conservationism. Electronic Stonemasonry training resources enhance traditional delivery techniques. Hands-on workshops are a good way to learn about stonemasonry also. Those wishing to become stonemasons should have little problem working at heights, possess reasonable hand-eye co-ordination, be moderately physically fit, and have basic mathematical ability. Most of these things can be developed while learning.

Tools

The foreground tool with serrated blades is a cockscomb, cock's comb or stonemason's drag, used on soft limestone

Stonemasons use a wide variety of tools to handle and shape stone blocks (ashlar) and slabs into finished articles. The basic tools for shaping the stone are a mallet, chisels, and a metal straight edge. With these one can make a flat surface - the basis of all stone masonry.

Chisels come in a variety of sizes and shapes, dependent upon the function for which they are being used. There are different chisels for different materials and sizes of material being worked, for removing large amounts of material and for putting a fine finish on the stone.

Mixing mortar is normally done today with mortar mixers which usually use a rotating drum or rotating paddles to mix the mortar.

The masonry trowel is used for the application of the mortar between and around the stones as they are set into place. Filling in the gaps (joints) with mortar is referred to as pointing. Pointing in smaller joints can be accomplished using tuck pointers, pointing trowels, and margin trowels, among other tools.

At least one tool bears the name of the tradesmen that use it, and that is the Stonemason's hammer. This hammer can be used in place of a chisel in certain circumstances. The

hammer can also be used to make shims and chinks while holding a small stone in one hand and striking it with the hammer.

Stonemasons use a Lewis together with a crane or winch to hoist building stones into place.

Today power tools such as compressed-air chisels, abrasive spinners and angle grinders are much used: these save time and money, but are hazardous and require just as much skill as the hand tools that they augment. But many of the basic tools of stonemasonry have remained virtually the same throughout vast amounts of time, even thousands of years.

History

Stonemasonry is one of the earliest trades in civilisation's history. During the time of the Neolithic Revolution and domestication of animals, people learned how to use fire to create quicklime, plasters, and mortars. They used these to fashion homes for themselves with mud, straw, or stone, and masonry was born.

The Ancients heavily relied on the stonemason to build the most impressive and long lasting monuments to their civilizations. The Egyptians built their pyramids, the civilizations of Central American had their step pyramids, the Persians their palaces, the Greeks their temples, and the Romans their public works and wonders. Among the famous ancient stonemasons is Sophroniscus, the father of Socrates, who was a stone-cutter.

Castle building was an entire industry for the medieval stonemasons. When the Western Roman Empire fell, building in dressed stone decreased in much of Western Europe, and there was a resulting increase in timber-based construction. Stone work experienced a resurgence in the 9th and 10th centuries in Europe, and by the 12th century religious fervour resulted in the construction of thousands of impressive churches and cathedrals in stone across Western Europe.

Bavarian stonemasons, c. 1505

Medieval stonemasons' skills were in high demand, and members of the guild, gave rise to three classes of stonemasons: apprentices, journeymen, and master masons. Apprentices were indentured to their masters as the price for their training, journeymen had a higher level of skill and could go on journeys to assist their masters, and master masons were considered freemen who could travel as they wished to work on the projects of the patrons. During the Renaissance, the stonemason's guild admitted members who were not stonemasons, and eventually evolved into the Society of Freemasonry; fraternal groups which observe the traditional culture of stonemasons, but are not typically involved in modern construction projects.

A medieval stonemason would often carve a personal symbol onto their block to differentiate their work from that of other stonemasons. This also provided a simple ‘quality assurance’ system.

The Renaissance saw stonemasonry return to the prominence and sophistication of the Classical age. The rise of the Humanist philosophy gave people the ambition to create

marvelous works of art. The centre stage for the Renaissance would prove to be Italy, where city-states such as Florence erected great structures, including the Cathedral of Santa Maria del Fiore, the Fountain of Neptune, and the Laurentian Library which was planned and built by Michelangelo Buonarroti, a famous stonemason of the Renaissance.

When Europeans settled the Americas, they brought the stonemasonry techniques of their respective homelands with them. Settlers used what materials were available, and in some areas stone was the material of choice. In the first waves, building mimicked that of Europe, to eventually be replaced by unique architecture later on.

In the 20th century, stonemasonry saw its most radical changes in the way the work is accomplished. Prior to the first half of the century, most heavy work was executed by draft animals or human muscle power. With the arrival of the internal combustion engine, many of these hard aspects of the trade have been made simpler and easier. Cranes and forklifts have made moving and laying heavy stones relatively easy for the stonemasons. Motor powered mortar mixers have saved much in time and energy as well. Compressed-air powered tools have made working of stone less time-intensive. Petrol and electric powered abrasive saws can cut through stone much faster and with more precision than chiseling alone. Carbide-tipped chisels can stand up to much more abuse than the steel and iron chisels made by blacksmiths of old.

Chapter- 3

Fashion Design

Finale of fashion show, 2009

Fashion design is the art of the application of design and aesthetics or natural beauty to clothing and accessories. Fashion design is influenced by cultural and social attitudes, and has varied over time and place. Fashion designers work in a number of ways in designing clothing and accessories. Some work alone or as part of a team. They attempt to satisfy consumer desire for aesthetically designed clothing; and, because of the time required to bring a garment onto the market, must at times anticipate changing consumer tastes. Some designers in fact have a reputation which enables them to set fashion trends.

Fashion designers attempt to design clothes which are functional as well as aesthetically pleasing. They must consider who is likely to wear a garment and the situations in which it will be worn. They have a wide range and combinations of materials to work with and a

wide range of colors, patterns and styles to choose from. Though most clothing worn for everyday wear fall within a narrow range of conventional styles, unusual garments are usually sought for special occasions, such as evening wear or party dresses.

Some clothes are made specifically for an individual, as in the case of haute couture. Today, most clothing is designed for the mass market, especially casual and every-day wear.

Structure

Fashion designers can work in a number of ways. Fashion designers may work full-time for one fashion company, known as 'in-house designers' which owns the designs. They may work alone or as part of a team. Freelance designers work for themselves, selling their designs to fashion houses, directly to shops, or to clothing manufacturers. The garments bear the buyer's label. Some fashion designers set up their own labels, under which their designs are marketed. Some fashion designers are self-employed and design for individual clients. Other high-fashion designers cater to specialty stores or high-fashion department stores. These designers create original garments, as well as those that follow established fashion trends. Most fashion designers, however, work for apparel manufacturers, creating designs of men’s, women’s, and children’s fashions for the mass market. Large designer brands which have a 'name' as their brand such as Calvin Klein, Gucci, or Chanel are likely to be designed by a team of individual designers under the direction of a designer director.

Designing a garment

Fashion designers work in different ways. Some sketch their ideas on paper, while others drape fabric on a dress form. When a designer is completely satisfied with the fit of the *toile* (or muslin), he or she will consult a professional pattern maker who then makes the finished, working version of the pattern out of card. The pattern maker's job is very precise and painstaking. The fit of the finished garment depends on their accuracy. Finally, a sample garment is made up and tested on a model to make sure it is an operational outfit.

History

Fashion design is generally considered to have started in the 19th century with Charles Frederick Worth who was the first designer to have his label sewn into the garments that he created. Before the former draper set up his *maison couture* (fashion house) in Paris, clothing design and creation was handled by largely anonymous seamstresses, and high fashion descended from that worn at royal courts. Worth's success was such that he was able to dictate to his customers what they should wear, instead of following their lead as earlier dressmakers had done. The term *couturier* was in fact first created in order to describe him. While all articles of clothing from any time period are studied by

academics as costume design, only clothing created after 1858 could be considered as fashion design.

It was during this period that many design houses began to hire artists to sketch or paint designs for garments. The images were shown to clients, which was much cheaper than producing an actual sample garment in the workroom. If the client liked their design, they ordered it and the resulting garment made money for the house. Thus, the tradition of designers sketching out garment designs instead of presenting completed garments on models to customers began as an economy.

Types of fashion

The garments produced by clothing manufacturers fall into three main categories, although these may be split up into additional, more specific categories:

Haute couture

Until the 1950s, fashion clothing was predominately designed and manufactured on a made-to-measure or haute couture basis (French for high-fashion), with each garment being created for a specific client. A couture garment is made to order for an individual customer, and is usually made from high-quality, expensive fabric, sewn with extreme attention to detail and finish, often using time-consuming, hand-executed techniques. Look and fit take priority over the cost of materials and the time it takes to make.

Ready-to-wear

Ready-to-wear clothes are a cross between haute couture and mass market. They are not made for individual customers, but great care is taken in the choice and cut of the fabric. Clothes are made in small quantities to guarantee exclusivity, so they are rather expensive. Ready-to-wear collections are usually presented by fashion houses each season during a period known as Fashion Week. This takes place on a city-wide basis and occurs twice a year.

Mass market

Currently the fashion industry relies more on mass market sales. The mass market caters for a wide range of customers, producing ready-to-wear clothes in large quantities and standard sizes. Inexpensive materials, creatively used, produce affordable fashion. Mass market designers generally adapt the trends set by the famous names in fashion. They often wait around a season to make sure a style is going to catch on before producing their own versions of the original look. In order to save money and time, they use cheaper fabrics and simpler production techniques which can easily be done by machine. The end product can therefore be sold much more cheaply.

There is a type of design called "kutch" design originated from the German word "kitschen" meaning "ugly" or "not aesthetically pleasing." *Kitsch* can also refer to

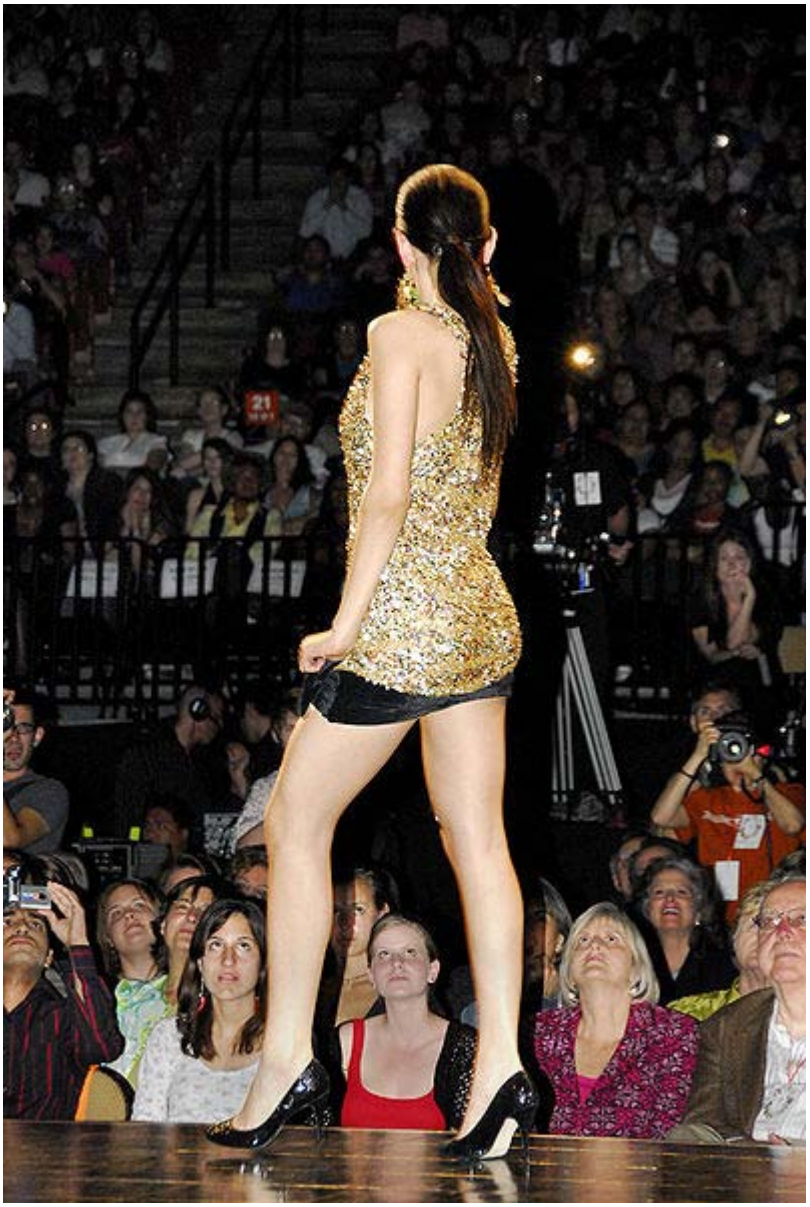
"wearing or displaying something that is therefore no longer in fashion." Often, high-waisted trousers, associated with the 1980s, are considered a "kitsch" fashion statement.

Income

Median annual wages for salaried fashion designers were $61,160 in May 2008. The middle 50 percent earned between $42,150 and $87,120. The lowest 10 percent earned less than $32,150, and the highest 10 percent earned more than $124,780. Median annual earnings were $52,860 (£28,340) in apparel, piece goods, and notions - the industry employing the largest numbers of fashion designers.

Fashion education

A classroom filled with sewing machines and mannequins



A student fashion show, 2007

There are a number of well known art schools and design schools world wide that offer degrees in fashion design and fashion design technology. Some colleges also offer Masters of Fashion courses. Though it is not a requirement to have a Masters level, it is recommended by those already working in the industry to study at this level. The most notable of design schools in Europe include Central Saint Martins College of Art and Design, London College of Fashion, University of Westminster and Kingston University in London, Limerick School of Art and Design and the National College of Art and Design in Ireland, Edinburgh College of Art in Scotland, Istituto Marangoni and Politecnico of Milan in Milan, the European third level education chain, Istituto Europeo di Design, University Iuav of Venice, the Fashion Federation PARIS] European Fashion Accreditation, Antwerp Fashion Academy in Belgium. There is Parsons The New School

for Design, Fashion Institute of Technology and the Pratt Institute in New York City. Elsewhere in the United States there is the Savannah College of Art and Design, Fashion Institute of Design & Merchandising in Los Angeles, School of the Art Institute of Chicago and Columbia College Chicago in Chicago. The National Institute of Fashion Technology in India, Shih Chien University in Hong Kong, RMIT University in Melbourne, Fu Jen Catholic University in Taiwan and the Asian University chain, Raffles College of Design and Commerce, all have reputable fashion design courses.

The only Ivy League University having a Fashion Design undergraduate program is Cornell University in Ithaca, NY. The program is offered by the department of Fiber Science & Apparel Design]. Cornell University also offers the only Ph.D. program in apparel design in the United States. The program is intended to address the needs of academia, industry and research by considering apparel design as an applied science that embraces design, technology, physical sciences, the humanities and social sciences in order to meet the human needs for clothing. There are many universities that offer fashion design throughout the United States. The major incorporating fashion design may have alternative names like Apparel and Textiles or Apparel and Textile Design and may be housed in departments such as Art and Art History or Family and Consumer Studies.

