NIILM University

Industrial Development

CONTENTS

CHAPTER 1

Industry Development

Industry is the production of a good or service within an economy. Manufacturing industry became a key sector of production and labour in European and North American countries during the Industrial Revolution, upsetting previous mercantile and feudal economies. This occurred through many successive rapid advances in technology, such as the production of steel and coal. Following the Industrial Revolution, perhaps a third of the world's economic output is derived from manufacturing industries. Many developed countries and many developing/semi-developed countries (People's Republic of China, India etc.) depend significantly on industry. Industries, the countries they reside in, and the economies of those countries are interlinked in a complex web of interdependence.

Classification of industry

Industries can be classified in a variety of ways. At the top level, industry is often classified into sectors: Primary or extractive, secondary or manufacturing, and tertiary or services. Some authors add quaternary (knowledge) or even quinary (culture and research) sectors. Over time, the fraction of a society's industry within each sector changes.

Sector Definition

Primary This involves the extraction of resources directly from the Earth; this includes farming, mining and logging. They do not process the products at all. They send it off to factories to make a profit.

Secondary This group is involved in the processing products from primary industries. This includes all factories—those that refine metals, produce furniture, or pack farm products such as meat.

Tertiary This group is involved in the provision of services. They include teachers, managers and other service providers.

Quaternary This group is involved in the research of science and technology and other high level tasks. They include scientists, doctors, and lawyers.

Quinary Sector Some consider there to be a branch of the quaternary sector called the quinary sector, which includes the highest levels of decision making in a society or economy. This sector would include the top executives or officials in such fields as government, science, universities, nonprofit, healthcare, culture, and the media.

There are many other different kinds of industries, and often organized into different classes or sectors by a variety of industrial classifications. Market-based classification systems such as the Global Industry Classification Standard and the Industry Classification Benchmark are used in finance and market research. These classification systems commonly divide industries according to similar functions and markets and identify businesses producing related products. Industries can also be identified by product, such as: chemical industry, petroleum industry, automotive industry, electronic industry, meatpacking industry, hospitality industry, food industry, fish industry, software industry, paper industry, entertainment industry, semiconductor industry, cultural industry, and poverty industry.

Industrial development

The industrial revolution led to the development of factories for large-scale production, with consequent changes in society. Originally the factories were steam-powered, but later transitioned to electricity once an electrical grid was developed. The mechanized assembly line was introduced to assemble parts in a repeatable fashion, with individual workers performing specific steps during the process. This led to significant increases in efficiency, lowering the cost of the end process. Later automation was increasingly used to replace human operators. This process has accelerated with the development of the computer and the robot.

Essence of industry

Business

Cottage industry

Heavy industry

Light industry

Manufacturing

Business

A business, also known as an enterprise or a firm, is an organization involved in the trade of goods, services, or both to consumers. Businesses are prevalent in capitalist economies, where most of them are privately owned and provide goods and services to customers for profit. Businesses may also be not-for-profit or state-owned. A business owned by multiple individuals may be referred to as a company, although that term also has a more precise meaning.

The etymology of "business" stems from the state of being busy, and implies commercially viable and profitable work. The term "business" has at least three usages, depending on the scope in which it is used. A business can mean a particular organization, while a more generalized usage refers to a particular market sector, i.e. "the music business". Compound forms such as agribusiness represent subsets of the word's broadest meaning, which encompasses all the activity by all the suppliers of goods and services.

Basic forms of business ownership

Forms of business ownership vary by jurisdiction, but several common forms exist:

Sole proprietorship: A sole proprietorship is owned by one person and operates for profit. The owner may operate the business alone or employ other people. A sole proprietor has unlimited liability for all obligations incurred by the business, whether from operating costs or judgements against the business. All assets of the business belong to a sole proprietor, including, for example, computer infrastructure, any inventory, manufacturing equipment and/or retail fixtures, as well as any real property owned by the business.

Partnership: A partnership is a business owned by two or more people. In most forms of partnerships, each partner has unlimited liability for the debts incurred by the business. The three most prevalent types of for-profit partnerships are general partnerships, limited partnerships, and limited liability partnerships.

Corporation: The owners of a corporation have limited liability and the business has a separate legal personality from its owners. Corporations can be either government-owned or owned by individuals. They can organize either for profit or as not-for-profit organizations. A non-government for-profit corporation is owned by its shareholders, who elect a board of directors to direct the corporation and hire its managerial staff. A privately owned, for-profit corporation can be either privately held by a small group of individuals, or publicly held, with publicly traded shares listed on a stock exchange.

Cooperative: Often referred to as a "co-op", a cooperative is a limited liability business that can organize for-profit or not-for-profit. A cooperative differs from a corporation in that it has members, not shareholders, and they share decision-making authority. Cooperatives are typically classified as either consumer cooperatives or worker cooperatives. Cooperatives are fundamental to the ideology of economic democracy.

Classifications

Agriculture and mining businesses produce raw material, such as plants or minerals.

Financial businesses include banks and other companies that generate profits through investment and management of capital.

Information businesses generate profits primarily from the sale of intellectual property and include movie studios, publishers and internet and software companies.

Manufacturers produce products, from raw materials or from component parts, then sell their products at a profit. Companies that make tangible goods such as cars, clothing or pipes are considered manufacturers.

Real estate businesses sell, rent, and develop properties including land, residential homes, and other buildings.

Retailers and distributors act as middlemen and get goods produced by manufacturers to the intended consumers, and make their profits by marking up their price. Most stores and catalog companies are distributors or retailers.

Service businesses offer intangible goods or services and typically charge for labor or other services provided to government, consumers, or other businesses. Interior decorators, consulting firms and even entertainers are service businesses.

Transportation businesses deliver goods and individuals to their destinations for a fee.

Utilities produce public services such as electricity or sewage treatment, usually under a government charter.

Management

Main article: Management

The efficient and effective operation of a business, and study of this subject, is called management. The major branches of management are financial management, marketing management, human resource management, strategic management, production management, operations management, service management and information technology management.

Owners may administer their businesses themselves, or employ of managers to do this for them. Whether they are owners or employees, managers administer three primary components of the business' value: its financial resources, capital or tangible resources, and human resources. These resources are administered in at least five functional areas: legal contracting, manufacturing or service production, marketing, accounting, financing, and human resources.

Restructuring state enterprises

In recent decades, various states modeled some of their assets and enterprises after business enterprises. In 2003, for example, the People's Republic of China modeled 80% of its state-owned enterprises on a company-type management system.Many state institutions and enterprises in China and Russia have transformed into joint-stock companies, with part of their shares being listed on public stock markets.

Business process management (BPM) is a holistic management approach focused on aligning all aspects of an organization with the wants and needs of clients. It promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology. BPM attempts to improve processes continuously. It can therefore be described as a "process optimization process." It is argued that BPM enables organizations to be more efficient, more effective and more capable of change than a functionally focused, traditional hierarchical management approach.

Organization and government regulation

See also: Theory of the firm

Most legal jurisdictions specify the forms of ownership that a business can take, creating a body of commercial law for each type.

The major factors affecting how a business is organized are usually:

The size and scope of the business firm and its structure, management, and ownership, broadly analyzed in the theory of the firm. Generally a smaller business is more flexible, while larger businesses, or those with wider ownership or more formal structures, will usually tend to be organized as corporations or (less often) partnerships. In addition, a business that wishes to raise money on a stock market or to be owned by a wide range of people will often be required to adopt a specific legal form to do so.

The sector and country. Private profit-making businesses are different from government-owned bodies. In some countries, certain businesses are legally obliged to be organized in certain ways.

Limited Liability Companies (LLC), limited liability partnerships, and other specific types of business organization protect their owners or shareholders from business failure by doing business under a separate legal entity with certain legal protections. In contrast, unincorporated businesses or persons working on their own are usually not so protected.

Tax advantages. Different structures are treated differently in tax law, and may have advantages for this reason.

Disclosure and compliance requirements. Different business structures may be required to make less or more information public (or report it to relevant authorities), and may be bound to comply with different rules and regulations.

Many businesses are operated through a separate entity such as a corporation or a partnership (either formed with or without limited liability). Most legal jurisdictions allow people to organize such an entity by filing certain charter documents with the relevant Secretary of State or equivalent and complying with certain other ongoing obligations. The relationships and legal rights of shareholders, limited partners, or members are governed partly by the charter documents and partly by the law of the jurisdiction where the entity is organized. Generally speaking, shareholders in a corporation, limited partners in a limited partnership, and members in a limited liability company are shielded from personal liability for the debts and obligations of the entity, which is legally treated as a separate "person". This means that unless there is misconduct, the owner's own possessions are strongly protected in law if the business does not succeed.

Where two or more individuals own a business together but have failed to organize a more specialized form of vehicle, they will be treated as a general partnership. The terms of a partnership are partly governed by a partnership agreement if one is created, and partly by the law of the jurisdiction where the partnership is located. No paperwork or filing is necessary to create a partnership, and without an agreement, the relationships and legal rights of the partners will be entirely governed by the law of the jurisdiction where the partnership is located.

A single person who owns and runs a business is commonly known as a sole proprietor, whether that person owns it directly or through a formally organized entity.

CHAPTER 2

Types of Industry

A few relevant factors to consider in deciding how to operate a business include:

General partners in a partnership (other than a limited liability partnership), plus anyone who personally owns and operates a business without creating a separate legal entity, are personally liable for the debts and obligations of the business.

Generally, corporations are required to pay tax just like "real" people. In some tax systems, this can give rise to so-called double taxation, because first the corporation pays tax on the profit, and then when the corporation distributes its profits to its owners, individuals have to include dividends in their income when they complete their personal tax returns, at which point a second layer of income tax is imposed.

In most countries, there are laws which treat small corporations differently from large ones. They may be exempt from certain legal filing requirements or labor laws, have simplified procedures in specialized areas, and have simplified, advantageous, or slightly different tax treatment.

"Going public" through a process known as an initial public offering (IPO) means that part of the business will be owned by members of the public. This requires organization as a distinct entity, and compliance with a tighter set of laws and procedures. Most public entities are corporations that have sold shares, but increasingly there are also public LLCs that sell units (sometimes also called shares), and other more exotic entities as well, such as, for example, real estate investment trusts in the USA, and unit trusts in the UK. A general partnership cannot "go public."

Commercial law

A very detailed and well-established body of rules that evolved over a very long period of time applies to commercial transactions. The need to regulate trade and commerce and resolve business disputes helped shape the creation of law and courts. The Code of Hammurabi dates back to about 1772 BC for example, and contains provisions that relate, among other matters, to shipping costs and dealings between merchants and brokers.The word "corporation" derives from the Latin corpus, meaning body, and the Maurya Empire in Iron-Age India accorded legal rights to business entities.

In many countries it is difficult to compile all the laws that can affect a business into a single reference source. Laws can govern treatment of labour and employee relations, worker protection and safety, discrimination on the basis of age, gender, disability, race, and in some jurisdictions, sexual orientation, and the minimum wage, as well as unions, worker compensation, and working hours and leave.

Some specialized businesses may also require licenses, either due to laws governing entry into certain trades, occupations or professions, that require special education, or to raise revenue for local governments. Professions that require special licenses include law, medicine, piloting aircraft, selling liquor, radio broadcasting, selling investment securities, selling used cars, and roofing. Local jurisdictions may also require special licenses and taxes just to operate a business.

Some businesses are subject to ongoing special regulation, for example, public utilities, investment securities, banking, insurance, broadcasting, aviation, and health care providers. Environmental regulations are also very complex and can affect many businesses.

Capital

When businesses need to raise money (called capital), they sometimes offer securities for sale.

Capital may be raised through private means, by an initial public offering or IPO on a stock exchange, or in other ways.

Major stock exchanges include the Shanghai Stock Exchange, Singapore Exchange, Hong Kong Stock Exchange, New York Stock Exchange and Nasdaq (USA), the London Stock Exchange (UK), the Tokyo Stock Exchange (Japan), and Bombay Stock Exchange (India). Most countries with capital markets have at least one.

Businesses that have gone public are subject to regulations concerning their internal governance, such as how executive officers' compensation is determined, and when and how information is disclosed to shareholders and to the public. In the United States, these regulations are primarily implemented and enforced by the United States Securities and Exchange Commission (SEC). Other Western nations have comparable regulatory bodies. The regulations are implemented and enforced by the China Securities Regulation Commission (CSRC) in China. In Singapore, the regulation authority is the Monetary Authority of Singapore (MAS), and in Hong Kong, it is the Securities and Futures Commission (SFC).

The proliferation and increasing complexity of the laws governing business have forced increasing specialization in corporate law. It is not unheard of for certain kinds of corporate transactions to require a team of five to ten attorneys due to sprawling regulation. Commercial law spans general corporate law, employment and labor law, health-care law, securities law, mergers and acquisitions, tax law, employee benefit plans, food and drug regulation, intellectual property law on copyrights, patents, trademarks and such, telecommunications law, and more.

Other types of capital sourcing includes crowd sourcing on the internet, venture capital, bank loans and debentures.

Intellectual property

Businesses often have important "intellectual property" that needs protection from competitors for the company to stay profitable. This could require patents, copyrights, trademarks or preservation of trade secrets. Most businesses have names, logos and similar branding techniques that could benefit from trademarking. Patents and copyrights in the United States are largely governed by federal law, while trade secrets and trademarking are mostly a matter of state law. Because of the nature of intellectual property, a business needs protection in every jurisdiction in which they are concerned about competitors. Many countries are signatories to international treaties concerning intellectual property, and thus companies registered in these countries are subject to national laws bound by these treaties. In order to protect trade secrets, companies may require employees to sign non-compete clauses which will impose limitations on an employee's interactions with stakeholders, and competitors.

Cottage industry

Definition An industry where the creation of products and services is home-based, rather than factory-based. While products and services created by cottage industry are often unique and distinctive given the fact that they are usually not mass-produced, producers in this sector often face numerous disadvantages when trying to compete with much larger factory-based companies.

A cottage industry is an industry—primarily manufacturing—which includes many producers, working from their homes, typically part time. The term originally referred to home workers who were engaged in a task such as sewing, lace-making, wall hangings or household manufacturing. Some industries which are usually operated from large centralized factories were cottage industries before the Industrial Revolution. Business operators would travel around, buying raw materials, delivering them to people who would work on them, and then collecting the finished goods to sell, or typically to ship to another market. One of the factors which allowed the Industrial Revolution to take place in Western Europe was the presence of these business people who had the ability to expand the scale of their operations. Cottage industries were very common in the time when a large proportion of the population was engaged in agriculture, because the farmers (and their families) often had both the time and the desire to earn additional income during the part of the year (winter) when there was little work to do farming or selling produce by the farm's roadside.