Areas of fashion design

(that is, has regular buyers and is well-known by both the trade and the public), it may decide to expand into a new area. If the firm has made a name for the clothes it already produces, this helps to sell the new line. It is usually safest for a company to expand into an area similar to the one it already knows. For example, a designer of women's sportswear might expand into men's sportswear. The chart below shows the areas in which many designers choose to specialize.

Area	Brief	Market
Women's Day wear	Practical, comfortable, fashionable	Haute couture, ready-to-wear, mass market
Women's Evening wear	Glamorous, sophisticated, apt for the occasion	Haute couture, ready-to-wear, mass market
Women's Lingerie	Glamorous, comfortable, washable	Haute Couture, ready-to-wear, mass market
Men's Day wear	Casual, practical, comfortable	Tailoring, ready-to-wear, mass market
Men's Evening wear	Smart, elegant, formal, apt for the occasion	Tailoring, ready-to-wear, mass market
Kidswear	Trendy or Classy, practical, washable, functional	Ready-to-wear, mass market
Girls' Wear	Pretty, colorful, practical, washable, inexpensive	Ready-to-wear, mass market
Teenager Girl	Colorful,comfortable,glamorous,pretty,	Ready-to-wear, mass

Wear		market
Sportswear	Comfortable, practical, well-ventilated, washable, functional	Ready-to-wear, mass market
Knitwear	Right weight and color for the season	Ready-to-wear, mass market
Outerwear	Stylish, warm, right weight and color for the season	Ready-to-wear, mass market
Bridal wear	Sumptuous, glamorous, classic	Haute couture, ready-to-wear, mass market
Accessories	Striking, fashionable	Haute couture, ready-to-wear, mass market

Star system

Designers work within a hierarchical system.

"The designers are most stratified in the French system of fashion [...] Fashion ensures the functioning of a system of dominant and subordinate positions within a social order. Fashion is ideological in that it is also part of the process in which particular social groups, in this case elite designers, establish, sustain and reproduce positions of power and relations of dominance and subordination. The positions of dominance and subordination appear natural and legitimate, not only to those in positions of dominance, but also to those in subordinate positions. Fashion and the medium of fashion, that is clothing, offer means to make inequalities of socioeconomic status appear legitimate, and, therefore, acceptable."

A "mythical conception of a designer as a 'creative genius' disconnected from social conditions" is central for the working of the fashion system and for the reproduction of fashion as ideology. Creativity is socially constructed and not an innate given, i.e. many may be gifted but no one can become a famous designer without being legitimized by the fashion system and its gatekeepers.

The star system is as essential for the fashion industry as for any Culture industry. "Genre and the star system are attempts to produce something analogous to brand names in cultural industries. [...] Stars are indispensable because it is part of the ideology of creativity that creative works must have an identifiable author."

World fashion industry

Fashion today is a global industry, and most major countries have a fashion industry. Some countries are major manufacturing centers, notably China, South Korea, Spain, Germany, Brazil, and India. Five countries have established an international reputation in fashion: France, Italy, the United Kingdom, the United States, and Japan.

American fashion design

The majority of American fashion houses are based in New York, although there are also a significant number in Los Angeles, where a substantial percentage of high fashion clothing manufactured in the US is actually made. There are also burgeoning industries in Miami, Chicago and especially San Francisco. American fashion design is dominated by a clean-cut, urban, casual style; reflecting the athletic, health-conscious lifestyles of American city-dwellers. A designer who helped to set the trend in the United States for sport-influenced day wear throughout the 1940s and 50's was Claire McCardell. Many of her designs have been revived in recent decades.

British fashion design

London has long been the capital of the UK fashion industry and has a wide range of foreign designs which have integrated with modern British styles. Typical British design is smart but innovative yet recently has become more and more unconventional, fusing traditional styles with modern techniques.

French fashion design

Most French fashion houses are in Paris, which is the capital of French fashion. Traditionally, French fashion is chic and stylish, defined by its sophistication, cut, and smart accessories. Although the Global Language Monitor placed it 3rd in the Media, after Milan and New York, French fashion is internationally acclaimed and Paris remains the symbolic home of fashion.

Italian fashion design

Milan is Italy's capital of fashion. Most of the older Italian couturiers are in Rome. However, Milan and Florence are the Italian fashion capitals, and it is the exhibition venue for their collections. Italian fashion features casual elegance and luxurious fabrics.

Swiss fashion design

Most of the Swiss fashion houses are in Zürich. The Swiss look is casual elegant and luxurious.

Japanese fashion design

Most Japanese fashion houses are in Tokyo. The Japanese look is loose and unstructured (often resulting from complicated cutting), colours tend to the sombre and subtle, and richly textured fabrics. Famous Japanese designers are Yohji Yamamoto, Kenzo, Issey Miyake (masterful drape and cut), and Comme des Garçons 's Rei Kawakubo, who developed a new way of cutting (comparable to Madeleine Vionnet's innovation in the 1930s).

Indian fashion design

Most of Indian fashion designers are born from bollywood industry.Fashion design from the south has also reached out pretty well.

Fashion design terms

- A **the fashion designer** conceives garment combinations of line, proportion, color, and texture. While sewing and pattern-making skills are beneficial, they are not a pre-requisite of successful fashion design. Most fashion designers are formally trained or apprenticed.
- A **pattern maker** (or *pattern cutter*) drafts the shapes and sizes of a garment's pieces. This may be done manually with paper and measuring tools or by using an AutoCAD computer software program. Another method is to drape fabric directly onto a dress form. The resulting pattern pieces can be constructed to produce the intended design of the garment and required size. Formal training is usually required for working as a pattern marker.
- A **tailor** makes custom designed garments made to the client's measure; especially suits (coat and trousers, jacket and skirt, et cetera). Tailors usually undergo an apprenticeship or other formal training.
- A **textile designer** designs fabric weaves and prints for clothes and furnishings. Most textile designers are formally trained as apprentices and in school.
- A **stylist** co-ordinates the clothes, jewelry, and accessories used in fashion photography and catwalk presentations. A stylist may also work with an individual client to design a coordinated wardrobe of garments. Many stylists are trained in fashion design, the history of fashion and historical costume, and have a high level of expertise in the current fashion market and future market trends. However, some simply have a strong aesthetic sense for pulling great looks together.
- A **fashion buyer** selects and buys the mix of clothing available in retail shops, department stores and chain stores. Most fashion buyers are trained in business and/or fashion studies.
- A **seamstress** sews ready to wear or mass produced clothing by hand or with a sewing machine, either in a garment shop or as a sewing machine operator in a factory. She (or he) may not have the skills to make (design and cut) the garments, or to fit them on a model.
- A **teacher of fashion design** teaches the art and craft of fashion design in art or fashion school.
- A **custom clothier** makes custom-made garments to order, for a given customer.
- A **dressmaker** specializes in custom-made women's clothes: day, cocktail, and evening dresses, business clothes and suits, trousseaus, sports clothes, and lingerie.
- An **illustrator** draws and paints clothing designs for commercial use.
- A **fashion forecaster** predicts what colours, styles and shapes will be popular ("on-trend") before the garments are on sale in stores.
- A **model** wears and displays clothes at fashion shows and in photographs.

- A **fit model** aids the fashion designer by wearing and commenting on the fit of clothes during their design and pre-manufacture. Fit models need to be a particular size for this purpose.
- A **fashion journalist** writes fashion articles describing the garments presented or fashion trends, for magazines or newspapers.
- An **alterations specialist** (**alterationist**) adjusts the fit of completed garments, usually ready-to-wear, and sometimes re-styles them. NOTE: despite tailors altering garments to fit the client, not all alterationists are tailors.
- An **Image Consultant**, **wardrobe consultant** or **fashion advisor** recommends styles and colors that are flattering to the client.

Costume design

Historical costumes of Le Cateau Cambrésis, France

Costume design is the fabrication of apparel for the overall appearance of a character or performer. This usually involves researching, designing and building the actual items from conception. Costumes may be for a theater or cinema performance but may not be limited to such. Costume design should not be confused with Costume coordination which merely involves altering existing clothing.

Four types of costumes are used in theatrical design, Historical, fantastic, dance, and modern.

Designs are first sketched out and approved, then either draped on a form or a pattern drafted. Along with the fabricated portion, the costume may require accessories such as footwear, hats and head dresses for the actors to wear, but it may also include designing masks, makeup, wigs, underwear or other unusual specialty items, such as the full body animal suits for the characters in the musical *Cats* (designed by John Napier, winner of the 1983 Tony Award for Best Costume Design). Costumes budgets will generally be as high a cost as other departments or theatrical needs such as set design.

History

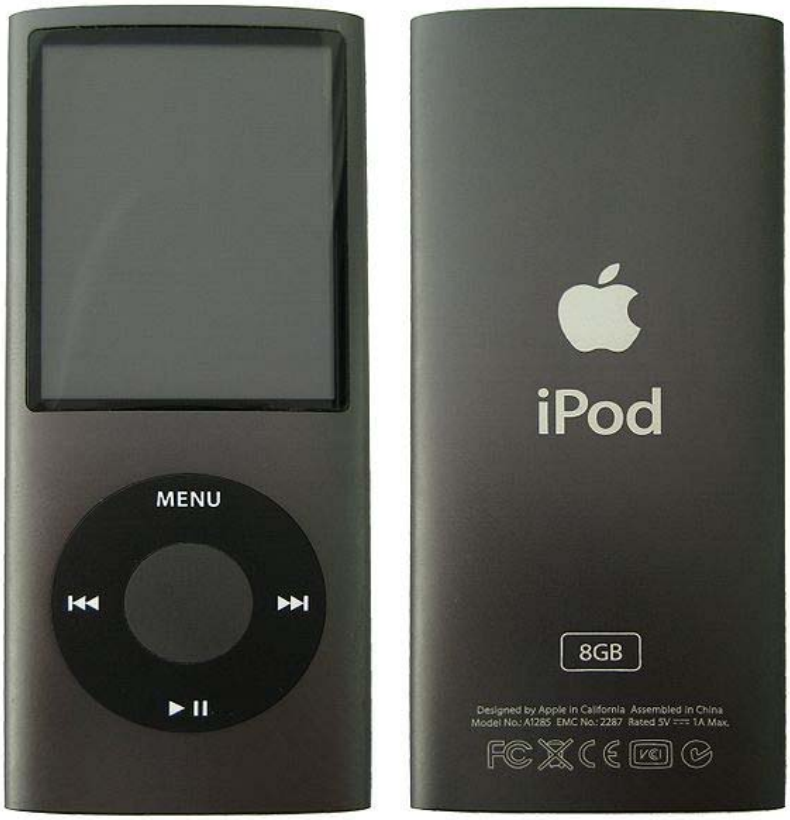
Costume design for Gianetta - The Gondoliers

In its earliest form, costumes consisted of theatrical prop masks from the time of the ancient Greeks. Costume design evolved as the need for more elaborate and detailed characterizations were needed as the performances became more intricate and more complex characters began to emerge on stage. Defining each character separately allowing the audience the ability to follow a storyline with a conceptualised look defined prior to a performance was, and is needed as part of preproduction preparations.

Early performers were generally male, therefore costuming was needed for gender disguise so as to create the illusion of the opposite sex. In Asia, the men would dress up as women. Costuming also helps create other character building imagery such as age. The leading characters will have more detail and design to make them stand out and relate a sense of trust to the audience. Styles and technique has changed over the centuries but have maintained basic principles of clothing design yet geared towards pushing the characters traits out in its appearance. The designer meets the cast, measuring each performer and making certain that the costumes will be appropriate for each individual.

Chapter- 4

Industrial Design



An iPod, an industrially designed product

KitchenAid 5 qt. Stand Mixer, designed in 1937 by Egmont Arens, remains very successful today

Industrial design is a combination of applied art and applied science, whereby the aesthetics, ergonomics and usability of products may be improved for marketability and production. The role of an industrial designer is to create and execute design solutions towards problems of form, usability, physical ergonomics, marketing, brand development and sales.

The term "industrial design" is often attributed to the designer Joseph Claude Sinel in 1919 (although he himself denied it in later interviews) but the discipline predates that by at least a decade. Its origins lay in the industrialization of consumer products. For instance the Deutscher Werkbund, founded in 1907 and a precursor to the Bauhaus, was a state-sponsored effort to integrate traditional crafts and industrial mass-production techniques, to put Germany on a competitive footing with England and the United States.

Definition of industrial design

Western Electric model 302 Telephone, found almost universally in the United States from 1937 until the introduction of touch-tone dialing, as the Family's life was extended into the 1960s

General

The objective of this area is to study both function and form, and the connection between product and the user - product as it happens in any other architecture area, being the only difference, that here the professionals that participate in the process are all specialized in small scale design, rather than in other massive colossal equipments like buildings or ships. Architects do not design the gears or motors that make machines move, or the circuits that control the movement (that task is usually attributed to engineers), but they can affect technical aspects through usability design and form relationships. And usually, they partner a whole of other professionals like marketers, to identify and fulfill needs, wants and expectations.

In Depth

"Industrial Design (ID) is the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer".

Design, itself, is often difficult to define to non-designers because the meaning accepted by the design community is not one made of words. Instead, the definition is created as a result of acquiring a critical framework for the analysis and creation of artifacts. One of the many accepted (but intentionally unspecific) definitions of design originates from Carnegie Mellon's School of Design, "Design is the process of taking something from its existing state and moving it to a preferred state." This applies to new artifacts, whose existing state is undefined, and previously created artifacts, whose state stands to be improved.

According to the Chartered Society of Designers, design is a force that delivers innovation that in turn has exploited creativity. Their design framework known as the Design Genetic Matrix determines a set of competences in 4 key genes that are identified to define the make up of designers and communicate to a wide audience what they do. Within these genes the designer demonstrates the core competences of a designer and specific competences determine the designer as an 'industrial designer'. This is normally within the context of delivering innovation in the form of a three dimensional product that is produced in quantity. However the definition also extends to products that have been produced using an industrial process.

According to the ICSID (International Council of Societies of Industrial Design), "Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange."

It is critical to the product development process that the industrial design and engineering aspects of a product are considered simultaneously. This can occur via two methods. The most streamlined method is for the product designer to have an education and/or background that encompasses both industrial design and engineering. Unfortunately, there are very few educational establishments (especially in the United States) that embrace this educational ideology. A survey of engineering and industrial design curricula clearly demonstrates this fault. The other method, which is utilized by most U.S. companies, is to employ or contract with separate teams that focus somewhat independently, with occasional meetings to ensure the primary goals of each team are met or exceeded. The difficulty with the latter process is that there is sometimes a vast disconnect behind the skills, education, and understanding of the two groups. This disconnect can sometimes become extremely cumbersome to the design process, and possibly fatal to the ultimate success of the product.

Process of design

A Fender Stratocaster with sunburst finish, one of the most widely recognized electric guitars in the world.

Model 1300 Volkswagen Beetle

Although the process of design may be considered 'creative', many analytical processes also take place. In fact, many industrial designers often use various design methodologies in their creative process. Some of the processes that are commonly used are user research, sketching, comparative product research, model making, prototyping and testing. These processes can be chronological, or as best defined by the designers and/or other team members. Industrial designers often utilize 3D software, computer-aided industrial design and CAD programs to move from concept to production. Product characteristics specified by the industrial designer may include the overall form of the object, the location of details with respect to one another, colors, texture, sounds, and aspects concerning the use of the product ergonomics. Additionally the industrial designer may specify aspects concerning the production process, choice of materials and the way the product is presented to the consumer at the point of sale. The use of industrial designers in a product development process may lead to added values by improved usability, lowered production costs and more appealing products. However, some classic industrial designs are considered as much works of art as works of engineering: the iPod, the Jeep, the Fender Stratocaster, the Coke bottle, and the VW Beetle are frequently cited examples.

Industrial design also has a focus on technical concepts, products and processes. In addition to considering aesthetics, usability, and ergonomics, it can also encompass the engineering of objects, usefulness as well as usability, market placement, and other concerns such as seduction, psychology, desire, and the emotional attachment of the user to the object. These values and accompanying aspects on which industrial design is based can vary, both between different schools of thought and among practicing designers.

Product design and industrial design can overlap into the fields of user interface design, information design and interaction design. Various schools of industrial design and/or product design may specialize in one of these aspects, ranging from pure art colleges (product styling) to mixed programs of engineering and design, to related disciplines like

exhibit design and interior design, to schools where aesthetic design is almost completely subordinated to concerns of function and ergonomics of use (the so-called *functionalist* school).

Also used to describe a technically competent product designer or industrial designer is the term *Industrial Design Engineer*. The Cyclone vacuum cleaner inventor James Dyson for example could be considered to be in this category.

Industrial design rights

Industrial design rights are intellectual property rights that make exclusive the visual design of objects that are not purely utilitarian. An industrial design consists of the creation of a shape, configuration or composition of pattern or color, or combination of pattern and color in three dimensional form containing aesthetic value. An industrial design can be a two- or three-dimensional pattern used to produce a product, industrial commodity or handicraft. Under the Hague Agreement Concerning the International Deposit of Industrial Designs, a WIPO-administered treaty, a procedure for an international registration exists. An applicant can file for a single international deposit with WIPO or with the national office in a country party to the treaty. The design will then be protected in as many member countries of the treaty as desired.

Notable industrial designers

A number of industrial designers have made such a significant impact on culture and daily life that they have attained a level of notability beyond that of an average designer. Alvar Aalto, renowned as an architect, also designed a significant number of household items, such as chairs, stools, lamps, a tea-cart, and vases. Raymond Loewy was a prolific American designer who is responsible for the Royal Dutch Shell corporate logo, the original BP logo (in use until 2000), the PRR S1 steam locomotive, the Studebaker Starlight (including the later iconic bulletnose), as well as Schick electric razors, Electrolux refrigerators, short-wave radios, Le Creuset French ovens, and a complete line of modern furniture, among many other items. Richard A. Teague, who spent most of his career with the American Motor Company, originated the concept of using interchangeable body panels so as to create a wide array of different vehicles using the same stampings. He was responsible for such unique automotive designs as the Pacer, Gremlin, Matador coupe, Jeep Cherokee, and the complete interior of the Eagle Premier. Viktor Schreckengost designed bicycles manufactured by Murray bicycles for Murray and Sears, Roebuck and Company. With engineer Ray Spiller, he designed the first truck with a cab-over-engine configuration, a design in use to this day. Schreckengost also founded The Cleveland Institute of Art's school of industrial design. Charles and Ray Eames were most famous for their unique furniture design, such as the Eames Lounge Chair Wood and Eames Lounge Chair.

Another example is German industrial designer Dieter Rams, who is closely associated with the consumer products company Braun (where he worked until 1995) and the

Functionalist school of industrial design. He is famous for his "ten principles to good design", in addition to designing many iconic products at Braun. More recently, Jonathan Ive, the Senior Vice President of Design at Apple Inc., is credited for designing products for the company, which has a strong philosophy in aesthetics. His designs include the iPod and iPhone.

3D printing

3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. 3D printers are generally faster, more affordable and easier to use than other additive manufacturing technologies. 3D printers offer product developers the ability to print parts and assemblies made of several materials with different mechanical and physical properties in a single build process. Advanced 3D printing technologies yield models that closely emulate the look, feel and functionality of product prototypes.

A 3D printer works by taking a 3D computer file and using and making a series of cross-sectional slices. Each slice is then printed one on top of the other to create the 3D object.

Since 2003 there has been large growth in the sale of 3D printers. Additionally, the cost of 3D printers has declined. The technology also finds use in the jewellery, footwear, industrial design, architecture, engineering and construction (AEC), automotive, aerospace, dental and medical industries.

Methods

A large number of competing technologies are available to do 3D printing. Their main differences are found in the way layers are built to create parts. Some methods use melting or softening material to produce the layers (SLS, FDM) where others lay liquid materials that are cured with different technologies. In the case of lamination systems, thin layers are cut to shape and joined together.

A comparison of two ceramic art objects. The original was created by John Balistreri and then duplicated using a 3D Scanner and printed using 3D Ceramic Rapid Prototyping.

Each method has its advantages and drawbacks, and consequently some companies offer a choice between powder and polymer as the material from which the object emerges. Generally, the main considerations are speed, cost of the printed prototype, cost of the 3D printer, choice of materials, colour capabilities, etc.

One method of 3D printing consists of an inkjet printing system. The printer creates the model one layer at a time by spreading a layer of powder (plaster, or resins) and inkjet printing a binder in the cross-section of the part. The process is repeated until every layer is printed. This technology is the only one that allows for the printing of full colour prototypes. This method also allows overhangs. It is also recognized as the fastest method.

In DLP, or Digital Light Processing, a vat of liquid polymer is exposed to light from a DLP projector under safelight conditions. The exposed liquid polymer hardens. The build plate then moves down in small increments and the liquid polymer is again exposed to

light. The process repeats until the model is built. The liquid polymer is then drained from the vat, leaving the solid model. The ZBuilder Ultra is an example of a DLP rapid prototyping system.

Fused deposition modeling (FDM), a technology developed by Stratasys that is used in traditional rapid prototyping, uses a nozzle to deposit molten polymer onto a support structure, layer by layer.

Another approach is selective fusing of print media in a granular bed. In this variation, the unfused media serves to support overhangs and thin walls in the part being produced, reducing the need for auxiliary temporary supports for the workpiece. Typically a laser is used to sinter the media and form the solid. Examples of this are SLS (Selective laser sintering) and DMLS (Direct Metal Laser Sintering), using metals.

Finally, ultra-small features may be made by the 3D microfabrication technique of 2-photon photopolymerization. In this approach, the desired 3D object is traced out in a block of gel by a focused laser. The gel is cured to a solid only in the places where the laser was focused, due to the nonlinear nature of photoexcitation, and then the remaining gel is washed away. Feature sizes of under 100 nm are easily produced, as well as complex structures such as moving and interlocked parts.

Unlike stereolithography, inkjet 3D printing is optimized for speed, low cost, and ease-of-use, making it suitable for visualizing during the conceptual stages of engineering design through to early-stage functional testing. No toxic chemicals like those used in stereolithography are required, and minimal post printing finish work is needed; one need only to use the printer itself to blow off surrounding powder after the printing process. Bonded powder prints can be further strengthened by wax or thermoset polymer impregnation. FDM parts can be strengthened by wicking another metal into the part.

In 2006, John Balistreri and others at Bowling Green State University began research into 3D Rapid Prototyping machines, creating printed ceramic art objects. This research has led to the invention of ceramic powders and binder systems that enable clay material to be printed from a computer model and then fired for the first time.

Resolution

Resolution is given in layer thickness and X-Y resolution in dpi. Typical layer thickness is around 100 micrometres (0.1 mm), while X-Y resolution is comparable to that of laser printers. The particles (3D dots) are around 50 to 100 micrometres (0.05-0.1 mm) in diameter.

Applications

An example of real object replication by means of 3D scanning and 3D printing: the gargoyle model on the left was digitally acquired by using a 3D scanner and the produced 3D data was processed using MeshLab. The resulting digital 3D model, shown on the laptop's screen, was used by a rapid prototyping machine to create a real resin replica of the original object

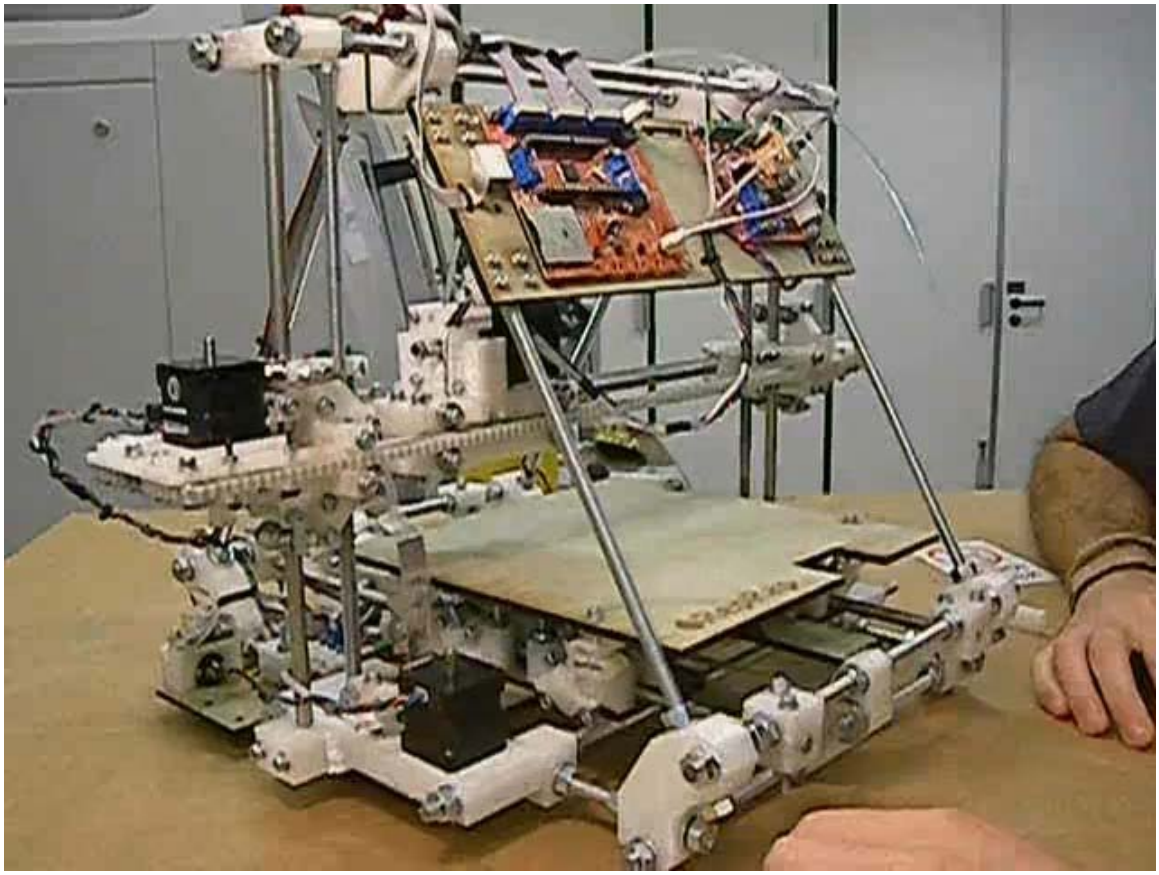
Standard applications include design visualization, prototyping/CAD, metal casting, architecture, education, geospatial, healthcare, entertainment/retail, etc. Other applications would include reconstructing fossils in paleontology, replicating ancient and priceless artifacts in archaeology, reconstructing bones and body parts in forensic pathology and reconstructing heavily damaged evidence acquired from crime scene investigations.

More recently, the use of 3D printing technology for artistic expression has been suggested. Artists have been using 3D printers in various ways.

3D printing technology is currently being studied by biotechnology firms and academia for possible use in tissue engineering applications where organs and body parts are built using inkjet techniques. Layers of living cells are deposited onto a gel medium and slowly built up to form three dimensional structures. Several terms have been used to refer to this field of research: Organ printing, bio-printing, and computer-aided tissue engineering among others. 3D printing can produce a personalised hip replacement in one pass, with the ball permanently inside the socket, and even at current printing resolutions the unit will not require polishing.

The use of 3D scanning technologies allow the replication of real objects without the use of molding techniques, that in many cases can be more expensive, more difficult, or too invasive to be performed; particularly with precious or delicate cultural heritage artifacts where the direct contact of the molding substances could harm the surface of the original object.

Home 3D Printers



RepRap version 2.0 (Mendel)

There have been several, often related efforts to develop 3D printers suitable for desktop use, and to make this technology available at price points affordable to many individual end-users. Much of this work was driven by and targeted on DIY/enthusiast/early adopter communities, with links to both the academic and hacker communities.

- RepRap is a project that aims to produce a FLOSS 3D printer, whose full specifications are released under the GNU General Public License, and which can print a copy of itself. As of November 2010, the RepRap can only print plastic parts. Research is under way to let the device print circuit boards too, as well as metal parts.

Prototyping technologies and their base materials

1. Selective laser sintering (SLS): Thermoplastics, metals, sand, glass
2. Fused Deposition Modeling (FDM): Thermoplastics
3. Stereolithography (SL): Photopolymer
4. Laminated object manufacturing: Laminate Sheets (often paper) and glue
5. Electron Beam Melting (EBM): Titanium alloys
6. 3D Printing (3DP): Various materials, including resins
7. 3D Ceramic Printing: Various clay and ceramic materials

Chapter- 5

Interior Design

An electric wire reel reused like a center table in a Rio de Janeiro decoration fair. The reuse of materials is a very sustainable practice that is rapidly growing among designers in Brazil

Interior design is a multi–faceted profession in which creative and technical solutions are applied within a structure to achieve a built interior environment.

The interior design process follows a systematic and coordinated methodology, including research, analysis, and integration of knowledge into the creative process, whereby the needs and resources of the client are satisfied to produce an interior space that fulfills the project goals.

Working conditions

There are a wide range of working conditions and employment opportunities within interior design. Large and tiny corporations often hire interior designers as employees on regular working hours. Designers for smaller firms usually work on a contract or per-job basis. Self-employed designers, which make up 26% of interior designers, usually work the most hours. Interior designers often work under stress to meet deadlines, stay on budget, and meet clients' needs. In some cases, licensed professionals review the work and sign it before submitting the design for approval by clients or construction permisioning. The need for licensed review and signature varies by locality, relevant legislation, and scope of work. Their work can involve significant travel to visit different locations, however with technology development, the process of contacting clients and communicating design alternatives has become easier and requires less travel.