The use of the term has expanded, and is used to refer to any event which allows a large number of people to work part time. For example, eBay is said to have spawned a cottage industry of people who buy surplus merchandise, and sell it on their auction system. Another example of a cottage industry is the "ecosystem of devoted news sites" dedicated to the prediction of products that Apple Inc. will roll out next.

Homeworkers or home workers are defined by the International Labour Organization as people working from their homes or from other premises of their choosing other than the workplace, for payment, which results of a product or service specified by the employer. There are an estimated 300 million homeworkers in the world, though because these workers generally function in the informal economy, and are seldom registered and often not contracted, exact numbers are difficult to come by. Recently, the phenomenon of homework has grown with increased communication technology, as well as changes in supply chains, particularly the development of Just In Time inventory systems.

Homeworkers differ from entrepreneurs, or self-employed, or family business, in that they are hired by companies for specific activities or services to be done from their homes. Homeworkers do not own or operate the business they work for. Though there is a significant body of highly skilled homeworkers, particularly in information technology, most homeworkers are considered low skilled labour. Recently, working conditions have worsened for homeworkers, and they are becoming a point of concern for international development organizations and non-governmental organizations.

Heavy industry

Heavy industry does not have a single fixed meaning as compared to light industry. It can mean production of products which are either heavy in weight or in the processes leading to their production. In general, it is a popular term used within the name of many Japanese and Korean firms, meaning 'construction' for big projects. Example projects include the construction of large buildings, chemical plants, the H-IIA rocket and also includes the production of construction equipment such as cranes and bulldozers. Alternatively, heavy industry projects can be generalized as more capital intensive or as requiring greater or more advanced resources, facilities or management.

U. S. Steel Košice (in Slovakia) - a typical example of a heavy industry factory.

Many East Asian companies rely on heavy industry as part of their overall economy. Amongst Japanese and Korean firms with "heavy industry" in their names, many are also manufacturers of aerospace products and defense armaments, along with being defense contractors to their respective countries' governments such as Japan's Fuji Heavy Industries and Korea's Hyundai Rotem, a joint project of Hyundai Heavy Industries and Daewoo Heavy Industries.

Heavy industry is also sometimes a special designation in local zoning laws.

Light industry

Light industry is usually less capital intensive than heavy industry, and is more consumer-oriented than business-oriented (i.e., most light industry products are produced for end users rather than as intermediates for use by other industries). Light industry facilities typically have less environmental impact than those associated with heavy industry, and zoning laws are more likely to permit light industry near residential areas. It is the production of small consumer goods.

One economic definition states that light industry is a "manufacturing activity that uses moderate amounts of partially processed materials to produce items of relatively high value per unit weight".

Examples of light industries include the manufacturing of clothes, shoes, furniture, consumer electronics and home appliances. Conversely, ship building would fall under heavy industry.

Characteristics

Low industries require only a small amount of raw materials, area and power. The value of the goods are low and they are easy to transport. The number of products is high. While light industry typically causes little pollution, particularly when compared to heavy industries, some light industry can cause significant pollution or risk of contamination. Electronics manufacturing, itself often a light industry, can create potentially harmful levels of lead or chemical wastes in soil due to improper handling of solder and waste products (such as cleaning and degreasing agents used in manufacture).

Manufacturing

Manufacturing is the production of merchandise for use or sale using labor and machines, tools, chemical and biological processing, or formulation. The term may refer to a range of human activity, from handicraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods on a large scale. Such finished goods may be used for manufacturing other, more complex products, such as aircraft, household appliances or automobiles, or sold to wholesalers, who in turn sell them to retailers, who then sell them to end users – the "consumers".

Manufacturing takes turns under all types of economic systems. In a free market economy, manufacturing is usually directed toward the mass production of products for sale to consumers at a profit. In a collectivist economy, manufacturing is more frequently directed by the state to supply a centrally planned economy. In mixed market economies, manufacturing occurs under some degree of government regulation.

Modern manufacturing includes all intermediate processes required for the production and integration of a product's components. Some industries, such as semiconductor and steel manufacturers use the term fabrication instead.

The manufacturing sector is closely connected with engineering and industrial design. Examples of major manufacturers in North America include General Motors Corporation, General Electric, Procter & Gamble, General Dynamics, Boeing, and Pfizer. Examples in Europe include Volkswagen Group, Siemens, and Michelin. Examples in Asia include Toyota, Samsung, and Bridgestone.

History and development

In its earliest form, manufacturing was usually carried out by a single skilled artisan with assistants. Training was by apprenticeship. In much of the pre-industrial world, the guild system protected the privileges and trade secrets of urban artisans.

Before the Industrial Revolution, most manufacturing occurred in rural areas, where household-based manufacturing served as a supplemental subsistence strategy to agriculture (and continues to do so in places). Entrepreneurs organized a number of manufacturing households into a single enterprise through the putting-out system.

Toll manufacturing is an arrangement whereby a first firm with specialized equipment processes raw materials or semi-finished goods for a second firm.

CHAPTER 3

Industrial Design

Industrial design is the use of both applied art and applied science to improve the aesthetics, ergonomics, functionality, and/or usability of a product, and it may also be used to improve the product's marketability and even production. The role of an industrial designer is to create and execute design solutions for problems of form, usability, physical ergonomics, marketing, brand development, and sales.

Industrial design can overlap significantly with engineering design, and in different countries the boundaries of the two concepts can vary, but in generalengineering focuses principally on functionality or Utility of Products whereas industrial design focuses principally on aesthetic and user-interfaceaspects of products. In many jurisdictions this distinction is effectively defined by credentials and/or licensure required to engage in the practice of engineering. "Industrial design" as such does not overlap much with the engineering sub-discipline of industrial engineering, except for the latter's sub-specialty of ergonomics.

The first use of the term "industrial design" is often attributed to the industrial designer Joseph Claude Sinel in 1919 (although he himself denied this in interviews), but the discipline predates 1919 by at least a decade. Christopher Dresser is considered the world's first industrial designer. Industrial design's origins lie 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.

The earliest use of the term may have been in The Art Union, A monthly Journal of the Fine Arts, 1839:

"Dyce's report to the Board of Trade on foreign schools of Design for Manufactures. Mr Dyces official visit to France, Prussia and Bavaria for the purpose of examining the state of schools of design in those countries will be fresh in the recollection of our readers. His report on this subject was ordered to be printed some few months since, on the motion of Mr Hume."

"The school of St Peter, at Lyons was founded about 1750 for the instruction of draftsmen employed in preparing patterns for the silk manufacture. It has been much more successful than the Paris school and having been disorganized by the revolution, was restored by Napoleon and differently constituted, being then erected into an Academy of Fine Art: to which the study of design for silk manufacture was merely attached as a subordinate branch. It appears that all the students who entered the school commence as if they were intended for artists in the higher sense of the word and are not expected to decide as to whether they will devote themselves to the Fine Arts or to Industrial Design, until they have completed their exercises in drawing and painting of the figure from the antique and from the living model. It is for this reason, and from the fact that artists for industrial purposes are both well paid and highly considered (as being well instructed men) that so many individuals in France engage themselves in both pursuits."

The practical draughtsman's book of industrial design: was printed in 1853.

Robert Lepper helped to establish one of the country's first industrial design degree programs at Carnegie Institute of Technology.

Education

Product design and industrial design overlap into the fields of user interface design, information design, and interaction design. Various schools of industrial design and design engineering specialize in one of these aspects, ranging from pure art colleges (product styling) through mixed programs of engineering and design, related disciplines such as exhibit design and interior design—to schools that almost completely subordinated aesthetic design to concerns of usage and ergonomics(the so-called functionalist school).

University and Institutions

Degrees in industrial design are offered at universities worldwide and typically take four to five years of study. The study results in a Bachelor of Industrial Design (B.I.D.) or Bachelor of Science(B.Sc). Afterwards, the bachelor programme can be extended to postgraduate degrees such as Master of Design, Master of Fine Arts and others to a Master of Arts or Master of Science.

Definition of industrial design

Industrial design studies function and form—and the connection between product, user, and environment. Generally, industrial design professionals work in small scale design, rather than overall design of complex systems such as buildings or ships. Industrial designers don't usually design motors, electrical circuits, or gearing that make machines move, but they may affect technical aspects through usability design and form relationships. Usually, they work with other professionals such as marketers to identify and fulfill customer needs and expectations.

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.

Industrial Designers Society of America,

Design, itself, is often difficult to describe to non-designers and engineers, because the meaning accepted by the design community is not 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.

Design process

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 are best defined by the industrial 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. They may also build a prototype first and then use industrial CT scanning to test for interior defects and generate a CAD model. From this the manufacturing process may be modified to improve the product.

Product characteristics specified by industrial designers may include the overall form of the object, the location of details with respect to one another,colors, texture, form, and aspects concerning the use of the product. Additionally they 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 inclusion of industrial designers in a product development process may lead to added value by improving usability, lowering production costs and developing more appealing products.

Industrial design may also focus on technical concepts, products, and processes. In addition to aesthetics, usability, and ergonomics, it can also encompass engineering, usefulness, market placement, and other concerns—such as psychology, desire, and the emotional attachment of the user. These values and accompanying aspects that form the basis of industrial design can vary—between different schools of thought, and among practicing designers.

Industrial design rights

Main article: Industrial design rights

Industrial design rights are intellectual property rights that make exclusive the visual design of objects that are not purely utilitarian. A design patent would also be considered under this category. 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.

Examples of iconic industrial design

Chair by Charles Eames

A number of industrial designers have made such a significant impact on culture and daily life that their work is documented by historians of social science. 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.

Oskar Barnack was a German optical engineer, precision mechanic, industrial designer, and the father of 35mm photography. He developed the Leica, which became the hallmark for photography for 50 years, and remains a high-water mark for mechanical and optical design.

Charles and Ray Eames were most famous for their pioneering furniture designs, such as the Eames Lounge Chair Wood and Eames Lounge Chair. Other influential designers included Henry Dreyfuss, Eliot Noyes, and Russel Wright.

Dieter Rams is a German industrial designer closely associated with the consumer products company Braun and the Functionalist school of industrial design.

According to some economists, manufacturing is a wealth-producing sector of an economy, whereas a service sector tends to be wealth-consuming.Emerging technologies have provided some new growth in advanced manufacturing employment opportunities in the Manufacturing

Belt in the United States. Manufacturing provides important material support for national infrastructure and for national defense.

On the other hand, most manufacturing may involve significant social and environmental costs. The clean-up costs of hazardous waste, for example, may outweigh the benefits of a product that creates it. Hazardous materials may expose workers to health risks. These costs are now well known and there is effort to address them by improving efficiency, reducing waste, using industrial symbiosis, and eliminating harmful chemicals. The increased use of technologies such as 3D printing also offer the potential to reduce the environmental impact of producing finished goods through distributed manufacturing.

The negative costs of manufacturing can also be addressed legally. Developed countries regulate manufacturing activity with labor laws and environmental laws. Across the globe, manufacturers can be subject to regulations and pollution taxes to offset the environmental costs of manufacturing activities. Labor unions and craft guilds have played a historic role in the negotiation of worker rights and wages. Environment laws and labor protections that are available in developed nations may not be available in the third world. Tort law and product liability impose additional costs on manufacturing. These are significant dynamics in the on-going process, occurring over the last few decades, of manufacture-based industries relocating operations to "developing-world" economies where the costs of production are significantly lower than in "developed-world" economies.

Manufacturing may require huge amounts of fossil fuels. Automobile construction requires, on average, 20 barrels of oil.

Manufacturing and investment

Surveys and analyses of trends and issues in manufacturing and investment around the world focus on such things as:

the nature and sources of the considerable variations that occur cross-nationally in levels of manufacturing and wider industrial-economic growth;

competitiveness; and

attractiveness to foreign direct.

In addition to general overviews, researchers have examined the features and factors affecting particular key aspects of manufacturing development. They have compared production and investment in a range of Western and non-Western countries and presented case studies of growth and performance in important individual industries and market-economic sectors.

On June 26, 2009, Jeff Immelt, the CEO of General Electric, called for the United States to increase its manufacturing base employment to 20% of the workforce, commenting that the U.S. has outsourced too much in some areas and can no longer rely on the financial sector and consumer spending to drive demand. Further, while U.S. manufacturing performs well compared to the rest of the U.S. economy, research shows that it performs poorly compared to manufacturing in other high-wage countries. A total of 3.2 million – one in six U.S. manufacturing jobs – have disappeared between 2000 and 2007. In the UK, EEF the manufacturers organisation has led calls for the UK economy to be rebalanced to rely less on financial services and has actively promoted the manufacturing agenda.

Exergy analysis is performed in the field of industrial ecology to use energy more efficiently. The term exergy was coined by Zoran Rant in 1956, but the concept was developed by J. Willard Gibbs. In recent decades, utilization of exergy has spread outside of physics and engineering to the fields of industrial ecology, ecological economics, systems ecology, and energetics.

Recently, there has been work advocating for large scale photovoltaic production facilities in an industrial ecology setting. These facilities not only reduce their environmental impact but also decrease the costs of photovoltaic productions to as little as $1 per Watt by economy of scale.

CHAPTER 4

Industrial Ecology

Industrial ecology (IE) is the study of material and energy flows through industrial systems. The global industrial economy can be modeled as a network of industrial processes that extract resources from the Earth and transform those resources into commodities which can be bought and sold to meet the needs of humanity. Industrial ecology seeks to quantify the material flows and document the industrial processes that make modern society function. Industrial ecologists are often concerned with the impacts that industrial activities have on the environment, with use of the planet's supply of natural resources, and with problems of waste disposal. Industrial ecology is a young but growing multidisciplinary field of research which combines aspects of engineering, economics, sociology, toxicology and the natural sciences.

Industrial ecology has been defined as a "systems-based, multidisciplinary discourse that seeks to understand emergent behaviour of complex integrated human/natural systems". The field approaches issues of sustainability by examining problems from multiple perspectives, usually involving aspects of sociology, the environment, economy and technology. The name comes from the idea that the analogy of natural systems should be used as an aid in understanding how to design sustainable industrial systems.

Example of Industrial Symbiosis. Waste steam from a waste incinerator (right) is piped to anethanol plant (left) where it is used as in input to their production process.

Industrial ecology is concerned with the shifting of industrial process from linear (open loop) systems, in which resource and capital investments move through the system to become waste, to a closed loop system where wastes can become inputs for new processes.

Much of the research focuses on the following areas:

- material and energy flow studies ("industrial metabolism")
- dematerialization and decarbonization
- technological change and the environment
- life-cycle planning, design and assessment

- design for the environment ("eco-design")
- extended producer responsibility ("product stewardship")
- eco-industrial parks ("industrial symbiosis")
- product-oriented environmental policy
- eco-efficiency

Industrial ecology seeks to understand the way in which industrial systems (for example a factory, an ecoregion, or national or global economy) interact with the biosphere. Natural ecosystems provide a metaphor for understanding how different parts of industrial systems interact with one another, in an "ecosystem" based on resources and infrastructural capital rather than on natural capital. It seeks to exploit the idea that natural systems do not have waste in them to inspire sustainable design.