Earnings

Interior design earnings vary based on employer, number of years with experience, and the reputation of the individual. For residential projects, self-employed interior designers usually earn a per-hour fee plus a percentage of the total cost of furniture, lighting, artwork, and other design elements. For commercial projects, they may charge per-hour fees, or a flat fee for the whole project. The median annual earning for wage and salary interior designers, in the year 2006, was $42,260. The middle 50% earned between $31,830 and $57,230. The lowest 10 percent earned less than $24,270, and the highest 10 percent earned more than $78,760. For example, if a person opens a business and decides to specialize in furniture design and flooring, they will get only clients focusing on these topics rather than a variety of every type of issue that comes with designing a home.

Interior styles

Contemporary style design at Expo Design MAP (2007)

A style, or theme, is a consistent idea used throughout a room to create a feeling of completeness. Styles are not to be confused with design concepts, or the higher-level party, which involve a deeper understanding of the architectural context, the socio-cultural and the programmatic requirements of the client. These themes often follow period styles. Examples of this are Louis XV, Louis XVI, Victorian, Islamic, Feng Shui, International, Mid-Century Modern, Minimalist, English Georgian, Gothic, Indian Mughal, Art Deco, and many more.

The evolution of interior decoration themes has now grown to include themes not necessarily consistent with a specific period style allowing the mixing of pieces from different periods. Each element should contribute to form, function, or both and maintain a consistent standard of quality and combine to create the desired design. A designer develops a home architecture and interior design for a customer that has a style and theme that the prospective owner likes and mentally connects to. For the last 10 years, decorators, designers, and architects have been re-discovering the unique furniture that was developed post-war of the 1950s and the 1960s from new material that were developed for military applications. Some of the trendsetters include Charles and Ray

Eames, Knoll and Herman Miller. Themes in home design are usually not overused, but serves as a guideline for designing.

On television

Interior decoration has become the subject of television shows. In the United Kingdom (UK), popular interior decorating programs include *60 Minute Makeover* (ITV), *Changing Rooms* (BBC) and *Selling Houses* (Channel 4). Famous interior designers whose work is featured in these programs include Linda Barker and Laurence Llewelyn-Bowen. In the United States, the TLC Network aired a popular program called *Trading Spaces*, a show based on the UK program *Changing Rooms*. In Canada, popular shows include Divine Design with Candice Olsen and Design Inc., featuring Sarah Richardson. In addition, both Home & Garden Television (*HGTV*) and the Discovery Home networks also televise many programs about interior design and decorating, featuring the works of a variety of interior designers, decorators and home improvement experts in a myriad of projects. Fictional interior decorators include the Sugarbaker sisters on *Designing Women* and Grace Adler on *Will & Grace*. There is also another show called *Home MADE*. There are two teams and two houses and whoever has the designed and made the worst room, according to the judges, is eliminated. Another show on the Style Network, hosted by Niecy Nash, is *Clean House* where they re-do messy homes into themed rooms that the clients would like. Other shows include *Design on a Dime*, *Designed to Sell* and *The Decorating Adventures of Ambrose Price*. The show called *Design Star* has become more popular through the 5 seasons that have already aired. The winners of this show end up getting their own TV shows, of which are *Color Splash* hosted by David Bromstad, *Myles of Style* hosted by Kim Myles, *Paint-Over!* hosted by Jennifer Bertrand, *The Antonio Treatment* hosted by Antonio Ballatore, and finally *Secrets from a Stylist* hosted by Emily Henderson.

Interior decorators

Other early interior decorators:

- Elsie de Wolfe
- Syrie Maugham
- Sybil Colefax
- Dorothy Draper
- Pierre François Léonard Fontaine

Many of the most famous designers and decorators during the 20th Century had no formal training. Sister Parish,Robert Denning and Vincent Fourcade, Kerry Joyce, Kelly Wearstler, Stéphane Boudin, Georges Geffroy, Emilio Terry, Carlos de Beistegui, Nina Petronzio, Lorenzo Mongiardino, David Nightingale Hicks and many others were trend-setting innovators in the worlds of design and decoration.

Interior Stylist

Advises and prepares construction documents consisting of plans, elevations, details and specifications to illustrate various elements of the design concept, including the non-structural and/or non-seismic partition layouts, power and communications locations, acoustic plans, lighting designs, furniture layouts and materials and finishes.

Lighting

Low-intensity lighting and haze in a concert hall allows laser effects to be visible

Daylight used at the train station Gare de l'Est Paris

Lighting or **illumination** is the deliberate application of light to achieve some aesthetic or practical effect. Lighting includes use of both artificial light sources such as lamps and natural illumination of interiors from daylight. Daylighting (through windows, skylights, etc.) is often used as the main source of light during daytime in buildings given its high quality and low cost. Artificial lighting represents a major component of energy consumption, accounting for a significant part of all energy consumed worldwide. Artificial lighting is most commonly provided today by electric lights, but gas lighting, candles, or oil lamps were used in the past, and still are used in certain situations. Proper lighting can enhance task performance or aesthetics, while there can be energy wastage and adverse health effects of poorly designed lighting. Indoor lighting is a form of fixture or furnishing, and a key part of interior design. Lighting can also be an intrinsic component of landscaping.

Fixtures

Lighting fixtures come in a wide variety of styles for various functions. The most important functions are as a holder for the light source, to provide directed light and to avoid visual glare. Some are very plain and functional, while some are pieces of art in

themselves. Nearly any material can be used, so long as it can tolerate the excess heat and is in keeping with safety codes.

An important property of light fixtures is the luminous efficacy or wall-plug efficiency, meaning the amount of usable light emanating from the fixture per used energy, usually measured in lumen per watt. A fixture using replaceable light sources can also have its efficiency quoted as the percentage of light passed from the "bulb" to the surroundings. The more transparent the lighting fixture is, the higher efficacy. Shading the light will normally decrease efficacy but increase the directionality and the visual comfort probability.

Forms of Lighting

Indoor Lighting

Forms of lighting include alcove lighting, which like most other uplighting is indirect. This is often done with fluorescent lighting or rope light, or occasionally with neon lighting. It is a form of backlighting.

Soffit or close to wall lighting can be general or a decorative wall-wash, sometimes used to bring out texture (like stucco or plaster) on a wall, though this may also show its defects as well. The effect depends heavily on the exact type of lighting source used.

Recessed lighting (often called "pot lights" in Canada, "can lights" or 'high hats" in the U.S.) is popular, with fixtures mounted into the ceiling structure so as to appear flush with it. These downlights can use narrow beam spotlights, or wider-angle floodlights, both of which are bulbs having their own reflectors. There are also downlights with internal reflectors designed to accept common 'A' lamps (light bulbs) which are generally less costly than reflector lamps. Downlights can be incandescent, fluorescent, HID (high intensity discharge) or LED.

Track lighting, invented by Lightolier, was popular at one point because it was much easier to install than recessed lighting, and individual fixtures are decorative and can be easily aimed at a wall. It has regained some popularity recently in low-voltage tracks, which often look nothing like their predecessors because they do not have the safety issues that line-voltage systems have, and are therefore less bulky and more ornamental in themselves. A master transformer feeds all of the fixtures on the track or rod with 12 or 24 volts, instead of each light fixture having its own line-to-low voltage transformer. There are traditional spots and floods, as well as other small hanging fixtures. A modified version of this is cable lighting, where lights are hung from or clipped to bare metal cables under tension.

A sconce is a wall-mounted fixture, particularly one that shines up and sometimes down as well. A torchiere is an uplight intended for ambient lighting. It is typically a floor lamp but may be wall-mounted like a sconce.

The portable or table lamp is probably the most common fixture, found in many homes and offices. The standard lamp and shade that sits on a table is general lighting, while the desk lamp is considered task lighting. Magnifier lamps are also task lighting.

Animated fountain in Moscow's Square of Europe, lit at night

The illuminated ceiling was once popular in the 1960s and 1970s but fell out of favor after the 1980s. This uses diffuser panels hung like a suspended ceiling below fluorescent lights, and is considered general lighting. Other forms include neon, which is not usually intended to illuminate anything else, but to actually be an artwork in itself. This would probably fall under accent lighting, though in a dark nightclub it could be considered general lighting.

In a movie theater each step in the aisles is usually marked with a row of small lights, for convenience and safety when the film has started, hence the other lights are off. Traditionally made up of small low wattage, low voltage lamps in a track or translucent tube, these are rapidly being replaced with LED based versions.

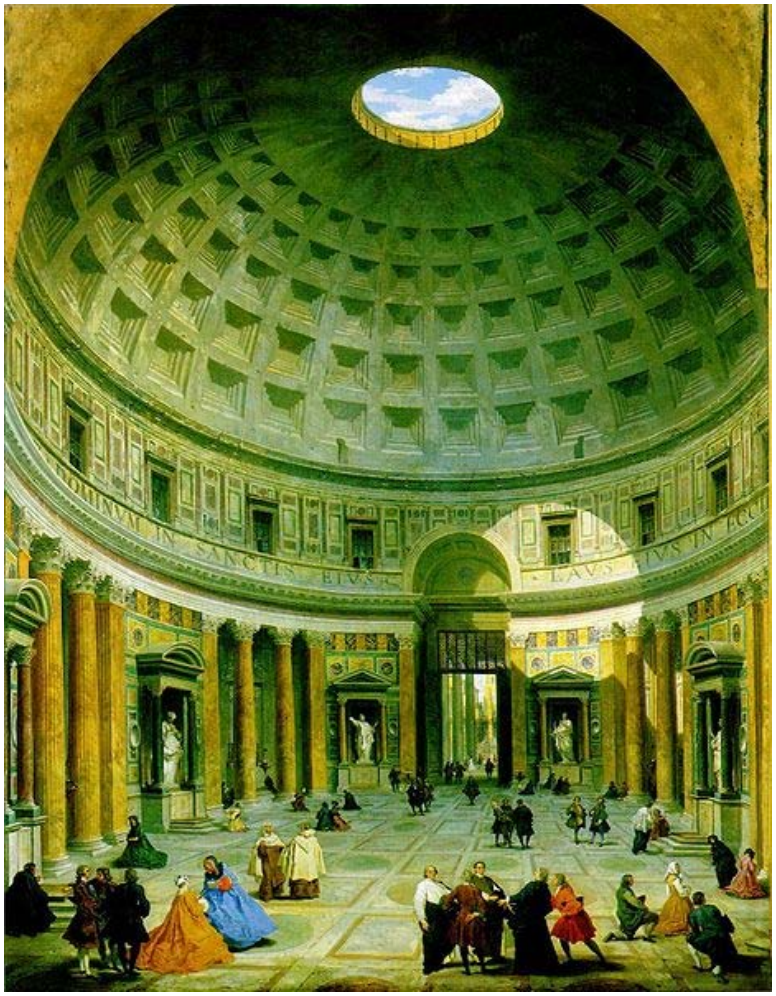
Lamps

Commonly called 'light bulbs', lamps are the removable and replaceable portion of a luminaire which converts electrical energy to both visible and non-visible electromagnetic energy. Specialists who work with lighting, carefully avoid energetic units for measuring of the light output of sources of light due to the spectral response of human visual perception. For example, instead of watt per steradian, the special unit candela is used; 1 candela=(1/683) W/steradian for monochromatic light at 555 nm wavelength. Common characteristics used to evaluate lamp quality include efficacy measured in lumens per watt, typical lamp life measured in hours, and Color Rendering Index on a scale of 0 to 100. Cost of replacement lamps is also an important factor in any design.

It is important to be able to differentiate types of lamps and lamp technologies. These include:

- "Ballast: A ballast is an auxiliary piece of equipment designed to start and properly control the flow of power to discharge light sources such as fluorescent and high intensity discharge (HID) lamps. Some lamps require the ballast to have thermal protection.
- Fluorescent light: A long straight tube coated with phosphor containing low pressure mercury vapor that produces white light.
- Halogen: High pressure incandescent lamps containing halogen gases such as iodine or bromine, allowing filaments to be operated at higher temperatures.
- Luminaire: A complete lighting unit consisting of a lamp, ballast as required with the parts designed to distribute the light, position and protect the lamp and connect them to the power supply.
- Neon: A low pressure gas contained within a glass tube; the color emitted depends on the gas.
- Light emitting diodes: Light emitting diodes (LED) are tiny light bulbs wihtout the filaments that would burn out on ordinary light bulbs, illuminated solely by the movement of electrons in a semiconductor material. "
- Compact fluorescent lamps: CFLs are emerging as a good alternative to incandescent lamps (bulbs) due to their lower power consumption and longer lamp life. CFLs consume 2-5 times less power, lasts 8-10 times longer and saves about $30 (Rs2500/year) over its life compared to a bulb.

Design and architecture



Lighting without windows: The Pantheon in the 18th century, painted by Giovanni Paolo Panini.

Lighting design as it applies to the built environment, also known as 'architectural lighting design', is both a science and an art. Lighting of structures must consider aesthetic elements as well as practical considerations of quantity of light required, occupants of the structure, energy efficiency and cost. For simple installations, hand-calculations based on tabular data can be used to provide an acceptable lighting design. More critical or optimized designs now routinely use mathematical modeling on a computer.

In some design instances, materials used on walls and furniture play a key role in the lighting effect. Dark paint tends to absorb light, making the room appear smaller and more dim than it is, whereas light paint does the opposite. In addition to paint, reflective surfaces also have an effect on lighting design. Surfaces or floors that are too reflective create unwanted glare.

Measurement

Luminance is a photometric measure of the density of luminous intensity in a given direction. It describes the amount of light that passes through or is emitted from a particular area, and falls within a given solid angle. The SI unit for luminance is candela per square metre (cd/m^2). The CGS unit of luminance is the stilb, which is equal to one candela per square centimetre or 10 kcd/m^2.

Several measurement methods have been developed to control glare resulting from indoor lighting design. The Unified Glare Rating (UGR) athe Visual Comfort Probability, and the Daylight Glare Index are some of the most well-known methods of measurement. In addition to these new methods, four main factors influence the degree of discomfort glare; the luminance of the glare source, the solid angle of the glare source, the background luminance, and the position of the glare source in the field of view must all be taken into account.

Color Properties

To define light source color properties, the lighting industry predominantly relies on two metrics, correlated color temperature (CCT), commonly used as an indication of the apparent “warmth” or “coolness” of the light emitted by a source, and color rendering index (CRI), an indication of the light source’s ability to make objects appear natural.

However, these two metrics, developed in the last century, are facing increased challenges and criticisms as new types of light sources, particularly light emitting diodes (LEDs), become more prevalent in the market.