Along with more general energy conservation and material conservation goals, and redefining commodity markets and product stewardshiprelations strictly as a service economy, industrial ecology is one of the four objectives of Natural Capitalism. This strategy discourages forms of amoral purchasing arising from ignorance of what goes on at a distance and implies a political economy that values natural capital highly and relies on more instructional capital to design and maintain each unique industrial ecology.

History

History of Industrial Ecology

Industrial ecology was popularized in 1989 in a Scientific American article by Robert Frosch and Nicholas E. Gallopoulos. Frosch and Gallopoulos' vision was "why would not our industrial system behave like an ecosystem, where the wastes of a species may be resourceto another species? Why would not the outputs of an industry be the inputs of another, thus reducing use of raw materials, pollution, and saving on waste treatment?" A notable example resides in a Danish industrial park in the city of Kalundborg. Here several linkages of byproducts and waste heat can be found between numerous entities such as a large power plant, an oil refinery, a pharmaceutical plant, a plasterboard factory, an enzyme manufacturer, a waste company and the city itself.

The scientific field Industrial Ecology has grown quickly in recent years. The Journal of Industrial Ecology (since 1997), the International Society for Industrial Ecology (since 2001), and the journal Progress in Industrial Ecology (since 2004) give Industrial Ecology a strong and dynamic position in the international scientific community. Industrial Ecology principles are also emerging in various policy realms such as the concept of the Circular Economy that is being promoted in China. Although the definition of the Circular Economy has yet to be formalized, generally the focus is on strategies such as creating a circular flow of materials, and cascading energy flows. An example of this would be using waste heat from one process to run another process that requires a lower temperature. The hope is that strategy such as this will create a more efficient economy with fewer pollutants and other unwanted by-products.

Principles

One of the central principles of Industrial Ecology is the view that societal and technological systems are bounded within the biosphere, and do not exist outside of it. Ecology is used as ametaphor due to the observation that natural systems reuse materials and have a largely closed loop cycling of nutrients. Industrial Ecology approaches problems with the hypothesis that by using similar principles as natural systems, industrial systems can be improved to reduce their impact on the natural environment as well. The table shows the general metaphor.

Biosphere Technosphere

- Environment
- Organism
- Natural Product
- Natural Selection
- Ecosystem
- Ecological Niche

- Anabolism / Catabolism
- Mutation and Selection
- Succession
- Adaptation
- Food Web
- Market
- Company
- Industrial Product
- Competition
- Eco-Industrial Park
- Market Niche
- Manufacturing / Waste Management
- Design for Environment
- Economic Growth
- Innovation
- Product Life Cycle

The Kalundborg industrial park is located in Denmark. This industrial park is special because companies reuse each other's waste (which then becomes by-products). For example, the Energy E2 Asnæs Power Station produces gypsum as a by-product of the electricity generation process; this gypsum becomes a resource for the BPB Gyproc A/S which produces plasterboards.This is one example of a system inspired by the biosphere-technosphere metaphor: in ecosystems, the waste from one organism is used as inputs to other organisms; in industrial systems, waste from a company is used as a resource by others.

Apart from the direct benefit of incorporating waste into the loop, the use of an eco-industrial park can be a means of making renewable energy generating plants, like Solar PV, more economical and environmentally friendly. In essence, this assists the growth of the renewable energy industry and the environmental benefits that come with replacing fossil-fuels.

IE examines societal issues and their relationship with both technical systems and the environment. Through this holistic view , IE recognizes that solving problems must involve understanding the connections that exist between these systems, various aspects cannot be viewed in isolation. Often changes in one part of the overall system can propagate and cause changes in another part. Thus, you can only understand a problem if you look at its parts in relation to the whole. Based on this framework, IE looks at environmental issues with a systems thinking approach.

Take a city for instance. A city can be divided into commercial areas, residential areas, offices, services, infrastructures, etc. These are all sub-systems of the 'big city' system. Problems can emerge in one sub-system, but the solution has to be global. Let's say the price of housing is rising dramatically because there is too high a demand for housing. One solution would be to build new houses, but this will lead to more people living in the city, leading to the need of more infrastructure like roads, schools, more supermarkets, etc. This system is a simplified interpretation of reality whose behaviors can be 'predicted'.

In many cases, the systems IE deals with are complex systems. Complexity makes it difficult to understand the behavior of the system and may lead to rebound effects. Due to unforeseen behavioral change of users or consumers, a measure taken to improve environmental performance does not lead to any improvement or may even worsen the situation. For instance, in big cities, traffic can become problematic. Let's imagine the government wants to reduce air pollution and makes a policy stating that only cars with an even license plate number can drive on Tuesdays and Thursdays. Odd license plate numbers can drive on Wednesdays and Fridays. Finally, the other days, both cars are allowed on the roads. The first effect could be that people buy a second car, with a specific demand for license plate numbers, so they can drive every day. The rebound effect is that, the days when all cars are allowed to drive, some inhabitants now use both cars (whereas they only had one car to use before the policy). The policy did obviously not lead to environmental improvement but even made air pollution worse.

Moreover, life cycle thinking is also a very important principle in industrial ecology. It implies that all environmental impacts caused by a product, system, or project during its life cycle are taken into account. In this context life cycle includes

- Raw material extraction
- Material processing
- Manufacture
- Use
- Maintenance
- Disposal

The transport necessary between these stages is also taken into account as well as, if relevant, extra stages such as reuse, remanufacture, and recycle. Adopting a life cycle approach is essential to avoid shifting environmental impacts from one life cycle stage to another. This is commonly referred to as problem shifting. For instance, during the re-design of a product, one can choose to reduce its weight, thereby decreasing use of resources. However, it is possible that the lighter materials used in the new product will be more difficult to dispose of. The environmental impacts of the product gained during the extraction phase are shifted to the disposal phase. Overall environmental improvements are thus null.

A final and important principle of IE is its integrated approach or multidisciplinarity. IE takes into account three different disciplines: social sciences (including economics), technical sciences and environmental sciences. The challenge is to merge them into a single approach.

Tools

People Planet Profit Modeling

- Stakeholder analysis
- Strength Weakness Opportunities Threats Analysis (SWOT Analysis)
- Ecolabelling

- ISO 14000
- Environmental management system (EMS)
- Integrated chain management (ICM)
- Technology assessment
- Environmental impact assessment (EIA)
- Input-output analysis (IOA)
- Life-cycle assessment (LCA)
- Material flow analysis (MFA)
- Substance flow analysis (SFA)
- MET Matrix
- Cost benefit analysis (CBA)
- Full cost accounting (FCA)
- Life cycle costing (LCC)
- Stock and flow analysis
- Agent based modeling

Criticisms

The discipline of industrial ecology is to a large part based on the implicit assumption that if "we just get our technologies right", the problems of environmental pollution and unsustainability will be solved. This is the reason why most current research in industrial ecology is focused on technological innovation (i.e., the T in the IPAT equation), such as improvements in eco-efficiency, design for environment, material flow analysis, etc. This simplistic view has been recently questioned by Huesemann and Huesemann who demonstrate that negative unintended consequences of technology are inherently unpredictable and unavoidable, that most current techno-optimism reflected in industrial ecology is unjustified, and that modern technology, in the presence of continued economic growth, does not promote sustainability, but hastens collapse. Therefore, more than technological tinkering is needed to achieve long-term sustainability. Most importantly, the problem of human overpopulation must be addressed immediately and a transition to a steady state economy is needed to guarantee environmental and societal sustainability.

Future directions

The ecosystem metaphor popularized by Frosch and Gallopoulos has been a valuable creative tool for helping researchers look for novel solutions to difficult problems. Recently, it has been pointed out that this metaphor is based largely on a model of classical ecology, and that advancements in understanding ecology based on complexity science have been made by researchers.

CHAPTER 5

Information Industry

The information industry or information industries are industries that are information intensive in one way or the other. It is considered one of the most important economic sectors for a variety of reasons.

There are many different kinds of information industries, and many different ways to classify them. Although there is no standard or distinctively better way of organizing those different views, the following section offers a review of what the term "information industry" might entail, and why. Alternative conceptualizations are that of knowledge industry and information-related occupation. The term "information industry" is mostly identified with computer programming, system design, telecommunications, and others.

Types

First, there are companies which produce and sell information in the form of goods or services. Media products such as television programs and movies, published books and periodicals would constitute probably among the most accepted part of what information goods can be. Some information is provided not as a tangible commodity but as a service. Consulting is among the least controversial of this kind. However, even for this category, disagreements can occur due to the vagueness of the term "information." For some, information is knowledge about a subject, something one can use to improve the performance of other activities—it does not include arts and entertainments. For others, information is something that is mentally processed and consumed, either to improve other activities (such as production) or for personal enjoyment; it would include artists and architects. For yet others, information may include anything that has to do with sensation, and therefore information industries may include even such things as restaurant, amusement parks, and prostitution to the extent that food, park ride, and sexual intercourse have to do with senses. In spite of the definitional problems, industries producing information goods and services are called information industries.

Second, there are information processing services. Some services, such as legal services, banking, insurance, computer programming, data processing, testing, and market research, require intensive and intellectual processing of information. Although those services do not necessarily provide information, they often offer expertise in making decisions on behalf of clients. These kinds of service industries can be regarded as an information-intensive part of various industries that is externalized and specialized.

Third, there are industries that are vital to the dissemination of the information goods mentioned above. For example, telephone, broadcasting and book retail industries do not produce much information, but their core business is to disseminate information others produced. These industries handle predominantly information and can be distinguished from wholesale or retail industries in general. It is just a coincidence, one can argue, that some of those industries are separately existing from the more obvious information-producing industries. For example, in the United States, as well as some other countries, broadcasting stations produce very limited amount of programs they broadcast. But this is not the only possible form of division of labor. If legal, economic,cultural, and historical circumstances were different, the broadcasters would have been the producers of their own programs. Therefore, in order to capture the information related activities of the economy, it might be a good idea to include this type of industry. These industries show how much of an economy is about information, as opposed to materials. It is useful to differentiate production of valuable information from processing that information in a sophisticated way, from the movement of information.

Fourth, there are manufacturers of information-processing devices that require research and sophisticated decision-making. These products are vital to information-processing activities of above mentioned industries. The products include computers of various levels and many other microelectronic devices, as well as software programs. Printing and copying machines, measurement and recording devices of various kinds, electronic or otherwise, are also in this category. The role of these tools are to automate certain information-processing activities. The use of some of these tools may be very simple (as in the case of some printing), and the processing done by the tools may be very simple (as in copying and some calculations) rather than intellectual and sophisticated. In other words, the specialization of these industries in an economy is neither production of information nor sophisticated decision-making. Instead, this segment serves as an infrastructure for those activities, making production of information and decision-making services will be a lot less efficient. In addition, these industries tend to be "high-tech" or research intensive - trying to find more efficient ways to boost efficiency of information production and sophisticated decision-making. For example, the function of a standard calculator is quite simple and it is easy to how to use it. However, manufacturing a well-functioning standard calculator takes a lot of processes, far more than the task of calculation performed by the users.

Fifth, there are very research-intensive industries that do not serve as infrastructure to information-production or sophisticated decision-making. Pharmaceutical, food-processing, some apparel design, and some other "high-tech" industries belong to this type. These products are not exclusively for information production or sophisticated decision-making, although many are helpful. Some services, such as medical examination are in this category as well. One can say these industries involve a great deal of sophisticated decision-making, although that part is combined with manufacturing or "non-informational" activities.

Finally, there are industries that are not research intensive, but serve as infrastructure for information production and sophisticated decision-making. Manufacturing of office furniture would be a good example, although it sometimes involves research in ergonomics and development of new materials.

As stated above, this list of candidates for information industries is not a definitive way of organizing differences that researchers may pay attention to when they define the term. Among the difficulties is, for example, the position of advertising industry.

Importance

Information industries are considered important for several reasons. Even among the experts who think industries are important, disagreements may exist regarding which reason to accept and which to reject.

First, information industries is a rapidly growing part of economy. The demand for information goods and services from consumers is increasing. In case of consumers, media including music and motion picture, personal computers, video game-related industries, are among the information industries. In case of businesses, information industries include computer programming, system design, so-called FIRE (finance, insurance, and real estate) industries, telecommunications, and others. When demand for these industries are growing nationally or internationally, that creates an opportunity for an urban, regional, or national economy to grow rapidly by specializing on these sectors.

Second, information industries are considered to boost innovation and productivity of other industries. An economy with a strong information industry might be a more competitive one than others, other factors being equal.

Third, some believe that the effect of the changing economic structure (or composition of industries within an economy) is related to the broader social change. As information becomes the central part of our economic activities we evolve into an "information society", with an increased role of mass media, digital technologies, and other mediated information in our daily life, leisure activities, social life, work, politics, education, art, and many other aspects of society.

he energy industry is the totality of all of the industries involved in the production and sale of energy, including fuel extraction, manufacturing, refining and distribution. Modern society consumes large amounts of fuel, and the energy industry is a crucial part of the infrastructure and maintenance of society in almost all countries.

In particular, the energy industry comprises:

- the petroleum industry, including oil companies, petroleum refiners, fuel transport and end-user sales at gas stations
- the gas industry, including natural gas extraction, and coal gas manufacture, as well as distribution and sales
- the electrical power industry, including electricity generation, electric power distribution and sales
- the coal industry
- the nuclear power industry
- the renewable energy industry, comprising alternative energy and sustainable energy companies, including those involved in hydroelectric power, wind power, and solar power generation, and the manufacture, distribution and sale of alternative fuels

- traditional energy industry based on the collection and distribution of firewood, the use of which, for cooking and heating, is particularly common in poorer countries

Energy consumption in kilograms of oil equivalent (kgoe) per person per year per country (2001 data). Darker tones indicate larger consumption (dark grey areas are missing from the dataset). Red hue indicates increasing consumption, green hue indicates decreasing consumption, in the time between 1990 and 2001.

History

The use of energy has been a key in the development of the human society by helping it to control and adapt to the environment. Managing the use of energy is inevitable in any functional society. In the industrialized world the development of energy resources has become essential for agriculture, transportation, waste collection, information technology, communications that have become prerequisites of a developed society. The increasing use of energy since the Industrial Revolution has also brought with it a number of serious problems, some of which, such as global warming, present potentially grave risks to the world.

In society and in the context of humanities, the word energy is used as a synonym of energy resources, and most often refers to substances like fuels, petroleum products and electricity in general. These are sources of usable energy, in that they can be easily transformed to other kinds of energy sources that can serve a particular useful purpose. This difference vis a vis energy in natural sciences can lead to some confusion, because energy resources are not conserved in nature in the same way as energy is conserved in the context of physics. The actual energy content is always conserved, but when it is converted into heat for example, it usually becomes less useful to society, and thus appears to have been "used up".

Ever since humanity discovered various energy resources available in nature, it has been inventing devices, known as machines, that make life more comfortable by using energy resources. Thus, although the primitive man knew the utility of fire to cook food, the invention of devices like gas burners and microwave ovens has increased the usage of energy for this purpose alone manifold. The trend is the same in any other field of social activity, be it construction of social infrastructure, manufacturing of fabrics for covering; porting; printing; decorating, for example textiles, air conditioning; communication of information or for moving people and goods (automobiles).

Economics

Production and consumption of energy resources is very important to the global economy. All economic activity requires energy resources, whether to manufacture goods, provide transportation, run computers and other machines.

Widespread demand for energy may encourage competing energy utilities and the formation of retail energy markets. Note the presence of the "Energy Marketing and Customer Service" (EMACS) sub-sector.

Management

Main article: Energy demand management

Since the cost of energy has become a significant factor in the performance of economy of societies, management of energy resources has become very crucial. Energy management involves utilizing the available energy resources more effectively that is with minimum incremental costs. Many times it is possible to save expenditure on energy without incorporating fresh technology by simple management techniques. Most often energy management is the practice of using energy more efficiently by eliminating energy wastage or to balance justifiable energy demand with appropriate energy supply. The process couples energy awareness with energy conservation.

Government

The United Nations developed the International Standard Industrial Classification, which is a list of economic and social classifications. There is no distinct classification for an energy industry, because the classification system is based on activities, products, and expenditures according to purpose.

Countries in North America use the North American Industry Classification System (NAICS). The NAICS sectors #21 and #22 (mining and utilities) might roughly define the energy industry in North America. This classification is used by the U.S. Securities and Exchange Commission.

Financial market

The Global Industry Classification Standard used by Morgan Stanley define the energy industry as comprising companies primarily working with oil, gas, coal and consumable fuels, excluding companies working with certain industrial gases.

Add also to expand this section: Dow Jones Industrial Average

Environmental impact

Main article: Environmental impact of the energy industry

Government encouragement in the form of subsidies and tax incentives for energy-conservation efforts has increasingly fostered the view of conservation as a major function of the energy industry: saving an amount of energy provides economic benefits almost identical to generating that same amount of energy. This is compounded by the fact that the economics of delivering energy tend to be priced for capacity as opposed to average usage. One of the purposes of a smart grid infrastructure is to smooth out demand so that capacity and demand curves align more closely.

Some parts of the energy industry generate considerable pollution, including toxic and greenhouse gases from fuel combustion, nuclear waste from the generation of nuclear power, and oil spillages as a result of petroleum extraction. Government regulations to internalize these externalities form an increasing part of doing business, and the trading of carbon credits and pollution credits on the free market may also result in energy-saving and pollution-control measures becoming even more important to energy provide

CHAPTER 6

Economy of scale

In microeconomics, economies of scale are the cost advantages that enterprises obtain due to size, throughput, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output (incremental production). Often operational efficiency is also greater with increasing scale, leading to lower variable cost as well.

Economies of scale apply to a variety of organizational and business situations and at various levels, such as a business or manufacturing unit, plant or an entire enterprise. For example, a large manufacturing facility would be expected to have a lower cost per unit of output than a smaller facility, all other factors being equal, while a company with many facilities should have a cost advantage over a competitor with fewer.

Some economies of scale, such as capital cost of manufacturing facilities and friction loss of transportation and industrial equipment, have a physical or engineering basis.

The economic concept dates back to Adam Smith and the idea of obtaining larger production returns through the use of division of labor. Diseconomies of scale are the opposite.

Economies of scale often have limits, such as passing the optimum design point where costs per additional unit begin to increase. Common limits include exceeding the nearby raw material supply, such as wood in the lumber, pulp and paper industry. A common limit for low cost per unit weight commodities is saturating the regional market, thus having to ship product uneconomical distances. Other limits include using energy less efficiently or having a higher defect rate.

Large producers are usually efficient at long runs of a product grade (a commodity) and find it costly to switch grades frequently. They will therefore avoid specialty grades even though they have higher margins. Often smaller (usually older) manufacturing facilities remain viable by changing from commodity grade production to specialty products.

The simple meaning of economies of scale is doing things more efficiently with increasing size or speed of operation. Economies of scale often originate with fixed capital, which is lowered per unit of production as design capacity increases. In wholesale and retail distribution, increasing the speed of operations, such as order fulfillment, lowers the cost of both fixed and working capital. Other common sources of economies of scale are purchasing (bulk buying of materials through long-term contracts), managerial (increasing the specialization of managers), financial (obtaining lower-interest charges when borrowing from banks and having access to a greater range of financial instruments), marketing (spreading the cost of advertising over a greater range of output inmedia markets), and technological (taking advantage of returns to scale in the production function). Each of these factors reduces the long run average costs (LRAC) of production by shifting theshort-run average total cost (SRATC) curve down and to the right.

Economies of scale is a practical concept that may explain real world phenomena such as patterns of international trade or the number of firms in a market. The exploitation of economies of scale helps explain why companies grow large in some industries. It is also a justification for free trade policies, since some economies of scale may require a larger market than is possible within a particular country—for example, it would not be efficient for Liechtenstein to have its own car maker, if they only sold to their local market. A lone car maker may be profitable, but even more so if they exported cars to global markets in addition to selling to the local market. Economies of scale also play a role in a "natural monopoly."

The management thinker and translator of the Toyota Production System for service, Professor John Seddon, argues that attempting to create economies by increasing scale is powered by myth in the service sector. Instead, he believes that economies will come from improving the flow of a service, from first receipt of a customer's demand to the eventual satisfaction of that demand. In trying to manage and reduce unit costs, firms often raise total costs by creating failure demand. Seddon claims that arguments for economy of scale are a mix of a) the plausibly obvious and b) a little hard data, brought together to produce two broad assertions, for which there is little hard factual evidence.

Physical and engineering basis

Some of the economies of scale recognized in engineering have a physical basis, such as the square-cube law, by which the surface of a vessel increases by the square of the dimensions while the volume increases by the cube. This law has a direct effect on the capital cost of such things as buildings, factories, pipelines, ships and airplanes.

In structural engineering, the strength of beams increases with the cube of the thickness.

Drag loss of vehicles like aircraft or ships generally increases less than proportional with increasing cargo volume, although the physical details can be quite complicated. Therefore, making them larger usually results in less fuel consumption per ton of cargo at a given speed.

Heat losses from industrial processes vary per unit of volume for pipes, tanks and other vessels in a relationship somewhat similar to the square-cube law.

Capital and operating cost

Overall costs of capital projects are known to be subject to economies of scale. A crude estimate is that if the capital cost for a given sized piece of equipment is known, changing the size will change the capital cost by the 0.6 power of the capacity ratio (the point six power rule).

In estimating capital cost, it typically requires an insignificant amount of labor, and possibly not much more in materials, to install a larger capacity electrical wire or pipe having significantly greater capacity.

The cost of a unit of capacity of many types of equipment, such as electric motors, centrifugal pumps, diesel and gasoline engines, decreases as size increases. Also, the efficiency increases with size.

Crew size and other operating costs for ships, trains and airplanes

Operating crew size for ships, airplanes, trains, etc., does not increase in direct proportion to capacity. (Operating crew consists of pilots, co-pilots, navigators, etc. and does not include passenger service personnel.) Many aircraft models were significantly lengthened or "stretched" to increase payload.

Many manufacturing facilities, especially those making bulk materials like chemicals, refined petroleum products, cement and paper, have labor requirements that are not greatly influenced by changes in plant capacity. This is because labor requirements of automated processes tend to be based on the complexity of the operation rather than production, and many manufacturing facilities have nearly the same basic number of processing steps and pieces of equipment, regardless of production.

Economical use of byproducts

Karl Marx noted that large scale manufacturing allowed economical use of products that would otherwise be waste. Marx cited the chemical industry as an example, which today along with petrochemicals, remains highly dependent on turning various residual reactant streams into salable products. In the pulp and paper industry it is economical to burn bark and fine wood particles to produce process steam and to recover the spent pulping chemicals for conversion back to usable form.

Economies of scale and returns to scale

Economies of scale is related to and can easily be confused with the theoretical economic notion of returns to scale. Where economies of scale refer to a firm's costs, returns to scale describe the relationship between inputs and outputs in a long-run (all inputs variable) production function. A production function has constant returns to scale if increasing all inputs by some proportion results in output increasing by that same proportion. Returns are decreasing if, say, doubling inputs results in less than double the output, and increasing if more than double the output. If a mathematical function is used to represent the production function, and if that production function is homogeneous, returns to scale are represented by the degree of homogeneity of the function. Homegeneous production functions with constant returns to scale are first degree homogeneous, increasing returns to scale are represented by degrees of homogeneity greater than one, and decreasing returns to scale by degrees of homogeneity less than one.

If the firm is a perfect competitor in all input markets, and thus the per-unit prices of all its inputs are unaffected by how much of the inputs the firm purchases, then it can be shown that at a particular level of output, the firm has economies of scale if and only if it has increasing returns to scale, has diseconomies of scale if and only if it has decreasing returns to scale, and has neither economies nor diseconomies of scale if it has constant returns to scale. In this case, with perfect competition in the output market the long-run equilibrium will involve all firms operating at the minimum point of their long-run average cost curves (i.e., at the borderline between economies and diseconomies of scale).

If, however, the firm is not a perfect competitor in the input markets, then the above conclusions are modified. For example, if there are increasing returns to scale in some range of output levels, but the firm is so big in one or more input markets that increasing its purchases of an input drives up the input's per-unit cost, then the firm could have diseconomies of scale in that range of output levels. Conversely, if the firm is able to get bulk discounts of an input, then it could have economies of scale in some range of output levels even if it has decreasing returns in production in that output range.

The literature assumed that due to the competitive nature of reverse auction, and in order to compensate for lower prices and lower margins, suppliers seek higher volumes to maintain or increase the total revenue. Buyers, in turn, benefit from the lower transaction costs and economies of scale that result from larger volumes. In part as a result, numerous studies have indicated that the procurement volume must be sufficiently high to provide sufficient profits to attract enough suppliers, and provide buyers with enough savings to cover their additional costs.

However, surprisingly enough, Shalev and Asbjornsen found, in their research based on 139 reverse auctions conducted in the public sector by public sector buyers, that the higher auction volume, or economies of scale, did not lead to better success of the auction. They found that Auction volume did not correlate with competition, nor with the number of bidder, suggesting that auction volume does not promote additional competition. They noted, however, that their data included a wide range of products, and the degree of competition in each market varied significantly, and offer that further research on this issue should be conducted to determine whether these findings remain the same when purchasing the same product for both small and high volumes. Keeping competitive factors constant, increasing auction volume may further increase competition.

Consumption of energy resources, (e.g. turning on a light) requires resources and has an effect on the environment. Many electric power plants burn coal, oil or natural gas in order to generate electricity for energy needs. While burning these fossil fuels produces a readily available and instantaneous supply of electricity, it also generates air pollutants including carbon dioxide

(CO_2), sulfur dioxide and trioxide (SO_x) and nitrogen oxides (NO_x). Carbon dioxide is an important greenhouse gas which is thought to be responsible for some fraction of the rapid increase in global warming seen especially in the temperature records in the 20th century, as compared with tens of thousands of years worth of temperature records which can be read from ice cores taken in Arctic regions. Burning fossil fuels for electricity generation also releases trace metals such as beryllium, cadmium, chromium, copper, manganese, mercury, nickel, and silver into the environment, which also act as pollutants.

The large-scale use of renewable energy technologies would "greatly mitigate or eliminate a wide range of environmental and human health impacts of energy use". Renewable energy technologies include biofuels, solar heating and cooling, hydroelectric power, solar power, and wind power. Energy conservation and the efficient use of energy would also help.

In addition, it is argued that there is also the potential to develop a more efficient energy sector. This can be done by:

- Fuel switching in the power sector from coal to natural gas;
- Power plant optimisation and other measures to improve the efficiency of existing CCGT power plants;
- Combined heat and power (CHP), from micro-scale residential to large-scale industrial;
- Waste heat recovery

Best available technology (BAT) offers supply-side efficiency levels far higher than global averages. The relative benefits of gas compared to coal are influenced by the development of increasinglyefficient energy production methods. According to an impact assessment carried out for the European Commission, the levels of energy efficiency of coal-fired plants built have now increased to 46-49% efficiency rates, as compared to coals plants built before the 1990s (32-40%). However, at the same time gas is can reach 58-59% efficiency levels with the best available technology. Meanwhile, combined heat and power can offer efficiency rates of 80-90%.

Politics

Since now energy plays an essential role in industrial societies, the ownership and control of energy resources plays an increasing role in politics. At the national level, governments seek to influence the sharing (distribution) of energy resources among various sections of the society through pricing mechanisms; or even who owns resources within their borders. They may also seek to influence the use of energy by individuals and business in an attempt to tackle environmental issues.

The most recent international political controversy regarding energy resources is in the context of the Iraq wars. Some political analysts maintain that the hidden reason for both 1991 and 2003 wars can be traced to strategic control of international energy resources. Others counter this analysis with the numbers related to its economics. According to the latter group of analysts, U.S. has spent about $336 billion in Iraq as compared with a background current value of $25 billion per year budget for the entire U.S. oil import dependence

Policy

Main article: Energy policy

Energy policy is the manner in which a given entity (often governmental) has decided to address issues of energy development including energy production, distribution and consumption. The attributes of energy policy may include legislation, international treaties, incentives to investment, guidelines for energy conservation, taxation and other public policy techniques.

Security

Main article: Energy security

Energy security is the intersection of national security and the availability of natural resources for energy consumption. Access to cheap energy has become essential to the functioning of modern economies. However, the uneven distribution of energy supplies among countries has led to significant vulnerabilities. Threats to energy security include the political instability of several energy producing countries, the manipulation of energy supplies, the competition over energy sources, attacks on supply infrastructure, as well as accidents,natural disasters, the funding to foreign dictators

CHAPTER 7

Culture Industry

The term culture industry (German: Kulturindustrie) was coined by the critical theorists Theodor Adorno (1903–1969) and Max Horkheimer (1895–1973), and was presented as critical vocabulary in the chapter "The Culture Industry: Enlightenment as Mass Deception", of the book Dialectic of Enlightenment (1944), wherein they proposed that popular culture is akin to a factory producing standardized cultural goods — films, radio programmes, magazines, etc. — that are used to manipulate mass society into passivity. Consumption of the easy pleasures of popular culture, made available by the mass communications media, renders people docile and content, no matter how difficult their economic circumstances. The inherent danger of the culture industry is the cultivation of false psychological needs that can only be met and satisfied by the products of capitalism; thus Adorno and Horkheimer especially perceived mass-produced culture as dangerous to the more technically and intellectually difficult high arts. In contrast, true psychological needs are freedom, creativity, and genuine happiness, which refer to an earlier demarcation of human needs, established by Herbert Marcuse. (See Eros and Civilization, 1955).