For example, in order to meet the expectations for good color rendering in retail applications, research suggests using the well-established CRI along with another metric called gamut area index (GAI). GAI represents the relative separation of object colors illuminated by a light source; the greater the GAI, the greater the apparent saturation or vividness of the object colors. As a result, light sources which balance both CRI and GAI are generally preferred over ones that have only high CRI or only high GAI.

Light Exposure

Typical measurements of light have used a Dosimeter. Dosimeters measure an individual's or an object's exposure to something in the environment, such as light dosimeters and ultraviolet dosimeters.

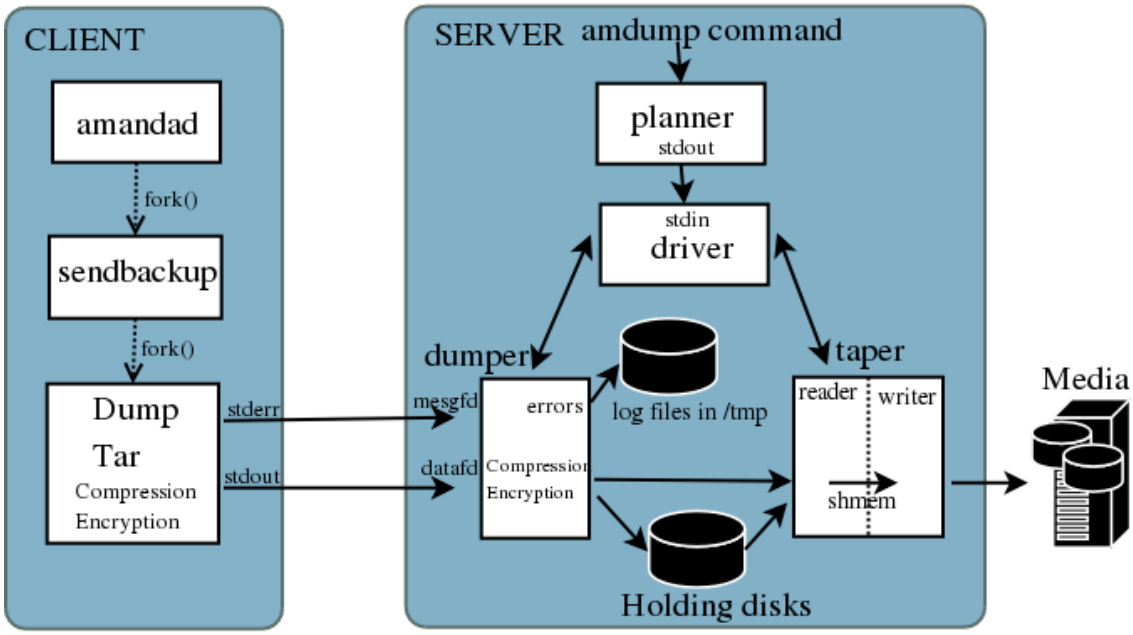
In order to specifically measure the amount of light entering the eye, personal circadian light meter called the Daysimeter has been developed. This is the first device created to accurately measure and characterize light (intensity, spectrum, timing, and duration) entering the eye that affects the human body's clock.

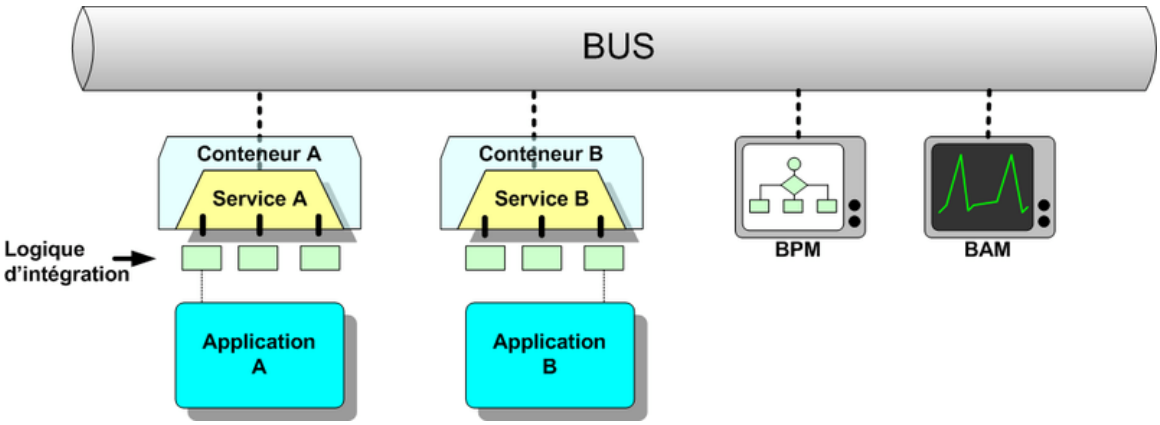
The small, head-mounted device measures an individual's daily rest and activity patterns, as well as exposure to short-wavelength light that stimulates the circadian system. The device measures activity and light together at regular time intervals and electronically stores and logs its operating temperature. The Daysimeter can gather data for up to 30 days for analysis.

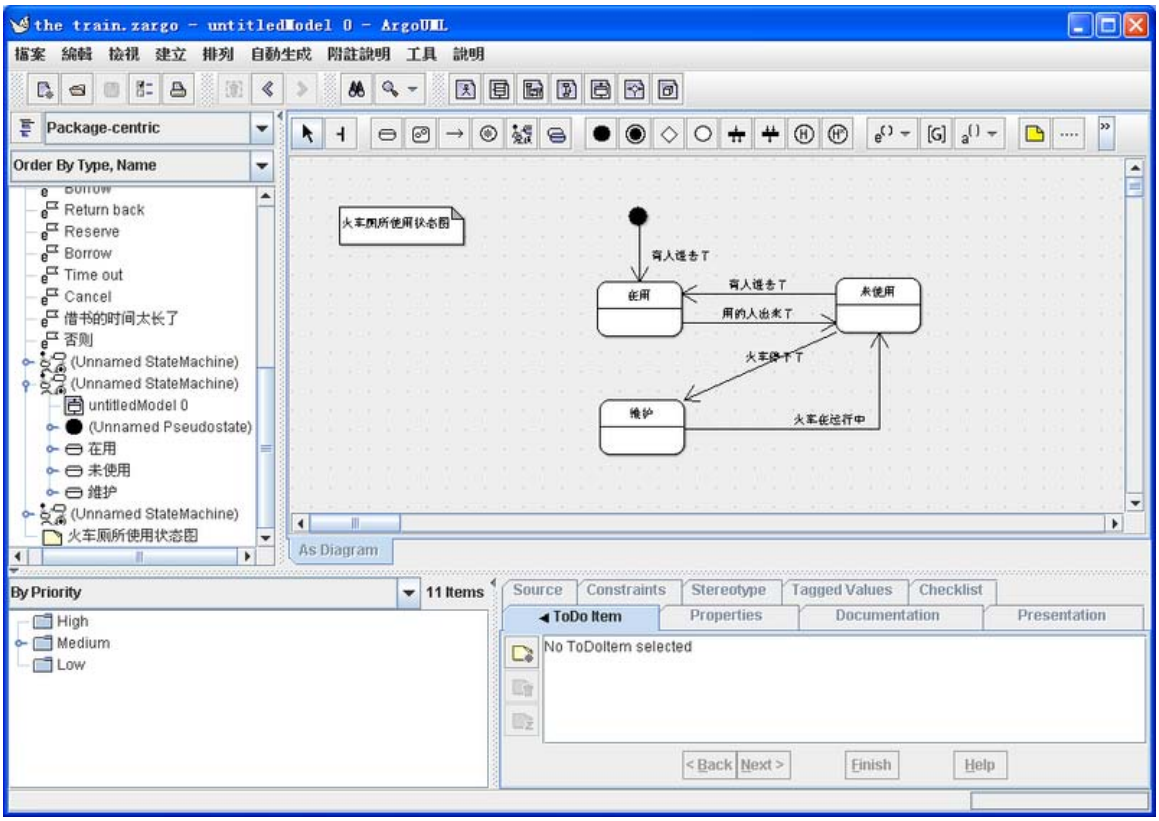
Chapter- 6

Software Design

Software design is a process of problem-solving and planning for a software solution. After the purpose and specifications of software are determined, software developers will design or employ designers to develop a plan for a solution. It includes low-level component and algorithm implementation issues as well as the architectural view.







Overview

The software requirements analysis (SRA) step of a software development process yields specifications that are used in software engineering. If the software is "semiautomated" or user centered, software design may involve user experience design yielding a story board to help determine those specifications. If the software is completely automated (meaning no user or user interface), a software design may be as simple as a flow chart or text describing a planned sequence of events. There are also semi-standard methods like Unified Modeling Language and Fundamental modeling concepts. In either case some documentation of the plan is usually the product of the design.

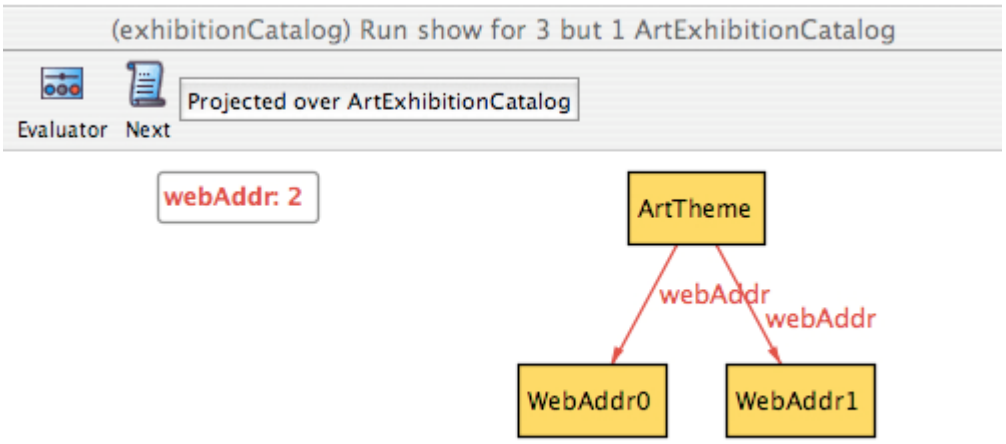
A software design may be platform-independent or platform-specific, depending on the availability of the technology called for by the design.

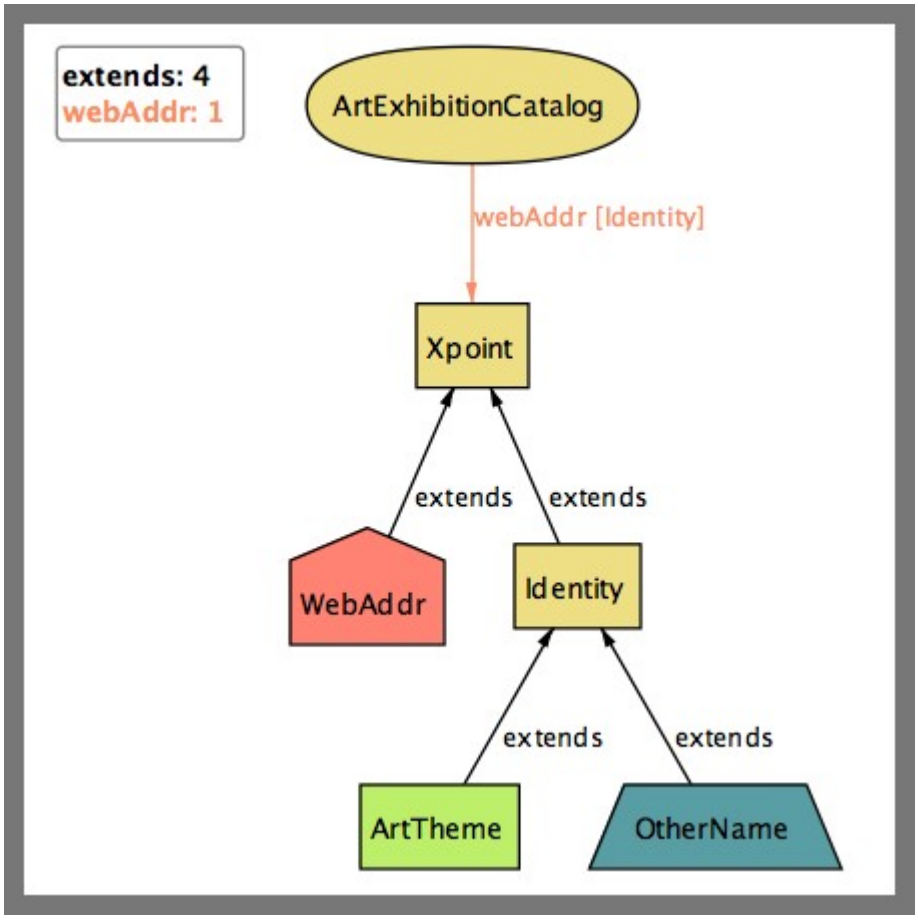
Software Design Topics

Design concepts

The design concepts provide the software designer with a foundation from which more sophisticated methods can be applied. A set of fundamental design concepts has evolved. They are:

1. Abstraction - Abstraction is the process or result of generalization by reducing the information content of a concept or an observable phenomenon, typically in order to retain only information which is relevant for a particular purpose.
2. Refinement - It is the process of elaboration. A hierarchy is developed by decomposing a macroscopic statement of function in a stepwise fashion until programming language statements are reached. In each step, one or several instructions of a given program are decomposed into more detailed instructions. Abstraction and Refinement are complementary concepts.
3. Modularity - Software architecture is divided into components called modules.
4. Software Architecture - It refers to the overall structure of the software and the ways in which that structure provides conceptual integrity for a system. A good software architecture will yield a good return on investment with respect to the desired outcome of the project, e.g. in terms of performance, quality, schedule and cost.
5. Control Hierarchy - A program structure that represent the organization of a program components and implies a hierarchy of control.
6. Structural Partitioning - The program structure can be divided both horizontally and vertically. Horizontal partitions define separate branches of modular hierarchy for each major program function. Vertical partitioning suggests that control and work should be distributed top down in the program structure.
7. Data Structure - It is a representation of the logical relationship among individual elements of data.
8. Software Procedure - It focuses on the processing of each modules individually
9. Information Hiding - Modules should be specified and designed so that information contained within a module is inaccessible to other modules that have no need for such information.