Adorno and Horkheimer were key members of the Frankfurt School. They were much influenced by the dialectical materialism and historical materialism ofKarl Marx, as well the revisitation of the dialectical idealism of Hegel, in both of which events are studied not in isolation but as part of the process of change. As a group later joined by Jürgen Habermas, they were responsible for the formulation of Critical Theory. In works such as Dialectic of Enlightenment and Negative Dialectics, Adorno and Horkheimer theorized that the phenomenon of mass culture has a political implication, namely that all the many forms of popular culture are parts of a single culture industry whose purpose is to ensure the continued obedience of the masses to market interests.

The theory

The essay is concerned with the production of cultural content in capitalist societies. It critiques the supply-driven nature of cultural economies as well as the apparently inferior products of the system. Horkheimer and Adorno argue that mass-produced entertainment aims, by its very nature, to appeal to vast audiences and therefore both the intellectual stimulation of high art and the basic release of low art. The essay does not suggest that all products of this system are inherently inferior, simply that they have replaced other forms of entertainment without properly fulfilling the important roles played by the now defunct sources of culture.

Horkheimer and Adorno make consistent comparisons between Fascist Germany and the American film industry. They highlight the presence of mass-produced culture, created and disseminated by exclusive institutions and consumed by a passive, homogenised audience in both systems. This illustrates the logic of domination in post-enlightenment modern society, by monopoly capitalism or the nation state. Horkheimer and Adorno draw attention to the problems associated with a system that ‘integrates its consumers from above’, arguing that in attempting to realise enlightenment values of reason and order, the holistic power of the individual is undermined.

Influences

Adorno and Horkheimer’s work was influenced by both the broader socio-political environment in which it was written and by other major theorists. Written in California in the early 1940s by two ethnically Jewish, German émigrés, The Culture Industry is influenced by European politics and the war by which the continent was consumed. Simultaneously, the American film industry was characterised by an unprecedented level of studio monopolisation, it was "Hollywood at its most classical, American mass culture at its most Fordist".

Horkheimer and Adorno were influenced heavily by major developers of social, political and economic theory, most notably:

- Karl Marx’s theories of alienation and commodity fetishism,
- Max Weber’s instrumental reason, and
- Georg Lukacs’ concept of the reification of consciousness.

Elements

Anything made by a person is a materialization of their labour and an expression of their intentions. There will also be a use value: the benefit to the consumer will be derived from its utility. The exchange value will reflect its utility and the conditions of the market: the prices paid by the television broadcaster or at the box office. Yet, the modern soap operas with their interchangeable plots and formulaic narrative conventions reflect standardized production techniques and the falling value of a mass-produced cultural product. Only rarely is a film released that makes a more positive impression on the general discourse and achieves a higher exchange value, e.g. Patton (1970), starring George C. Scott as the eponymous American general, was released at a time of considerable anti-war sentiment. The opening shot is of Patton in front of an American flag making an impassioned speech. This was a form of dialectic in which the audience could identify with the patriotism either sincerely (the thesis) or ironically (the antithesis) and so set the tone of the interpretation for the remainder of the film. However, the film is manipulating specific historical events, not only as entertainment, but also as a form of propaganda by demonstrating a link between success in strategic resource management situations and specified leadership qualities. Given that the subtext was instrumental and not "value free", ethical and philosophical considerations arise.

Normally, only high art criticizes the world outside its boundaries, but access to this form of communication is limited to the elite classes where the risks of introducing social instability are slight. A film like Patton is popular art which intends controversy in a world of social order and unity which, according to Adorno, is regressing into a cultural blandness. To Hegel, order is good a priori, i.e. it does not have to answer to those living under it. But, if order is disturbed? In Negative Dialectics, Adorno believed this tended towards progress by stimulating the possibility of class conflict. Marx's theory of Historical Materialism was teleological, i.e. society follows through a dialectic of unfolding stages from ancient modes of production to feudalism to capitalism to a future communism. But Adorno felt that the culture industry would never permit a sufficient core of challenging material to emerge on to the market that might disturb the status quo and stimulate the final communist state to emerge.

The culture Industry and mass culture

A central point of the Dialectic of Enlightenment is the topic of "the Enlightenment as the deception of the masses." The term "Culture Industry" is intended to refer to the commercial marketing of culture, the branch of industry that deals specifically with the production of culture. In contrast to that is "authentic culture."

Horkheimer and Adorno contend that industrially produced culture robs people of their imagination and takes over their thinking for him. The Culture Industry delivers the "goods" so that the people then only have left over the task of the consuming them. Through mass production, everything becomes homogenized and whatever diversity remains is constituted of small trivialities. Everything becomes compressed through a process of the imposition of schemas under the premise that what's best is to mirror physical reality as closely as possible. Psychological drives become stoked to the point to where sublimation is no longer possible.

Movies serve as an example. All films have become similar in their basic form. They are shaped to reflect facts of reality as closely as possible. Even fantasy films, which claim to not reflect such reality, don't really live up to what they claim to be. No matter how unusual they strive to be, the endings are usually easy to predict because of the existence of prior films which followed the same schemas. Also, for example, erotic depictions become so strong and so pronounced that a transformation to other forms is no longer possible.

The aims of the Culture Industry are - as in every industry - economic in nature. All endeavors become focused on economic success.

Authentic culture, however, is not goal oriented, but is an end in itself. Authentic culture fosters the capacity of human imagination by presenting suggestions and possibilities, but in a different way than the culture industry does, since it leaves room for independent thought. Authentic culture does not become channeled into regurgitating reality, but goes levels beyond such. Authentic culture is unique and cannot be forced into any pre-formed schemas.

As for discovering the causes of the development of the Cultural Industry, Horkheimer and Adorno contend that it arises from companies' pursuit of the maximization of profit, in the economic sense. However, this cannot be said to be culture, or what culture is supposed to be. It can only be described as being a form of commerce, just like any other kind of commerce.

The Culture Industry argument is often assumed to be fundamentally pessimistic in nature because its purveyors seem to condemn "mass media" and their consumers. However, for Adorno, the term "Culture Industry," does not refer to "mass culture," or the culture of the masses of people, in terms of something being produced by the masses and conveying the representations of the masses, but on the contrary, such involvement of the masses is only apparent, or a type of seeming democratic participation. Adorno contends that what is actually occurring is a type is "defrauding of the masses." Horkheimer and Adorno deliberately chose the term "Culture Industry", instead of "mass culture" or "mass media". "The culture industry perpetually cheats its consumers of what it perpetually promises." The Culture Industry even encroaches upon the small distractions of leisure activity: "Amusement has become an extension of labor under late capitalism." Horkheimer and Adorno, above all, in their critical analyses, delve into what they call "the fraying of art" and the "de-artification of art," and discuss how the arts are defused by the Culture Industry. Works of art have become commodified: Beethoven, Mozart and Wagner are only used in fragmentary forms when included in advertisement. According to Critical Theory, "selling out" is not the decisive factor involved, but rather it's the manner in which art is commodified and how art and culture are changed that is the crucial issue.

"Culture today is infecting everything with sameness." - For Adorno and Horkheimer, subversion has become no longer possible.

Observations

Critics of the theory say that the products of mass culture would not be popular if people did not enjoy them, and that culture is self-determining in its administration. This would deny Adorno contemporary political significance, arguing that politics in a prosperous society is more concerned with action than with thought. Wiggershaus (1994) notes that the young generation of critical theorists largely ignore Adorno's work which, in part, stems from Adorno's inability to draw practical conclusions from his theories. Adorno is also accused of a lack of consistency in his claims to be implementing Marxism. Whereas he accepted the classical Marxist analysis of society showing how one class exercises domination over another, he deviated from Marx in his failure to use dialectic as a method to propose ways to change. Marx's theory depended on the willingness of the working class to overthrow the ruling class, but Adorno and Horkheimer postulated that the culture industry has undermined the revolutionary movement. Adorno's idea that the mass of the people are only objects of the culture industry is linked to his feeling that the time when the working class could be the tool of overthrowing capitalism is over. Other critics note that "High culture" too is not exempt from a role in the justification of capitalism. The establishment and reinforcement of elitism is seen by these critics as a key element in the role of such genres as opera and ballet.

dominant countries reliance to the foreign oil supply. The limited supplies, uneven distribution, and rising costs of fossil fuels, such as oil and gas, create a need to change to more sustainable energy sources in the foreseeable future. With as much dependence that the U.S. currently has for oil and with the peaking limits of oil production; economies and societies will begin to feel the decline in the resource that we have become dependent upon. Energy security has become one of the leading issues in the world today as oil and other resources have become as vital to the world's people. However with oil production rates decreasing and oil production peak nearing the world has come to protect what resources we have left in the world. With new advancements in renewable resources less pressure has been put on companies that produce the worlds oil, these resources are, geothermal, solar power, wind power and hydro-electric. Although these are not all the current and possible future options for the world to turn to as the oil depletes the most important issue is protecting these vital resources from future threats. These new resources will become more useful as the price of exporting and importing oil will increase due to increase of demand.

Development

Main article: Energy development

Producing energy to sustain human needs is an essential social activity, and a great deal of effort goes into the activity. While most of such effort is limited towards increasing the production ofelectricity and oil, newer ways of producing usable energy resources from the available energy resources are being explored. One such effort is to explore means of producing hydrogen fuel from water. Though hydrogen use is environmentally friendly, its production requires energy and existing technologies to make it, are not very efficient. Research is underway to explore enzymaticdecomposition of biomass.

Other forms of conventional energy resources are also being used in new ways. Coal gasification and liquefaction are recent technologies that are becoming attractive after the realization that oil reserves, at present consumption rates, may be rather short lived. See alternative fuels.

Transportation

All societies require materials and food to be transported over distances, generally against some force of friction. Since application of force over distance requires the presence of a source of usable energy, such sources are of great worth in society.

While energy resources are an essential ingredient for all modes of transportation in society, the transportation of energy resources is becoming equally important. Energy resources are frequently located far from the place where they are consumed. Therefore their transportation is always in question. Some energy resources like liquid or gaseous fuels are transported using tankers or pipelines, while electricity transportation invariably requires a network of grid cables. The transportation of energy, whether by tanker, pipeline, or transmission line, poses challenges for scientists and engineers, policy makers, and economists to make it more risk-free and efficient.

Oil prices from 1861 to 2007

Economic and political instability can lead to an energy crisis. Notable oil crises are the 1973 oil crisis and the 1979 oil crisis. The advent of peak oil, the point in time when the maximum rate of global petroleum extraction is reached, will likely precipitate another energy crisis.

CHAPTER 8

Materail Science

Materials science, also commonly known as materials engineering, is an interdisciplinary field applying the properties of matter to various areas of science and engineering. This relatively new scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It incorporates elements of applied physics and chemistry. With significant media attention focused on Nano scienceand nanotechnology in recent years, materials science is becoming more widely known as a specific field of science and engineering. It is an important part of forensic engineering (Forensic engineering is the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing personal injury or damage to property.) and failure analysis, the latter being the key to understanding, for example, the cause of various aviation accidents. Many of the most pressing scientific problems that are currently faced today are due to the limitations of the materials that are currently available and, as a result, breakthroughs in this field are likely to have a significant impact on the future of technology.

Main article: History of materials science

The material of choice of a given era is often a defining point. Phrases such as Stone Age, Bronze Age, Iron Age, and Steel Age are good examples. Originally deriving from the manufacture ofceramics and its putative derivative metallurgy, materials science is one of the oldest forms of engineering and applied science. Modern materials science evolved directly from metallurgy, which itself evolved from mining and (likely) ceramics and the use of fire. A major breakthrough in the understanding of materials occurred in the late 19th century, when the American scientist Josiah Willard Gibbs demonstrated that the thermodynamic properties related to atomic structure in various phases are related to the physical properties of a material. Important elements of modern materials science are a product of the space race: the understanding and engineering of the metallic alloys, and silica and carbon materials, used in the construction of space vehicles enabling the exploration of space. Materials science has driven, and been driven by, the development of revolutionary technologies such as plastics, semiconductors, and biomaterials.

Before the 1960s (and in some cases decades after), many materials science departments were named metallurgy departments, from a 19th and early 20th century emphasis on metals. The field has since broadened to include every class of materials, including ceramics, polymers, semiconductors, magnetic materials, medical implant materials, biological materials and nanomaterials (materiomics).

Fundamentals

The basis of materials science involves relating the desired properties and relative performance of a material in a certain application to the structure of the atoms and phases in that material through characterization. The major determinants of the structure of a material and thus of its properties are its constituent chemical elements and the way in which it has been processed into its final form. These characteristics, taken together and related through the laws of thermodynamics, govern a material's microstructure, and thus its properties.

The manufacture of a perfect crystal of a material is currently physically impossible. Instead materials scientists manipulate the defects in crystalline materials such as precipitates, grain boundaries (Hall–Petch relationship), interstitial atoms, vacancies or substitutional atoms, to create materials with the desired properties.

Not all materials have a regular crystal structure. Polymers display varying degrees of crystallinity, and many are completely non-crystalline. Glass as, some ceramics, and many natural materials are amorphous, not possessing any long-range order in their atomic arrangements. The study of polymers combines elements of chemical and statistical thermodynamics to give thermodynamic, as well as mechanical, descriptions of physical properties.

In addition to industrial interest, materials science has gradually developed into a field which provides tests for condensed matter or solid state theories. New physics emerge because of the diverse new material properties that need to be explained.

Classes of materials

Materials science encompasses various classes of materials, each of which may constitute a separate field. There are several ways to classify materials. For instance by the type of bonding between the atoms. The traditional groups are ceramics, metals and polymers based on atomic structure and chemical composition. New materials have resulted in more classes. One way of classifying materials is:

- Biomaterials
- Carbon
- Ceramics
- Composite materials
- Glass
- Metals
- Nanomaterials
- Polymers
- Refractory
- Semiconductors
- Thin Films
- Functionally Graded Materials

Materials in industry

Radical materials advances can drive the creation of new products or even new industries, but stable industries also employ materials scientists to make incremental improvements and troubleshoot issues with currently used materials. Industrial applications of materials science include materials design, cost-benefit tradeoffs in industrial production of materials, processing techniques (casting, rolling, welding, ion implantation, crystal growth, thin-film deposition, sintering, glassblowing, etc.), and analytical techniques (characterization techniques such as electron microscopy, x-ray diffraction, calorimetry, nuclear microscopy (HEFIB), Rutherford backscattering, neutron diffraction, small-angle X-ray scattering (SAXS), etc.).

Besides material characterization, the material scientist/engineer also deals with the extraction of materials and their conversion into useful forms. Thus ingot casting, foundry techniques, blast furnace extraction, and electrolytic extraction are all part of the required knowledge of a metallurgist/engineer. Often the presence, absence or variation of minute quantities of secondary elements and compounds in a bulk material will have a great impact on the final properties of the materials produced, for instance, steels are classified based on 1/10 and 1/100 weight percentages of the carbon and other alloying elements they contain. Thus, the extraction and purification techniques employed in the extraction of iron in the blast furnace will have an impact of the quality of steel that may be produced.

The overlap between physics and materials science has led to the offshoot field of materials physics, which is concerned with the physical properties of materials. The approach is generally more macroscopic and applied than in condensed matter physics. See important publications in materials physics for more details on this field of study.

Ceramics and glasses

Si_3N_4 ceramic bearing parts

Another application of the material sciences is the structures of glass and ceramics, typically associated with the most brittle materials. Bonding in ceramics and glasses use covalent and ionic-covalent types with SiO_2 (silica or sand) as a fundamental building block. Ceramics are as soft as clay and as hard as stone and concrete. Usually, they are crystalline in form. Most glasses contain a metal oxide fused with silica. At high temperatures used to prepare glass, the material is a viscous liquid. The structure of glass forms into an amorphous state upon cooling. Windowpanes and eyeglasses are important examples. Fibers of glass are also available. Scratch resistant Corning Gorilla Glass is a well-known example of the application of materials science to drastically improve the properties of common components. Diamond and carbon in its graphite form are considered to be ceramics.

Engineering ceramics are known for their stiffness and stability under high temperatures, compression and electrical stress. Alumina, silicon carbide, andtungsten carbide are made from a fine powder of their constituents in a process of sintering with a binder. Hot pressing provides higher density material. Chemical vapor deposition can place a film of a ceramic on another material. Cermets are ceramic particles containing some metals. The wear resistance of tools is derived from cemented carbides with the metal phase of cobalt and nickel typically added to modify properties.

Composite materials

A 6 μm diameter carbon filament (running from bottom left to top right) siting atop the much larger human hair.

Filaments are commonly used for reinforcement in composite materials.

Another application of material science in industry is the making of composite materials. Composite materials are structured materials composed of two or more macroscopic phases. Applications range from structural elements such as steel-reinforced concrete, to the thermally insulative tiles which play a key and integral role in NASA's Space Shuttle thermal protection system which is used to protect the surface of the shuttle from the heat of re-entry into the Earth's atmosphere. One example is reinforced Carbon-Carbon (RCC), the light gray material which withstands re-entry temperatures up to 1510 °C (2750 °F) and protects the Space Shuttle's wing leading edges and nose cap. RCC is a laminated composite material made from graphite rayon cloth and impregnated with a phenolic resin. After curing at high temperature in an autoclave, the laminate is pyrolized to convert the resin to carbon, impregnated with furfural alcohol in a vacuum chamber, and cured/pyrolized to convert the furfural alcohol to carbon. In order to provide oxidation resistance for reuse capability, the outer layers of the RCC are converted to silicon carbide.

Other examples can be seen in the "plastic" casings of television sets, cell-phones and so on. These plastic casings are usually a composite materialmade up of a thermoplastic matrix such as acrylonitrile-butadiene-styrene (ABS) in which calcium carbonate chalk, talc, glass fibers or carbon fibers have been added for added strength, bulk, or electrostatic dispersion. These additions may be referred to as reinforcing fibers, or dispersants, depending on their purpose.

Polymers

Microstructure of part of a DNA double helix biopolymer.

Polymers are also an important part of materials science. Polymers are the raw materials (the resins) used to make what we commonly call plastics. Plastics are really the final product, created after one or more polymers or additives have been added to a resin during processing, which is then shaped into a final form. Polymers which have been around, and which are in current widespread use, include polyethylene, polypropylene, PVC, polystyrene, nylons,polyesters, acrylics, polyurethanes, and polycarbonates. Plastics are generally classified as "commodity", "specialty" and "engineering" plastics.

PVC (polyvinyl-chloride) is widely used, inexpensive, and annual production quantities are large. It lends itself to an incredible array of applications, fromartificial leather to electrical insulation and cabling, packaging and containers. Its fabrication and processing are simple and well-established. The versatility of PVC is due to the wide range of plasticisers and other additives that it accepts. The term "additives" in polymer science refers to the chemicals and compounds added to the polymer base to modify its material properties.

Polycarbonate would be normally considered an engineering plastic (other examples include PEEK, ABS). Engineering plastics are valued for their superior strengths and other special material properties. They are usually not used for disposable applications, unlike commodity plastics.

Specialty plastics are materials with unique characteristics, such as ultra-high strength, electrical conductivity, electro-fluorescence, high thermal stability, etc.

The dividing lines between the various types of plastics is not based on material but rather on their properties and applications. For instance, polyethylene(PE) is a cheap, low friction polymer commonly used to make disposable shopping bags and trash bags, and is considered a commodity plastic, whereasmedium-density polyethylene (MDPE) is used for underground gas and water pipes, and another variety called Ultra-high Molecular Weight PolyethyleneUHMWPE is an engineering plastic which is used extensively as the glide rails for industrial equipment and the low-friction socket in implanted hip joints.

Metal alloys

The study of metal alloys is a significant part of materials science. Of all the metallic alloys in use today, the alloys of iron (steel, stainless steel, cast iron,tool steel, alloy steels) make up the largest proportion both by quantity and commercial value. Iron alloyed with various proportions of carbon gives low, mid and high carbon steels. An iron carbon alloy is only considered steel if the carbon level is between 0.01% and 2.00%. For the steels, the hardness and tensile strength of the steel is related to the amount of carbon present, with increasing carbon levels also leading to lower ductility and toughness. Heat treatment processes such as quenching and tempering can significantly change these properties however. Cast Iron is defined as an iron–carbon alloy with more than 2.00% but less than 6.67% carbon. Stainless steel is defined as a regular steel alloy with greater than 10% by weight alloying content of Chromium. Nickel and Molybdenum are typically also found in stainless steels.

Other significant metallic alloys are those of aluminium, titanium, copper and magnesium. Copper alloys have been known for a long time (since the Bronze Age), while the alloys of the other three metals have been relatively recently developed. Due to the chemical reactivity of these metals, the electrolytic extraction processes required were only developed relatively recently. The alloys of aluminium, titanium and magnesium are also known and valued for their high strength-to-weight ratios and, in the case of magnesium, their ability to provide electromagnetic shielding. These materials are ideal for situations where high strength-to-weight ratios are more important than bulk cost, such as in the aerospace industry and certain automotive engineering applications.

Sub-disciplines of materials science

Below is a list of disciplines within or related to the materials science field. These range from biomaterials, to ceramics, to metals, to textile reinforced materials. Also note that these are linked to the respective main article.

CHAPTER 9

Industry Analyst

An industry analyst performs primary and secondary market research within an industry such as information technology, consulting or insurance. Analysts assess sector trends, create segment taxonomies, size markets, prepare forecasts, and develop industry models. Industry analysts usually work for research and advisory services firms, and some analysts also perform advisory (consulting) services. Typically, analysts specialize in a single segment or sub-segment, researching the broad development of the market rather than focusing on specific publicly traded companies, equities, investments, or associated financial opportunities as a financial analyst might.

The IIAR provides this official definition:

An information and communications technology (ICT) industry analyst is a person, working individually or within a firm, whose business model incorporates creating and publishing research about, and advising on how, why and where ICT-related products and services can be procured, deployed and used.

That is not to say that industry analysts do not focus on specific market participants and their product and service portfolios, or that financial analysts ignore industries. Gideon Gartner, one of the industry analyst business pioneers, was a former financial analyst before launching the Gartner Group in 1979. But industry analysts do research in the context of a specific sector or market segment, along with the competitive offerings of the other public and non-public companies that comprise the market. In many industries there is significant overlap between the work product of industry analysts and financial analysts. The information technology and consulting industries, however, are examples of industries where a significant proportion of important market participants are not publicly traded entities with readily available information and highly regulated disclosure requirements.

Most analyst firms focus on one or more market segments, such as cloud computing, wireless communications, audit services, or pharmaceutical industry safety monitoring. Analyst firms and the analysts that work for them are continuously expanding and shifting their coverage areas to keep pace with trends like technological convergence or media convergence, for example. This is because demand for industry analyst research services is closely associated with the frequency of change in an industry. So the largest analyst firms tend to have extremely dynamic offerings, and the concentration of service offerings of all market players tends to focus on industry areas that are currently undergoing change.

There are three industry analyst firms that have been in continuous operation since 1970 or earlier. Computer Review is the oldest analyst firm that has been in continuous operation since its inception in 1959, as Adams Associates. International Data Corp. has been providing industry analyst and publishing services since 1964, and continues to be operated as a private company by its founder, Patrick Joseph McGovern. The last of the three, the Yankee Group, was founded by Howard Anderson in 1970. Anderson ran the firm until 1999.

Many industry analyst firms and analysts trace their roots to one of these three firms, particularly IDC, Gartner and the Yankee Group. George Colony, for example, was an analyst at the Yankee Group before founding Forrester Research. Dale Kutnick was also a Yankee Group analyst and equity holder before joining Gartner and later founding the Meta Group, which was subsequently purchased by Gartner. Jim Lundy and Mike Anderson were analysts at Gartner before they founded Aragon Research.

Industry analyst business

There is a community of more than 740 analyst firms around the world. Research and advisory staffs at these companies range from one person to more than 1,000.

Well-known analyst firms using "traditional" business models include Gartner, IBISWorld, International Data Corporation, Informa Telecoms & Media, SNL Kagan, Ovum Ltd, Yankee Group, andDigital Clarity Group.

The "traditional" business model, based on continuous information services (CIS, aka subscriptions) where analysts author reports that are then sold to many clients is under pressure. Several firms are designing new analyst business models based on contemporary technologies, open source licensing concepts, emerging markets, loosely federated analysts, and/or a more radical and visible emphasis on offshoring. Notable examples of analyst firms creating models based on social media such as Canada's ConneKted Minds and "open research and analysis" include RedMonk, Macehiter Ward-Dutton, Quocirca, ResearchFarm, Freeform Dynamics] and Cambashi, all based in or having offices in the United Kingdom, and US-based Wikibon, an open source project. Meanwhile, Singapore-based Springboard Research (now owned by Forrester) exemplifies progressive use of offshoring research and Experton and Experture exemplify loose federations of independent analysts. capioIT is an example of a firm that is focused on emerging geographic and technology markets.

Roles and deliverables

Industry analysts provide a combination of syndicated and client-sponsored (bespoke) market research, competitive intelligence, and management consulting services.

Deliverables take many forms that can be grouped as follows:

- publications like research reports, white papers, research notes, and newsletters
- advisory services that include inquiries, briefings, consulting projects, study findings presentations or bespoke speaking engagements (for instance at internal client meetings or industry events)
- events such as conferences, seminars, roundtables
- market analysis, such as quantitative market trends, forecasts and market shares.

Analyst firms serve a management decision support function at corporations and public service organisations and for the vendors, regulators and investors serving those industries.

Industry analysts serving buyers of technology-based products and services, where the largest concentration of industry analysts provide services, work with three primary groups of clients:

- Commercial and public service entities that use technology-based products and services.
- Vendors providing products and services to commercial and public service organizations, and the channel intermediaries that resell or aggregate these products and services, including hardware manufacturers, communications companies, software firms, IT services providers, value-added resellers, mobile network operators, and content aggregators.

- Organizations that invest-in, regulate, or support the vendors and intermediaries, including investment banks, anti-trust regulators, chambers of commerce, and leasing companies.

The subjects of research conducted by analysts include many of the same stakeholders that also buy services from analysts. This has caused the integrity of the research to be questioned, which is covered in more detail below. These research subjects include product and service buyers, users, and implementers; the product and service providers themselves, including their key supply chain partners; and sources of investment capital for the vendors, capital for client purchases of vendor products and services, and regulators. Analysts also perform at least passive sales support for their firms, such as contributing to sales meetings, contracts, project profitability, or lead generation programs. This is necessary because the clients are paying for their expertise and must have an opportunity to assess associated capabilities.

At most firms, analysts set research agendas in close cooperation with clients, design surveys, analyse findings, and write research. They may also conduct the surveys themselves, or they may work with third-parties or interns to perform the data collection. Increasingly, analyst firms and their subcontractors employ online survey tools and offshoring to reduce research costs and turnaround time. In some cases, analyst firms are mining new sources of information from research partners, like consumer cell phone bills, RFID-enabled point of sale data, and analytics on Web traffic.

Typically, technology and service providers work to influence the analyst research agenda and coverage of their firm, and to build trusted relationships with individual analysts. This is done through a specialized marketing function called industry analyst relations or analyst relations, where some analyst relations staff members specialize themselves in certain product, service, industry, or geographic areas of the vendor organization. This function not only facilitates effective two-way communications between the analyst firm and the vendor, it attempts to concentrate and control spending on industry analyst research and advisory services.

It has become a common practice for analyst firms to assign a central "vendor relations" contact within their organization, to coordinate briefing, reprint and similar requests from vendors. Commercial and public sector client organizations have now assigned sourcing and procurement category managers as the primary contact for research and advisory services firms as well, to concentrate and better leverage spending on related products and services.

Skills

Companies participating in the industry analyst profession have not adopted universal standards for employee education, skills, or professional conduct. Some firms adhere to standards set by competitive intelligence, market research or other professional associations. Overall, this situation results in competitive differentiation among analyst firms.

Most analyst firms require above-average written and oral communication skills.

Integrity and transparency issues

Analyst objectivity and accuracy is an issue that is frequently debated. Much of the criticism appears to focus on the business relationships between analysts and the technology providers that are the subjects of their research. In short, analyst firms often rely heavily on revenues from the technology providers they cover (e.g., Darwin magazine, March 2001).

This source of revenue is a significant component of the business models of most analyst firms. Individual analysts and teams conduct research on industry segments where a vendor may provide products or services, and that same individual or group may provide research deliverables or advisory services to a vendor serving that segment. The analyst is then expected to provide independent objective advice to buyers of those products and services. This matrix of relationships presents opportunities where conflicts can arise. This is exacerbated by the training many vendor analyst relations professionals receive, where they are advised to focus spending on analysts that have the most ability to influence purchases of goods and services by clients, and to bypass controls analyst firms may have in place to preserve that objectivity by limiting direct access to certain analysts for non-research purposes.

There is also the issue of analyst firms signing boilerplate confidentiality agreements with vendor firms. This occurs when licensing research or performing advisory work, or when conducting detailed briefings in advance of announcements. The language in those agreements often limits the disclosure of certain information that may be disclosed to analysts in the normal course of their research, limiting their ability to fully disclose research findings to buyers of any research deliverable. Some research organizations now refuse to sign confidentiality agreements with vendors or service providers. But there may be a legacy of agreements in place that perpetually limit disclosure for some large vendor clients, so some of the smaller firms have limited work with vendors.