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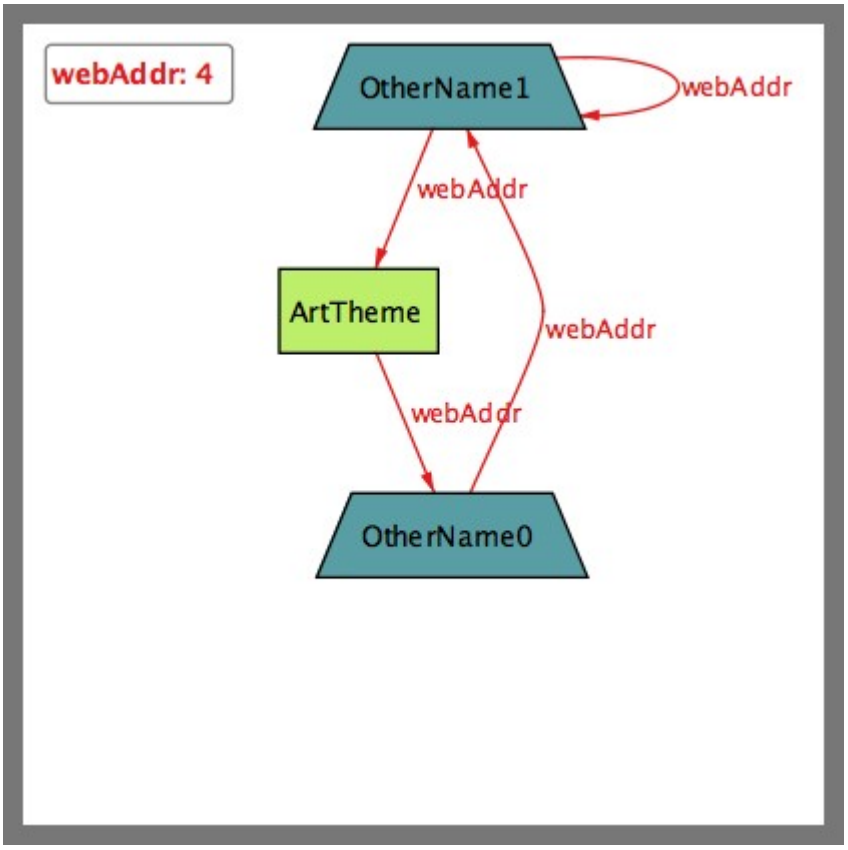
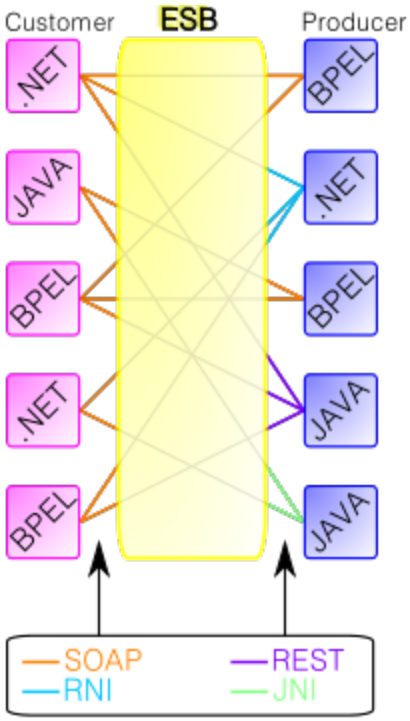


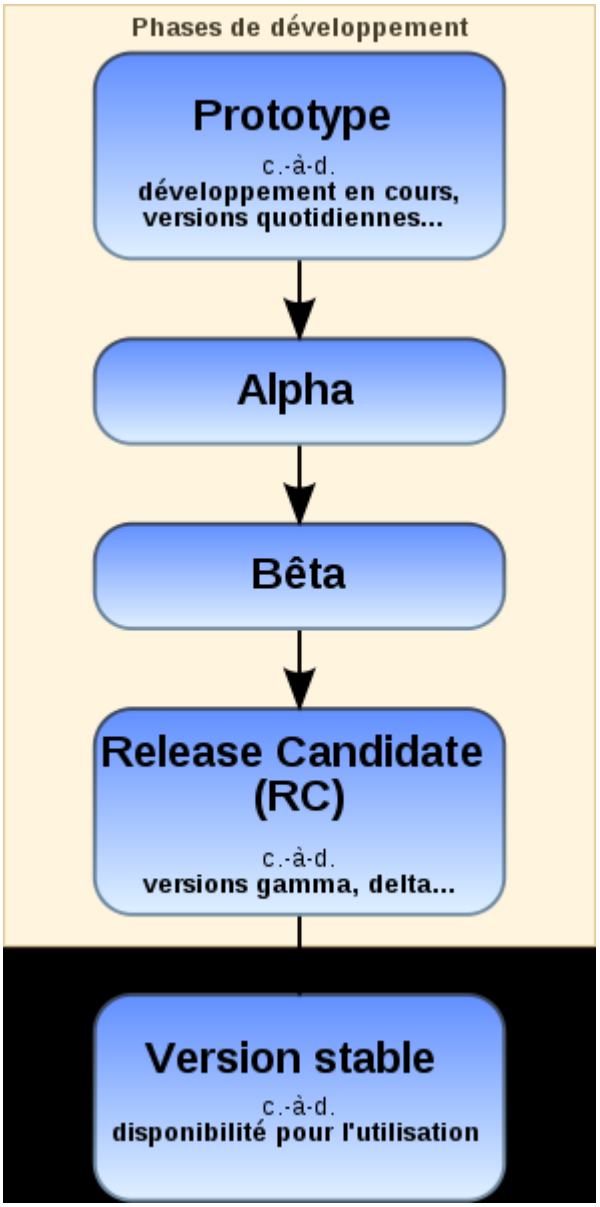
Design considerations

There are many aspects to consider in the design of a piece of software. The importance of each should reflect the goals the software is trying to achieve. Some of these aspects are:

- **Compatibility** - The software is able to operate with other products that are designed for interoperability with another product. For example, a piece of software may be backward-compatible with an older version of itself.
- **Extensibility** - New capabilities can be added to the software without major changes to the underlying architecture.
- **Fault-tolerance** - The software is resistant to and able to recover from component failure.
- **Maintainability** - The software can be restored to a specified condition within a specified period of time. For example, antivirus software may include the ability to periodically receive virus definition updates in order to maintain the software's effectiveness.
- **Modularity** - the resulting software comprises well defined, independent components. That leads to better maintainability. The components could be then implemented and tested in isolation before being integrated to form a desired software system. This allows division of work in a software development project.

- **Packaging** - Printed material such as the box and manuals should match the style designated for the target market and should enhance usability. All compatibility information should be visible on the outside of the package. All components required for use should be included in the package or specified as a requirement on the outside of the package.
- **Reliability** - The software is able to perform a required function under stated conditions for a specified period of time.
- **Reusability** - the software is able to add further features and modification with slight or no modification.
- **Robustness** - The software is able to operate under stress or tolerate unpredictable or invalid input. For example, it can be designed with a resilience to low memory conditions.
- **Security** - The software is able to withstand hostile acts and influences.
- **Usability** - The software user interface must be usable for its target user/audience. Default values for the parameters must be chosen so that they are a good choice for the majority of the users.

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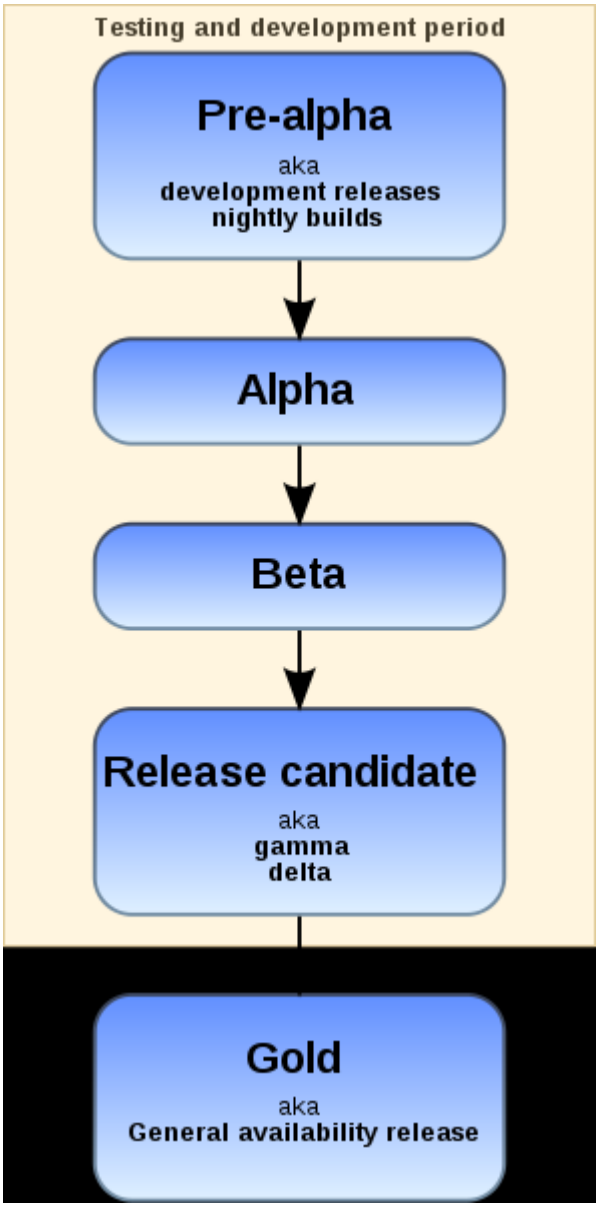


Modeling language

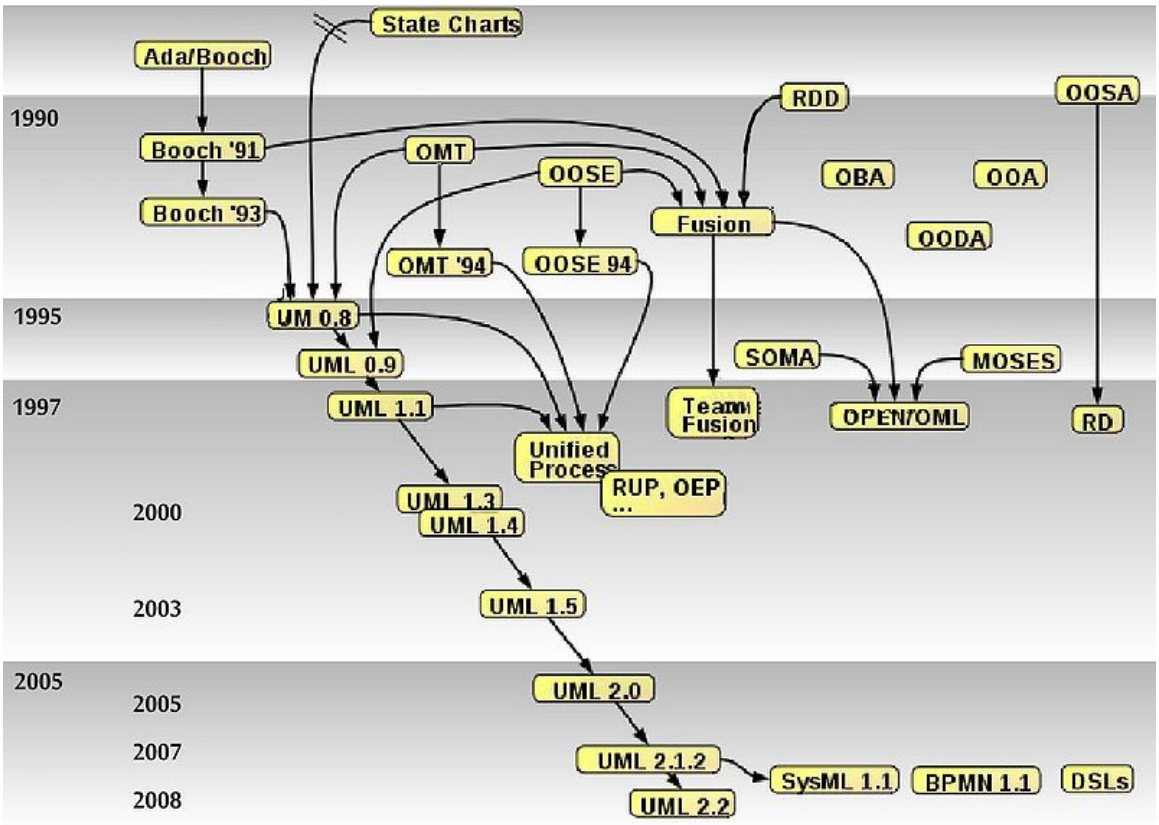
A modeling language is any artificial language that can be used to express information or knowledge or systems in a structure that is defined by a consistent set of rules. The rules are used for interpretation of the meaning of components in the structure. A modeling language can be graphical or textual. Examples of graphical modelling languages for software design are:

- Business Process Modeling Notation (BPMN) is an example of a Process Modeling language.
- EXPRESS and EXPRESS-G (ISO 10303-11) is an international standard general-purpose data modeling language.

- Extended Enterprise Modeling Language (EEML) is commonly used for business process modeling across a number of layers.
- Flowchart is a schematic representation of an algorithm or a stepwise process,
- Fundamental Modeling Concepts (FMC) modeling language for software-intensive systems.
- IDEF is a family of modeling languages, the most notable of which include IDEF0 for functional modeling, IDEF1X for information modeling, and IDEF5 for modeling ontologies.
- Jackson Structured Programming (JSP) is a method for structured programming based on correspondences between data stream structure and program structure
- LePUS3 is an object-oriented visual Design Description Language and a formal specification language that is suitable primarily for modelling large object-oriented (Java, C++, C#) programs and design patterns.
- Unified Modeling Language (UML) is a general modeling language to describe software both structurally and behaviorally. It has a graphical notation and allows for extension with a Profile (UML).
- Alloy (specification language) is a general purpose specification language for expressing complex structural constraints and behavior in a software system. It provides a concise language based on first-order relational logic.
- Systems Modeling Language (SysML) is a new general-purpose modeling language for systems engineering.