Burton Research, for example, enforces a cap of 20% of revenues to be derived from product vendors or service providers. Burton is now owned by Gartner, and continues to limit its vendor expenditures. Real Story Group is a small boutique firm that performs research on products and publishes evaluations. It works solely for buyers and refuses to accept business from vendors that are subjects of its evaluations. Despite a few exceptions, buy side industry analysts represent a small minority of analyst firms today. Even research firms whose services are tailored specifically to the interests of product and service buyers often derive some proportion of their revenues from vendors and service providers, since that information is important to them as well.

Another side to this debate is that analyst firms create hype and influence markets in several ways or at even influence deals directly when speaking to end-user buyers.

The debate over objectivity and independence has always been an active one, with some firms using independence (in absolute and relative terms) as a source of strategic differentiation. Other factors that affect research integrity include transparency with regard to research methodology and survey sampling, theoretical or shallow vs. in-depth or hands-on expertise of analysts,emphasis on qualitative over quantitative research, and the overall efficacy of a firm's research offerings toward the goal of improving the quality of business and technology decisions.

- Biomaterials – materials that are derived from and/or used with life forms.

- Ceramography – the study of the microstructures of high-temperature materials and refractories, including structural ceramics such as RCC, polycrystalline silicon carbide andtransformation toughened ceramics

- Crystallography – the study of regular arrangement of atoms and ions in a solid, the defects associated with crystal structures such as grain boundaries and dislocations, and the characterization of these structures and their relation to physical properties.

- Electronic and magnetic materials – materials such as semiconductors used to create integrated circuits, storage media, sensors, and other devices.

- Forensic engineering – the study of how products fail, and the vital role of the materials of construction

- Forensic materials engineering – the study of material failure, and the light it sheds on how engineers specify materials in their product

- Glass science – any non-crystalline material including inorganic glasses, vitreous metals and non-oxide glasses.

- Materials characterization – such as diffraction with x-rays, electrons, or neutrons, and various forms of spectroscopy and chemical analysis such as Raman spectroscopy, energy-dispersive spectroscopy (EDS), chromatography, thermal analysis, electron microscope analysis, etc., in order to understand and define the properties of materials. See also List of surface analysis methods

- Metallography - Metallography is the study of the physical structure and components of metals, typically using microscopy.

- Metallurgy – the study of metals and their alloys, including their extraction, microstructure and processing.

- Microtechnology – study of materials and processes and their interaction, allowing microfabrication of structures of micrometric dimensions, such as Microelectromechanical systems(MEMS).

CHAPTER 10

Externality

In economics, an externality is the cost or benefit that affects a party who did not choose to incur that cost or benefit.

For example, manufacturing activities that cause air pollution impose health and clean-up costs on the whole society, whereas the neighbors of an individual who chooses to fire-proof his home may benefit from a reduced risk of a fire spreading to their own houses. If external costs exist, such aspollution, the producer may choose to produce more of the product than would be produced if the producer were required to pay all associated environmental costs. If there are external benefits, such as in public safety, less of the good may be produced than would be the case if the producer were to receive payment for the external benefits to others. For the purpose of these statements, overall cost and benefit to society is defined as the sum of the imputed monetary value of benefits and costs to all parties involved. Thus, it is said that, for goods with externalities, unregulated market prices do not reflect the full social costs or benefit of the transaction.

External costs and benefits

Voluntary exchange is considered mutually beneficial to both parties involved, because buyers or sellers would not trade if either thought it detrimental to themselves. However, a transaction can cause additional effects on third parties. From the perspective of those affected, these effects may be negative (pollution from a factory), or positive (honey bees kept for honey that also pollinate neighboring crops). Neoclassical welfare economicsasserts that, under plausible conditions, the existence of externalities will result in outcomes that are not socially optimal. Those who suffer from external costs do so involuntarily, whereas those who enjoy external benefits do so at no cost.

A voluntary exchange may reduce societal welfare if external costs exist. The person who is affected by the negative externalities in the case of air pollution will see it as lowered utility: either subjective displeasure or potentially explicit costs, such as higher medical expenses. The externality may even be seen as a trespass on their lungs, violating their property rights. Thus, an external cost may pose an ethical or political problem. Alternatively, it might be seen as a case of poorly defined property rights, as with, for example, pollution of bodies of water that may belong to no one (either figuratively, in the case of publicly owned, or literally, in some countries and/or legal traditions).

On the other hand, a positive externality would increase the utility of third parties at no cost to them. Since collective societal welfare is improved, but the providers have no way of monetizing the benefit, less of the good will be produced than would be optimal for society as a whole. Goods with positive externalities include education (believed to increase societal productivity and well-being; but controversial, as these benefits are generally internalized, e.g., in the form of higher wages), public health initiatives (which may reduce the health risks and costs for third parties for such things as transmittable diseases) and law enforcement. Positive externalities are often associated with the free rider problem. For example, individuals who are vaccinated reduce the risk of contracting the relevant disease for all others around them, and at high levels of vaccination, society may receive large health and welfare benefits; but any one individual can refuse vaccination, still avoiding the disease by "free riding" on the costs borne by others.

There are a number of potential means of improving overall social utility when externalities are involved. The market-driven approach to correcting externalities is to "internalize" third party costs and benefits, for example, by requiring a polluter to repair any damage caused. But, in many cases internalizing costs or benefits is not feasible, especially if the true monetary values cannot be determined.

Laissez-faire economists such as Friedrich Hayek and Milton Friedman sometimes refer to externalities as "neighborhood effects" or "spillovers", although externalities are not necessarily minor or localized. Similarly, Ludwig von Mises argues that externalities arise from lack of "clear personal property definition."

Negative

Light pollution is an example of an externality because the consumption of street lighting has an effect on bystanders that is not compensated for by the consumers of the lighting.

A negative externality (also called "external cost" or "external diseconomy") is an action of a product on consumers that imposes a negative effect on a third party; it is "external cost".

Barry Commoner commented on the costs of externalities:

Clearly, we have compiled a record of serious failures in recent technological encounters with the environment. In each case, the new technology was brought into use before the ultimate hazards were known. We have been quick to reap the benefits and slow to comprehend the costs (Quoted from

Many negative externalities are related to the environmental consequences of production and use. The article on environmental economics also addresses externalities and how they may be addressed in the context of environmental issues.

• Air pollution from burning fossil fuels causes damages to crops, (historic) buildings and public health. The most extensive and integrated effort to quantify and monetise these impacts was in the European ExternE project series.

• Anthropogenic climate change is attributed to greenhouse gas emissions from burning oil, gas, and coal. The Stern Review on the Economics Of Climate Change says "Climate change presents a unique challenge for economics: it is the greatest example of market failure we have ever seen."

• Water pollution by industries that adds effluent, which harms plants, animals, and humans.

• Noise pollution which may be mentally and psychologically disruptive.

• Systemic risk describes the risks to the overall economy arising from the risks that the banking system takes. A condition of moral hazard can occur in the absence of well-designed banking regulation, or in the presence of badly designed regulation.

• Industrial farm animal production, on the rise in the 20th century, resulted in farms that were easier to run, with fewer and often less-skilled employees, and a greater output of uniform animal products. However, the externalities with these farms include "contributing to the increase in the pool of antibiotic-resistant bacteria because of the overuse of antibiotics; air quality problems; the contamination of rivers, streams, and coastal waters with concentrated animal waste; animal welfare problems, mainly as a result of the extremely close quarters in which the animals are housed."

- The harvesting by one fishing company in the ocean depletes the stock of available fish for the other companies and overfishing may be the result. The stock fish is an example of a common property resource, and that, in the absence of appropriate environmental governance, is vulnerable to the Tragedy of the commons.

- When car owners use roads, they impose congestion costs and higher accident risks on all other users.

- Consumption by one consumer causes prices to rise and therefore makes other consumers worse off, perhaps by reducing their consumption. These effects are sometimes called "pecuniary externalities" and are distinguished from "real externalities" or "technological externalities". Pecuniary externalities appear to be externalities, but occur within the market mechanism and are not a source of market failure or inefficiency.

- Shared costs of declining health and vitality caused by smoking and/or alcohol abuse. Here, the "cost" is that of providing minimum social welfare. Economists more frequently attribute this problem to the category of moral hazards, the prospect that parties insulated from risk may behave differently from the way they would if they were fully exposed to the risk. For example, individuals with insurance against automobile theft may be less vigilant about locking their cars, because the negative consequences of automobile theft are (partially) borne by the insurance company.

- The cost of storing nuclear waste from nuclear plants for more than 1,000 years (over 100,000 for some types of nuclear waste) is included in the cost of the electricity the plant produces, in the form of a fee paid to the government and held in the nuclear waste superfund. Conversely, the costs of managing the long term risks of disposal of chemicals, which may remain permanently hazardous, is not commonly internalized in prices. The USEPA regulates chemicals for periods ranging from 100 years to a maximum of 10,000 years, without respect to potential long-term hazard.

- Antibiotic use contributes to antibiotic resistance, reducing the future effectiveness of antibiotics. Individuals do not consider this efficacy cost when making usage decisions, leading to socially sub-optimal antibiotic consumption. Government policies proposed to preserve future antibiotic effectiveness include educational campaigns, regulation, Pigouvian taxes, and patents.

- In relation to 'environmental victims', externalities can often represent 'loss-costs', which reflects Kantian ideas of a distinction between 'value' that can be replaced, and 'dignity' which cannot.

Positive

Examples of positive externalities (beneficial externality, external benefit, external economy, or Merit goods) include:

- Increased education of individuals can lead to broader society benefits in the form of greater economic productivity, a lower unemployment rate, greater household mobility and higher rates of political participation.

- A beekeeper keeps the bees for their honey. A side effect or externality associated with such activity is the pollination of surrounding crops by the bees. The value generated by the pollination may be more important than the value of the harvested honey.

- An individual who maintains an attractive house may confer benefits to neighbors in the form of increased market values for their properties.

- An individual buying a product that is interconnected in a network (e.g., a video cellphone) will increase the usefulness of such phones to other people who have a video cellphone. When each new user of a product increases the value of the same product owned by others, the phenomenon is called a network externality or a network effect. Network externalities often have "tipping points" where, suddenly, the product reaches general acceptance and near-universal usage.

- In an area that does not have a public fire department, homeowners who purchase private fire protection services provide a positive externality to neighboring properties, which are less at risk of the protected neighbor's fire spreading to their (unprotected) house.

- An individual receiving a vaccination for a communicable disease not only decreases the likelihood of the individual's own infection, but also decreases the likelihood of others becoming infected through contact with the individual.

- A foreign firm demonstrates up-to-date technologies to local firms and improves their productivity.

The existence or management of externalities may give rise to political or legal conflicts.

Collective solutions or public policies are sometimes implemented to regulate activities with positive or negative externalities.

Positional

Positional externalities refer to a special type of externality that depends on the relative rankings of actors in a situation. Because every actor is attempting to "one up" other actors, the consequences are unintended and economically inefficient.

One example is the phenomenon of "over-education" (referring to post-secondary education) in the North American labour market. In the 1960s, many young middle-class North Americans prepared for their careers by completing a bachelor's degree. However, by the 1990s, many people from the same social milieu were completing master's degrees, hoping to "one up" the other competitors in the job market by signalling their higher quality as potential employees. By the 2000s, some jobs that had previously required only bachelor's degrees, such as policy analysis posts, were requiring master's degrees. Some economists argue that this increase in educational requirements was above that which was efficient, and that it was a misuse of the societal and personal resources that go into the completion of these master's degrees.

Another example is the buying of jewelry as a gift for another person, e.g. a spouse. For Husband A to show that he values Wife A more than Husband B values Wife B, Husband A must buy more expensive jewelry than Husband B. As in the first example, the cycle continues to get worse, because every actor positions him- or herself in relation to the other actors. This is sometimes called keeping up with the Joneses.

One solution to such externalities is regulations imposed by an outside authority. For the first example, the government might pass a law against firms requiring master's degrees unless the job actually required these advanced skills.

Inframarginal

Inframarginal externalities are externalities in which there is no benefit or loss to the marginal consumer. In other words, people neither gain nor lose anything at the margin, but benefits and costs do exist for those consumers within the given inframarginal range.

Technological

Technological externalities directly affect a firm's production and therefore, indirectly influence an individual's consumption.

Supply and demand diagram

The usual economic analysis of externalities can be illustrated using a standard supply and demand diagram if the externality can be valued in terms of money. An extra supply or demand curve is added, as in the diagrams below. One of the curves is the private cost that consumers pay as individuals for additional quantities of the good, which in competitive markets, is the marginal private cost. The other curve is the true cost that society as a whole pays for production and consumption of increased production the good, or the marginal social cost.

Similarly there might be two curves for the demand or benefit of the good. The social demand curve would reflect the benefit to society as a whole, while the normal demand curve reflects the benefit to consumers as individuals and is reflected as effective demand in the market.

CHAPTER 11

Construction

In the fields of architecture and civil engineering, construction is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of human multitasking. Normally, the job is managed by a project manager, and supervised by a construction manager, design engineer, construction engineer or project architect.

For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the environmental impact of the job, the successful scheduling, budgeting, construction site safety, availability of building materials,logistics, inconvenience to the public caused by construction delays and bidding, etc.

Types of construction projects

Condo construction in Canada

In general, there are five types of construction:

1. Residential building construction
2. Industrial construction
3. Commercial building construction
4. Institutional construction
5. Heavy civil construction

Each type of construction project requires a unique team to plan, design, construct and maintain the project.

Building construction

Building construction is the process of adding structure to real property or construction of buildings. The vast majority of building construction jobs are small renovations, such as addition of a room, or renovation of a bathroom. Often, the owner of the property acts as laborer, paymaster, and design team for the entire project. However, all building construction projects include some elements in common – design, financial, estimating and legal considerations. Many projects of varying sizes reach undesirable end results, such as structural collapse, cost overruns, and/or litigation. For this reason, those with experience in the field make detailed plans and maintain careful oversight during the project to ensure a positive outcome.

Commercial building construction is procured privately or publicly utilizing various delivery methodologies, including cost estimating, hard bid, negotiated price, traditional, management contracting, construction management-at-risk, design & build and design-build bridging.

Residential construction practices, technologies, and resources must conform to local building authority regulations and codes of practice. Materials readily available in the area generally dictate the construction materials used (e.g. brick versus stone, versus timber). Cost of construction on a per square meter (or per square foot) basis for houses can vary dramatically based on site conditions, local regulations, economies of scale (custom designed homes are often more expensive to build) and the availability of skilled tradespeople. As residential construction (as well as all other types of construction) can generate a lot of waste, careful planning again is needed here.

The most popular method of residential construction in the United States is wood framed construction. As efficiency codes have come into effect in recent years, new construction technologies and methods have emerged. University Construction Management departments are on the cutting edge of the newest methods of construction intended to improve efficiency, performance and reduce construction waste.