Design patterns

A software designer or architect may identify a design problem which has been solved by others before. A template or pattern describing a solution to a common problem is known as a design pattern. The reuse of such patterns can speed up the software development process, having been tested and proved in the past.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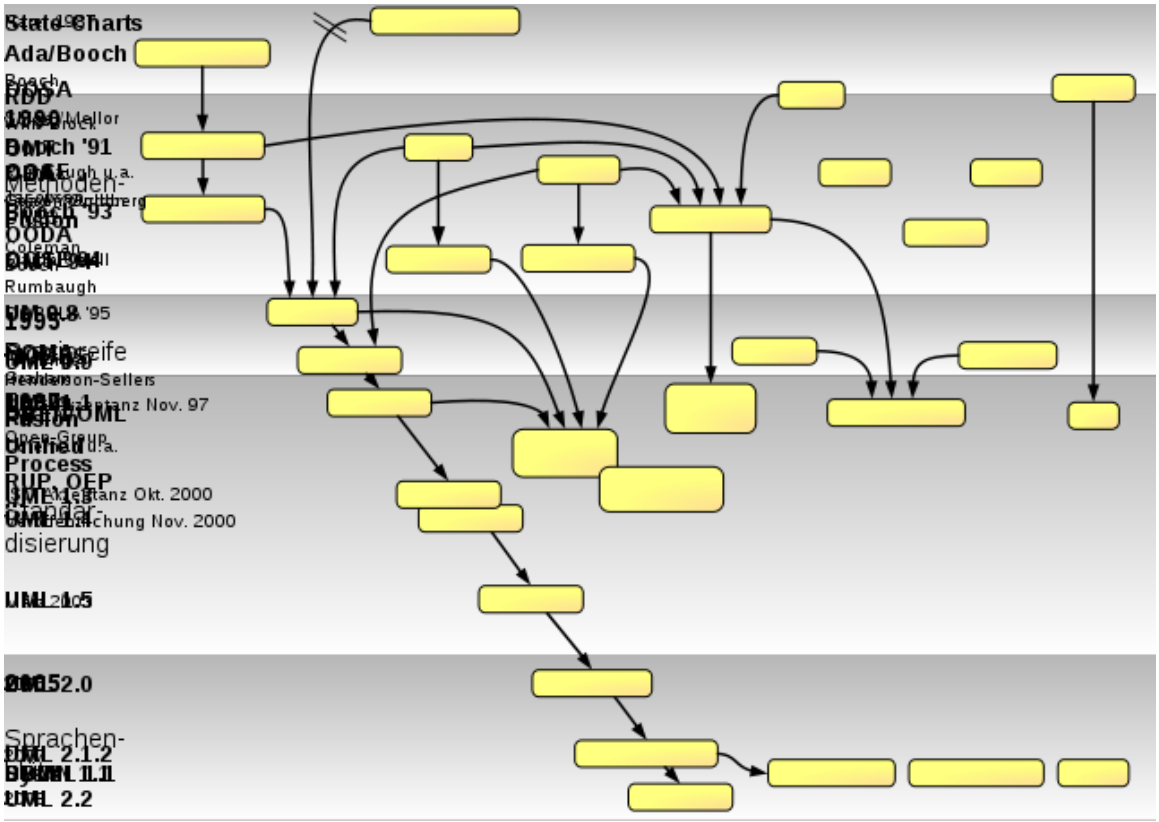
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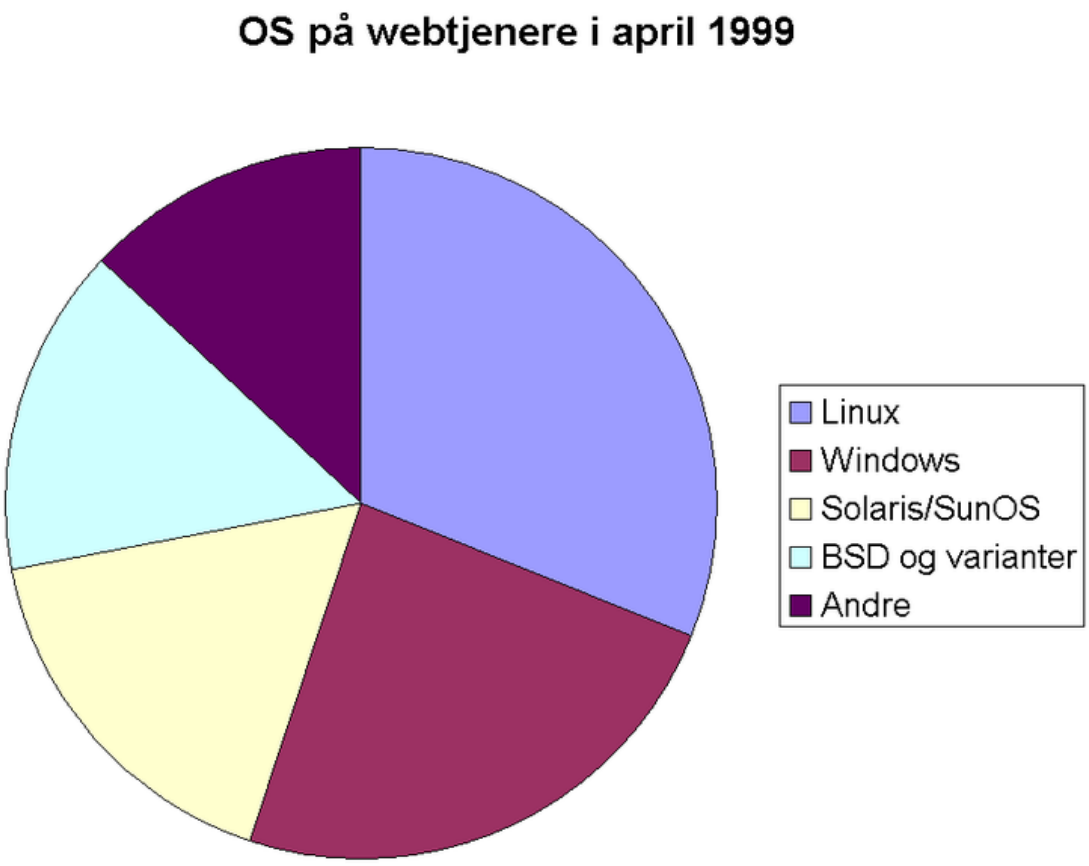
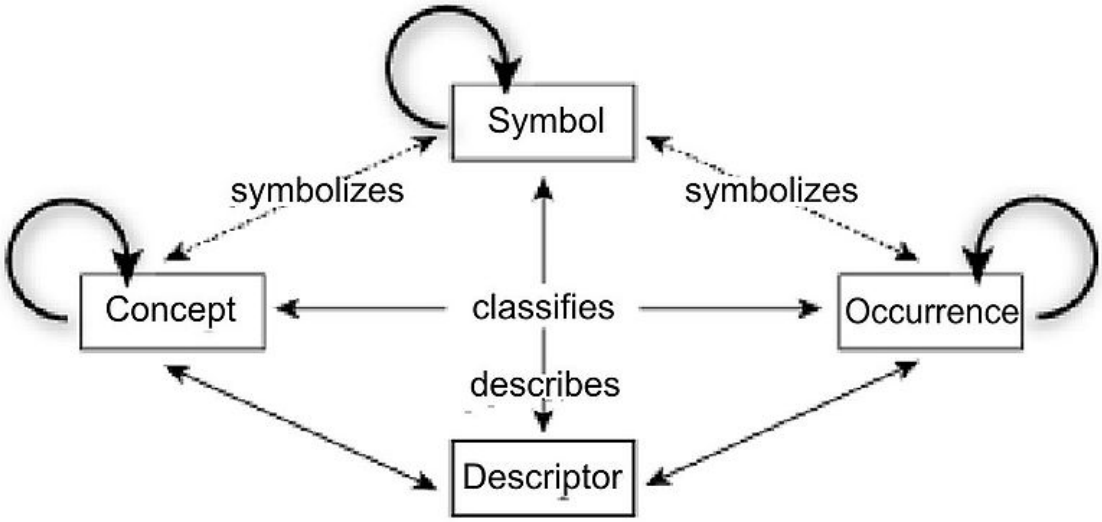


Usage

Software design documentation may be reviewed or presented to allow constraints, specifications and even requirements to be adjusted prior to programming. Redesign may occur after review of a programmed simulation or prototype. It is possible to design software in the process of programming, without a plan or requirement analysis, but for more complex projects this would not be considered a professional approach. A separate design prior to programming allows for multidisciplinary designers and Subject Matter Experts (SMEs) to collaborate with highly-skilled programmers for software that is both useful and technically sound.

Metamodeling



Example of a Geologic map information meta-model, with four types of meta-objects, and their self-references.

Metamodeling, or *meta-modeling* in software engineering and systems engineering among other disciplines, is the analysis, construction and development of the frames, rules, constraints, models and theories applicable and useful for modeling a predefined class of problems. As its name implies, this concept applies the notions of meta- and modeling.

Overview

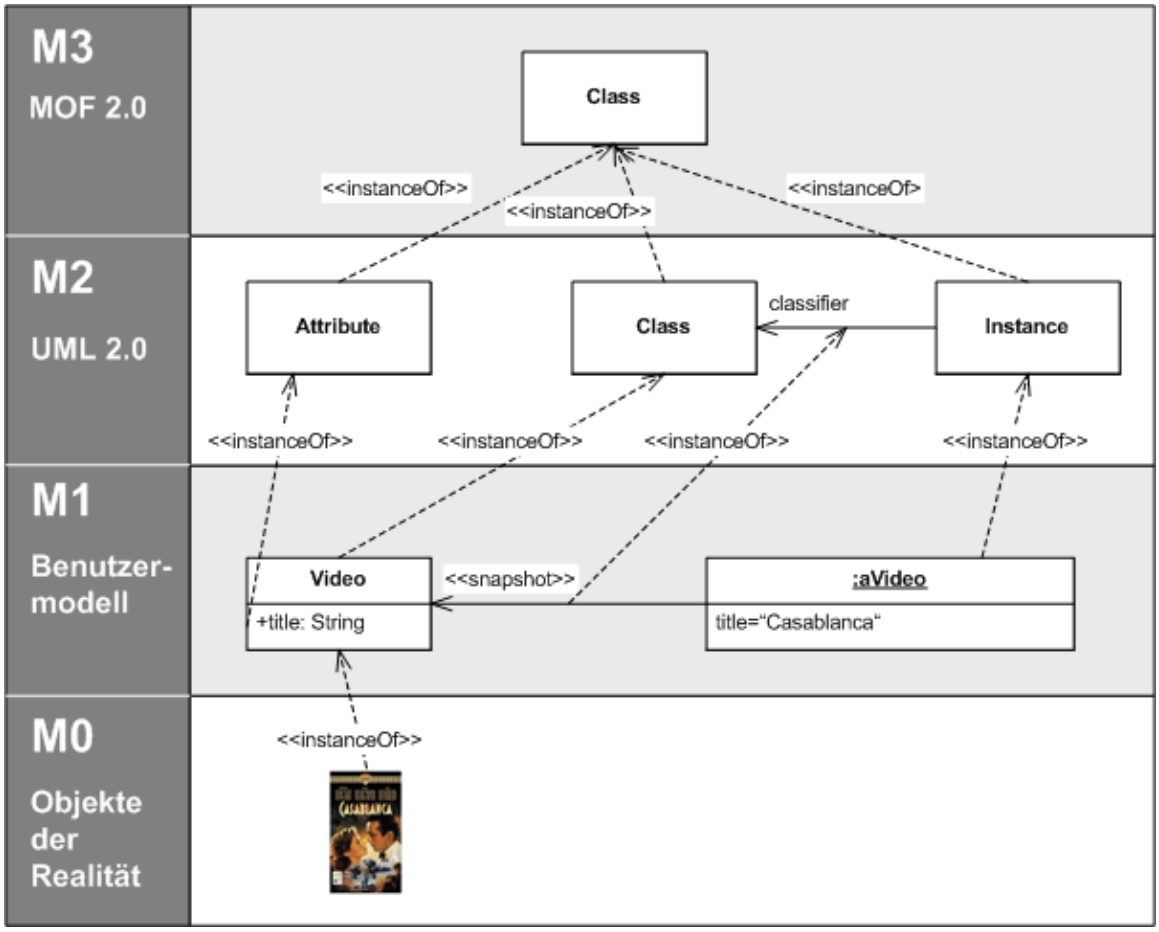
"Metamodeling" is the construction of a collection of "concepts" (things, terms, etc.) within a certain domain. A model is an abstraction of phenomena in the real world; a metamodel is yet another abstraction, highlighting properties of the model itself. A model conforms to its metamodel in the way that a computer program conforms to the grammar of the programming language in which it is written.

Common uses for metamodels are:

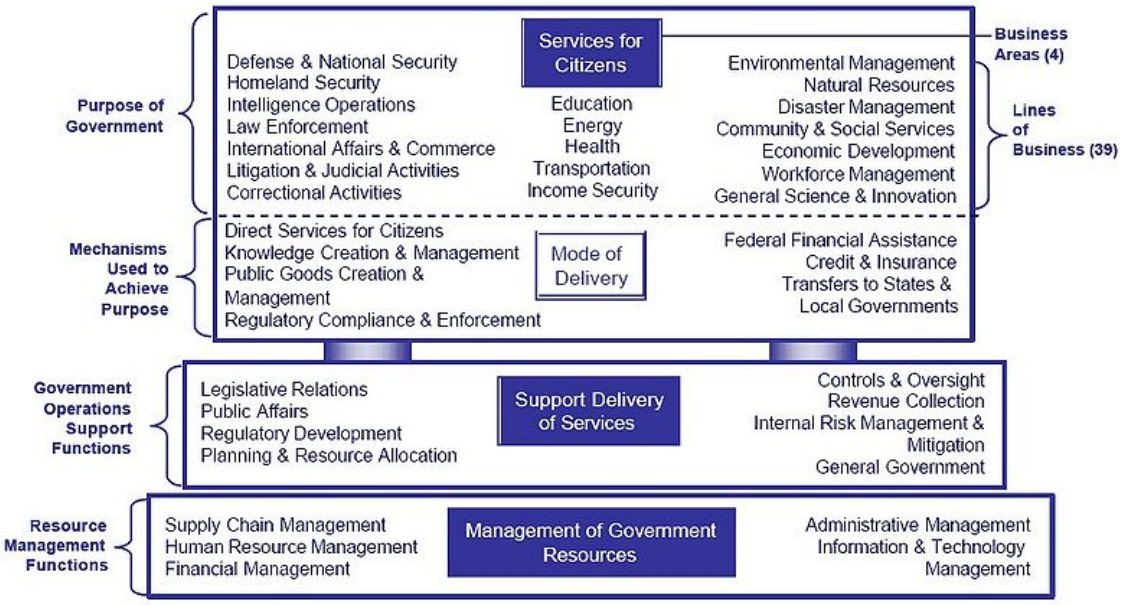
- As a schema for semantic data that needs to be exchanged or stored
- As a language that supports a particular method or process
- As a language to express additional semantics of existing information

Because of the "meta" character of metamodeling, both the praxis and theory of metamodels are of relevance to metascience, metaphilosophy, metatheories and systemics, and meta-consciousness.

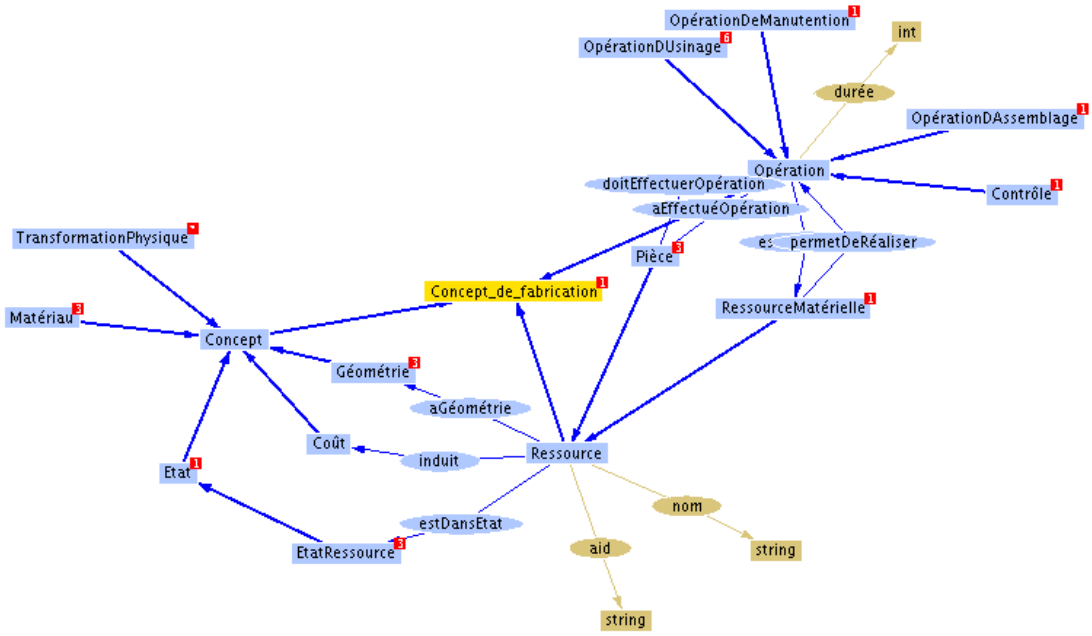
Metamodeling topics



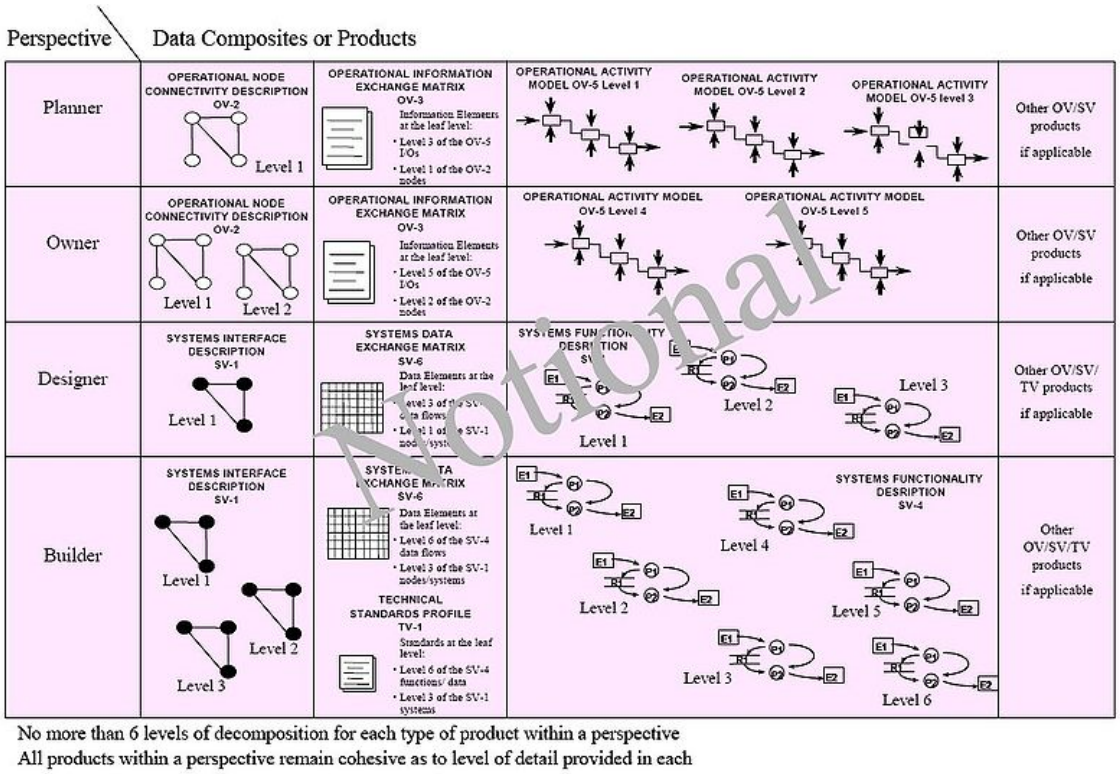
Meta-Object Facility Illustration



An US FEA Business reference model



Example of an ontology



A DoDAF metamodel

Definition

In software engineering, the use of models is more and more recommended. This should be contrasted with the classical code-based development techniques. A model always conforms to a unique metamodel. One of the currently most active branch of Model Driven Engineering is the approach named model-driven architecture proposed by OMG. This approach is based on the utilization of a language to write metamodels called the Meta Object Facility or MOF. Typical metamodels proposed by OMG are UML, SysML, SPEM or CWM. ISO has also published the standard metamodel ISO/IEC 24744. All the languages presented below could be defined as MOF metamodels.

Metadata modeling

Metadata modeling is a type of metamodeling used in software engineering and systems engineering for the analysis and construction of models applicable and useful to some predefined class of problems.

Model transformations

One important move in Model Driven Engineering is the systematic use of Model Transformation Languages. The OMG has proposed a standard for this called QVT for Queries/Views/Transformations. QVT is based on the Meta-Object Facility or MOF.

Among many other Model Transformation Languages (MTLs), some examples of implementations of this standard are AndroMDA, VIATRA, Tefkat, MT, ManyDesigns Portofino.

Relationship to ontologies

Meta-models are closely related to ontologies. Both are often used to describe and analyze the relations between concepts

- Ontologies: express something meaningful within a specified universe or domain of discourse by utilizing a grammar for using vocabulary. The grammar specifies what it means to be a well-formed statement, assertion, query, etc. (formal constraints) on how terms in the ontology's controlled vocabulary can be used together.
- Meta-modeling: can be considered as an *explicit* description (constructs and rules) of how a domain-specific model is built. In particular, this comprises a formalized specification of the domain-specific notations. Typically, metamodels are – and always should follow - a strict rule set. "A valid metamodel is an ontology, but not all ontologies are modeled *explicitly* as metamodels".

Types of meta-models

For software engineering, several *types* of models (and their corresponding modeling activities) can be distinguished:

- Metadata modeling (MetaData Model)
- Meta-Process Modeling (MetaProcess Model)
- Executable Meta-Modeling (combining both of the above and much more, as in the general purpose tool Kermeta)
- Model Transformation Language (see below)

Zoos of metamodels

A library of similar meta-models has been called a Zoo of meta-models. There are several types of meta-model zoos. Some are expressed in ECore. Others are written in MOF 1.4 - XMI 1.2. The metamodels expressed in UML-XMI1.2 may be uploaded in Poseidon for UML, a UML CASE tool.

Chapter- 7

Engineer

Conference of Engineers at the Menai Straits Preparatory to Floating one of the Tubes of the Britannia Bridge, by John Seymour Lucas, 1868

An **engineer** is a professional practitioner of engineering, concerned with applying scientific knowledge, mathematics, economics and ingenuity to develop solutions to meet economic and societal needs. Engineers design structures, machines and systems while considering the limitations imposed by practicality, safety and cost. The word *engineer* is derived from the Latin root *ingenium*, meaning "cleverness".

Engineers are grounded in applied sciences, and their work in research and development is distinct from the basic research focus of pure scientists. The work of engineers forms the link between scientific discoveries and the applications that meet the needs of society.

Roles and expertise

Design

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. Much of an engineer's time is spent on researching, locating, applying, and transferring information.

Engineers must weigh different design choices on their merits and choose the solution that best matches the requirements. Their crucial and unique task is to identify, understand, and interpret the constraints on a design in order to produce a successful result.

Analysis

Engineers conferring on prototype design, 1954

Engineers apply techniques of engineering analysis in testing, production, or maintenance. Analytical engineers may supervise production in factories and elsewhere, determine the causes of a process failure, and test output to maintain quality. They also estimate the time and cost required to complete projects. Supervisory engineers are responsible for major components or entire projects. Engineering analysis involves the application of scientific analytic principles and processes to reveal the properties and state of the system, device or mechanism under study. Engineering analysis proceeds by separating the engineering design into the mechanisms of operation or failure, analysing or estimating each component of the operation or failure mechanism in isolation, and re-combining the components. They may analyse risk.

Many engineers use computers to produce and analyze designs, to simulate and test how a machine, structure, or system operates, to generate specifications for parts, to monitor the quality of products, and to control the efficiency of processes.

Specialization

Most engineers specialize in one or more engineering disciplines. Numerous specialties are recognized by professional societies, and each of the major branches of engineering has numerous subdivisions. Civil engineering, for example, includes structural and transportation engineering, and materials engineering includes ceramic, metallurgical, and polymer engineering. Engineers also may specialize in one industry, such as motor vehicles, or in one type of technology, such as turbines or semiconductor materials.

Ethics

The *Challenger* disaster is held as a case study of engineering ethics

Engineers have obligations to the public, their clients, employers and the profession. Many engineering societies have established codes of practice and codes of ethics to guide members and inform the public at large. Each engineering discipline and professional society maintains a code of ethics, which the members pledge to uphold. Depending on their specializations, engineers may also be governed by specific statute, whistleblowing, product liability laws, and often the principles of business ethics.

Some graduates of engineering programs in North America may be recognized by the Iron Ring or Engineer's Ring, a ring made of iron or stainless steel that is worn on the little finger of the dominant hand. This tradition began in 1925 in Canada with The Ritual of the Calling of an Engineer, where the ring serves as a symbol and reminder of the engineer's obligations for the engineering profession. In 1972, the practice was adopted by several colleges in the United States including members of the Order of the Engineer.

Education

École centrale Paris, one of the oldest and most prestigious engineering schools in France

Most engineering programs involve a concentration of study in an engineering specialty, along with courses in both mathematics and the physical and life sciences. Many programs also include courses in general engineering. A design course, sometimes accompanied by a computer or laboratory class or both, is part of the curriculum of most programs. Often, general courses not directly related to engineering, such as those in the social sciences or humanities, also are required.

Graduate training is essential for engineering faculty positions and some research and development programs, but is not required for the majority of entry-level engineering jobs. Many experienced engineers obtain graduate degrees in engineering or business administration to learn new technology and broaden their education. Numerous high-level executives in government and industry began their careers as engineers.

Accreditation is the process by which engineering program are evaluated by an external body to determine if applicable standards are met. The Washington Accord serves as an international accreditation agreement for academic engineering degrees, recognizing the substantial equivalency in the standards set by many major national engineering bodies.

In the United States, post-secondary degree programs in engineering are accredited by the Accreditation Board for Engineering and Technology. In much of Europe and the Commonwealth professional accreditation is provided by Engineering Institutions, such as the Institution of Civil Engineers or the Institution of Mechanical Engineers from the United Kingdom.

Regulation

In many countries, engineering tasks such as the design of bridges, electric power plants, and chemical plants, must be approved by a licensed engineer. Most commonly titled as Professional Engineer or Chartered Engineer, the status of professional licensing is often indicated with the use of post-nominal letters; PE or P.Eng is common in North America, Eur Ing in Europe, while CEng and IEng is used in the United Kingdom and CEng in much of the Commonwealth.

In the United States, licensure is generally attainable through combination of education, pre-examination (Fundamentals of Engineering exam), examination (Professional Engineering Exam), and engineering experience (typically in the area of 5+ years). Each state tests and licenses Professional Engineers. Currently most states do not license by specific engineering discipline, but rather provide generalized licensure, and trust engineers to use professional judgement regarding their individual competencies; this is the favoured approach of the professional societies. Despite this, however, at least one of the examinations required by most states is actually focused on a particular discipline; candidates for licensure typically choose the category of examination which comes closest to their respective expertise.

In Canada, the profession in each province is governed by its own engineering association. For instance, in the Province of British Columbia an engineering graduate with four or more years of post graduate experience in an engineering-related field and passing exams in ethics and law will need to be registered by the Association for Professional Engineers and Geoscientists (APEGBC) in order to become a Professional Engineer and be granted the professional designation of P.Eng.

In Continental Europe, Latin America, Turkey and elsewhere the title is limited by law to people with an engineering degree and the use of the title by others is illegal. In Italy, the title is limited to people who both hold an engineering degree and have passed a professional qualification examination (*Esame di Stato*). In Portugal, professional engineer titles and accredited engineering degrees are regulated and certified by the *Ordem dos Engenheiros*. In the Czech Republic, the title "engineer" (Ing.) is given to people with a (masters) degree in chemistry, technology or economics for historical and traditional reasons. In Greece, the academic title of "Diploma Engineer" is awarded after completion of the five-year engineering study course and the title of "Certified Engineer" is awarded after completion of the four-year course of engineering studies at a Technological Educational Institute (TEI).

Perception

Statue of engineer Robert Fulton at the United States Capitol

Engineering is generally a well respected profession. British school children in the 1950s were brought up with stirring tales of 'the Victorian Engineers', chief amongst whom were the Brunels, the Stephensons, Telford and their contemporaries. In Canada, a 2002 study by the Ontario Society of Professional Engineers revealed that engineers are the third most respected professionals behind doctors and pharmacists. In India and China, engineering is one of the most sought after undergraduate courses, inviting thousands of applicants to show their ability in highly competitive entrance examinations. In Egypt, the educational system makes engineering the second-most-respected profession in the country (after medicine); engineering colleges at Egyptian universities require extremely high marks on the General Certificate of Secondary Education (Arabic: الثانوية العامة *al-Thānawiyyah al-`Āmmah*)—on the order of 97 or 98%—and are thus considered (with colleges of medicine, natural science, and pharmacy) to be among the "pinnacle colleges" (كليات القمة *kullīyāt al-qimmah*).

Sometimes engineering has been seen as a somewhat dry, uninteresting field in popular culture and has also been thought to be the domain of nerds. For example, the cartoon character Dilbert is an engineer. In science fiction, engineers are often portrayed as highly knowledgeable and respectable individuals who understand the overwhelming future technologies often portrayed in the genre. Several *Star Trek* characters are engineers. One difficulty in increasing public awareness of the profession is that average people, in the typical run of ordinary life, do not ever have any personal dealings with engineers, even though they benefit from their work every day. By contrast, it is common to visit a doctor at least once a year, the chartered accountant at tax time, and, occasionally, even a lawyer.

In companies and other organizations in some English-speaking countries (UK) there is a tendency to undervalue people with technical and scientific skills compared to managers. In his book *The Mythical Man-Month*, Fred Brooks Jr says that managers think of senior people as "too valuable" for technical tasks, and that management jobs carry higher prestige. He tells how some laboratories, such as Bell Labs, abolish all job titles to overcome this problem: a professional employee is a "member of the technical staff." IBM maintain a dual ladder of advancement; the corresponding managerial and technical rungs are equivalent. Brooks recommends that structures need to be changed; the boss must give a great deal of attention to keeping his managers and his technical people as interchangeable as their talents allow.