New techniques of building construction are being researched, made possible by advances in 3D printing technology. In a form of additive building construction, similar to the additive manufacturing techniques for manufactured parts, building printing is making it possible to flexibly construct small commercial buildings and private habitations in around 20 hours, with built-in plumbing and electrical facilities, in one continuous build, using large 3D printers. Working versions of 3D-printing building technology are already printing 2 metres (6 ft 7 in) of building material per hour as of January 2013, with the next-generation printers capable of 3.5

metres (11 ft) per hour, sufficient to complete a building in a week. Dutch archiect Janjaap Ruijssenaars'sperformative architecture 3D-printed building is scheduled to be built in 2014.

Construction processes

Design team

Shasta Dam under construction in June 1942

In the modern industrialized world, construction usually involves the translation of designs into reality. A formal design team may be assembled to plan the physical proceedings, and to integrate those proceedings with the other parts. The design usually consists of drawings and specifications, usually prepared by a design team including surveyors, civil engineers, cost engineers (or quantity surveyors), mechanical engineers, electrical engineers,structural engineers, fire protection engineers, planning consultants, architectural consultants, and archaeological consultants. The design team is most commonly employed by (i.e. in contract with) the property owner. Under this system, once the design is completed by the design team, a number of construction companies or construction management companies may then be asked to make a bid for the work, either based directly on the design, or on the basis of drawings and a bill of quantities provided by a quantity surveyor. Following evaluation of bids, the owner will typically award a contract to the most cost efficient bidder.

The modern trend in design is toward integration of previously separated specialties, especially among large firms. In the past, architects, interior designers, engineers, developers, construction managers, and general contractors were more likely to be entirely separate companies, even in the larger firms. Presently, a firm that is nominally an "architecture" or "construction management" firm may have experts from all related fields as employees, or to have an associated company that provides each necessary skill. Thus, each such firm may offer itself as "one-stop shopping" for a construction project, from beginning to end. This is designated as a "design build" contract where the contractor is given a performance specification and must undertake the project from design to construction, while adhering to the performance specifications.

Several project structures can assist the owner in this integration, including design-build, partnering and construction management. In general, each of these project structures allows the owner to integrate the services of architects, interior designers, engineers and constructors throughout design and construction. In response, many companies are growing beyond traditional offerings of design or construction services alone and are placing more emphasis on establishing relationships with other necessary participants through the design-build process.

The increasing complexity of construction projects creates the need for design professionals trained in all phases of the project's life-cycle and develop an appreciation of the building as an advanced technological system requiring close integration of many sub-systems and their individual components, including sustainability. Building engineering is an emerging discipline that attempts to meet this new challenge.

Construction projects can suffer from preventable financial problems. Underbids ask for too little money to complete the project. Cash flowproblems exist when the present amount of funding cannot cover the current costs for labour and materials, and because they are a matter of having sufficient funds at a specific time, can arise even when the overall total is enough. Fraud is a problem in many fields, but is notoriously prevalent in the construction field.Financial planning for the project is intended to ensure that a solid plan with adequate safeguards and contingency plans are in place before the project is started and is required to ensure that the plan is properly executed over the life of the project.

Mortgage bankers, accountants, and cost engineers are likely participants in creating an overall plan for the financial management of the building construction project. The presence of the mortgage banker is highly likely, even in relatively small projects since the owner's equity in the property is the most obvious source of funding for a building project. Accountants act to study the expected monetary flow over the life of the project and to monitor the payouts throughout the process. Cost engineers and estimators apply expertise to relate the work and materials involved to a proper valuation. Cost overruns with government projects have occurred when the contractor was able to identify change orders or changes in the project resulting in large increases in cost, which are not subject to competition by other firms as they have already been eliminated from consideration after the initial bid.

Large projects can involve highly complex financial plans and often start with a conceptual estimate performed by a building estimator. As portions of a project are completed, they may be sold, supplanting one lender or owner for another, while the logistical requirements of having the right trades and materials available for each stage of the building construction project carries forward. In many English-speaking countries, but not the United States, projects typically use quantity surveyors.

Legal aspects

Construction along Ontario Highway 401, widening the road from six to twelve travel lanes

A construction project must fit into the legal framework governing the property. These include governmental regulations on the use of property, and obligations that are created in the process of construction.

The project must adhere to zoning and building code requirements. Constructing a project that fails to adhere to codes will not benefit the owner. Some legal requirements come from malum in se considerations, or the desire to prevent things that are indisputably bad – bridge collapses or explosions. Other legal requirements come from malum prohibitum considerations, or things that are a matter of custom or expectation, such as isolating businesses to a business district and residences to a residential district. An attorney may seek changes or exemptions in the law governing the land where the building will be built, either by arguing that a rule is inapplicable (the bridge design will not collapse), or that the custom is no longer needed (acceptance of live-work spaces has grown in the community).

A construction project is a complex net of contracts and other legal obligations, each of which must be carefully considered. A contract is the exchange of a set of obligations between two or more parties, but it is not so simple a matter as trying to get the other side to agree to as much as possible in exchange for as little as possible. The time element in construction means that a delay costs money, and in cases of bottlenecks, the delay can be extremely expensive. Thus, the contracts must be designed to ensure that each side is capable of performing the obligations set out. Contracts that set out clear expectations and clear paths to accomplishing those expectations are far more likely to result in the project flowing smoothly, whereas poorly drafted contracts lead to confusion and collapse.

Legal advisors in the beginning of a construction project seek to identify ambiguities and other potential sources of trouble in the contract structure, and to present options for preventing problems. Throughout the process of the project, they work to avoid and resolve conflicts that arise. In each case, the lawyer facilitates an exchange of obligations that matches the reality of the project.

Interaction of expertise

Apartment complex under construction inDaegu, South Korea

Design, finance, and legal aspects overlap and interrelate. The design must be not only structurally sound and appropriate for the use and location, but must also be financially possible to build, and legal to use. The financial structure must accommodate the need for building the design provided, and must pay amounts that are legally owed. The legal structure must integrate the design into the surrounding legal framework, and enforce the financial consequences of the construction process.

Procurement

Procurement describes the merging of activities undertaken by the client to obtain a building. There are many different methods of construction procurement; however the three most common types of procurement are:

1. Traditional (design-bid-build)
2. Design and build
3. Management contracting

There is also a growing number of new forms of procurement that involve relationship contracting where the emphasis is on a co-operative relationship between the principal and contractor and other stakeholders within a construction project. New forms include partnering such as Public-Private Partnering (PPPs) aka private finance initiatives(PFIs) and alliances such as "pure" or "project" alliances and "impure" or "strategic" alliances. The focus on co-operation is to ameliorate the many problems that arise from the often highly competitive and adversarial practices within the construction industry.

Traditional

Main article: Design–bid–build

This is the most common method of construction procurement and is well established and recognized. In this arrangement, the architect or engineer acts as the project coordinator. His or her role is to design the works, prepare the specifications and produce construction drawings, administer the contract, tender the works, and manage the works from inception to completion. There are direct contractual links between the architect's client and the main contractor. Any subcontractor will have a direct contractual relationship with the main contractor.

Design and build

Main article: Design-build

This approach has become more common in recent years, and involves the client contracting a single entity to both provide a design and to build that design. In some cases, the Design and Build (D & B) package can also include finding the site, arranging funding and applying for all necessary statutory consents.

The owner produces a list of requirements for a project, giving an overall view of the project's goals. Several D&B contractors present different ideas about how to accomplish these goals. The owner selects the ideas he or she likes best and hires the appropriate contractor. Often, it is not just one contractor, but a consortium of several contractors working together. Once a contractor (or a consortium/consortia) has been hired, they begin building the first phase of the project. As they build phase 1, they design phase 2. This is in contrast to a design-bid-build contract, where the project is completely designed by the owner, then bid on, then completed.

Kent Hansen pointed out that state departments of transportation (DOTs) usually use design build contracts as a way of getting projects done when states don't have the resources. In DOTs, design build contracts are usually used for very large projects.

CHAPTER 12

Management procurement systems

In this arrangement the client plays an active role in the procurement system by entering into separate contracts with the designer (architect or engineer), the construction manager, and individualtrade contractors. The client takes on the contractual role, while the construction or project manager provides the active role of managing the separate trade contracts, and ensuring that they complete all work smoothly and effectively together.

Management procurement systems are often used to speed up the procurement processes, allow the client greater flexibility in design variation throughout the contract, give the ability to appoint individual work contractors, separate contractual responsibility on each individual throughout the contract, and to provide greater client control.

Authority having jurisdiction

See also: Planning permission

Construction of the Rivers Towers building in Cúcuta, Colombia

In construction, the authority having jurisdiction (AHJ) is the governmental agency or sub-agency which regulates the construction process. In most cases, this is the municipality in which the building is located. However, construction performed for supra-municipal authorities are usually regulated directly by the owning authority, which becomes the AHJ

Construction on the Federal Reserve building in Kansas City, Missouri

Before the foundation can be dug, contractors are typically required to verify and have existing utility lines marked, either by the utilities themselves or through a company specializing in such services. This lessens the likelihood of damage to the existing electrical, water, sewage, phone, and cable facilities, which could cause outages and potentially hazardous situations. During the construction of a building, the municipal building inspector inspects the building periodically to ensure that the construction adheres to the approved plans and the local building code. Once construction is complete and a final inspection has been passed, anoccupancy permit may be issued.

An operating building must remain in compliance with the fire code. The fire code is enforced by the local fire department.

Changes made to a building that affect safety, including its use, expansion, structural integrity, and fire protection items, usually require approval of the AHJ for review concerning the building code.

Industry characteristics

In the United States, the industry has around $850 billion in annual revenue according to statistics tracked by the Census Bureau, with an $857 billion annual rate in March 2013, of which $600 billion is private (split evenly between residential and nonresidential) and the remainder is government. As of 2005, there were about 667,000 firms employing 1 million contractors (200,000 general contractors, 38,000 heavy, and 432,000 specialty); the average contractor employed fewer than 10 employees. As a whole, the industry employed an estimated 5.8 million as of April 2013, with a 13.2% unemployment rate.

Careers

Helicopter view of the Atacama Large Millimeter/submillimeter Array (ALMA) Operations Support Facility (OSF) construction site

Ironworkers erecting the steel frame of a new building at Massachusetts General Hospital in Boston

A truck operator at Al Gamil, the largest construction company in Djibouti.

There are many routes to the different careers within the construction industry. These three main tiers are based on educational background and training, which vary by country:

- Unskilled and semi-skilled – General site labor with little or no construction qualifications.
- Skilled – Tradesmen who've served apprenticeships, typically in labor unions, and on-site managers who possess extensive knowledge and experience in their craft or profession.

- Technical and management – Personnel with the greatest educational qualifications, usually graduate degrees, trained to design, manage and instruct the construction process.

Skilled occupations include carpenters, electricians, plumbers, ironworkers, masons, and many other manual crafts, as well as those involved in project management. In the UK these require further education qualifications, often in vocational subject areas. These qualifications are either obtained directly after the completion of compulsory education or through "on the job" apprenticeship training. In the UK, 8500 construction-related apprenticeships were commenced in 2007.

Technical and specialized occupations require more training as a greater technical knowledge is required. These professions also hold more legal responsibility. A short list of the main careers with an outline of the educational requirements are given below:

- Quantity surveyor – Typically holds a master's degree in quantity surveying. Chartered status is gained from the Royal Institution of Chartered Surveyors.

- Architect – Typically holds 1, undergraduate 3 year degree in architecture + 1, post-graduate 2 year degree (DipArch or BArch) in architecture plus 24 months experience within the industry. To use the title "architect" the individual must be registered on the Architects Registration Board register of Architects.

- Civil engineer – Typically holds a degree in a related subject. The Chartered Engineer qualification is controlled by the Engineering Council, and is often achieved through membership of the Institution of Civil Engineers. A new university graduate must hold a master's degree to become chartered; persons with bachelor's degrees may become an Incorporated Engineer.

- Building services engineer – Often referred to as an "M&E Engineer" typically holds a degree in mechanical or electrical engineering. Chartered Engineer status is governed by the Engineering Council, mainly through the Chartered Institution of Building Services Engineers.

- Project manager – Typically holds a 4-year or greater higher education qualification, but are often also qualified in another field such as quantity surveying or civil engineering.

- Structural engineer – Typically holds a bachelor's or master's degree in structural engineering. A P.ENG is required from the Professional Engineers Ontario (Canada). New university graduates must hold a master's degree to gain chartered status from the Engineering Council, mainly through theInstitution of Structural Engineers (UK).

- Civil Estimators are professionals who typically have a background in civil engineering, construction project management, or constructionsupervision.

In 2010 a salary survey revealed the differences in remuneration between different roles, sectors and locations in the construction and built environment industry. The results showed that areas of particularly strong growth in the construction industry, such as the Middle East, yield higher average salaries than in the UK for example. The average earning for a professional in the construction industry in the Middle East, across all sectors, job types and levels of experience, is £42,090, compared to £26,719 in the UK. This trend is not necessarily due to the fact that more affluent roles are available, however, as architects with 14 or more years experience working in the Middle East earn on average £43,389 per annum, compared to £40,000 in the UK. Some construction workers in the US/Canada have made more than $100,000 annually, depending on their trade.

Safety

See also: Construction site safety

At-risk workers without appropriate safety equipment

Construction is one of the most dangerous occupations in the world, incurring more occupational fatalities than any other sector in both the United States and in the European Union. In 2009, the fatal occupational injury rate among construction workers in the United States was nearly three times that for all workers. Falls are one of the most common causes of fatal and non-fatal injuries among construction workers. Proper safety equipment such as harnesses and guardrails and procedures such as securing ladders and inspecting scaffolding can curtail the risk of occupational injuries in the construction industry. Other major causes of fatalities in the construction industry include electrocution, transportation accidents, and trench cave-ins.

History

A picture of a building under construction in India

Main article: History of construction

See also: History of architecture

The first huts and shelters were constructed by hand or with simple tools. As cities grew during the Bronze Age, a class of professional craftsmen, likebricklayers and carpenters, appeared. Occasionally, slaves were used for construction work. In the Middle Ages, these were organized into guilds. In the 19th century, steam-powered machinery appeared, and later diesel- and electric powered vehicles such as cranes, excavators and bulldozers. Architecture and construction involve creating awesome structures that can show the beauty and creativity of the human intellect.

Fast-track construction has been increasingly popular in the 21st century. Some estimates suggest that 40% of construction projects are now fast-track construction.

Construction phases

- Vision/fantasy/idea - a concept never intended to be built, may be an aesthetic or structural design exercise
- Proposed - a building concept that is under review by a government
- Approved - a building concept that will be constructed in the near future
- Deferred - a building concept that may be constructed in the far future
- Cancelled - a building concept that usually has lost funding or support, in some cases construction already started
- Under-construction - a fully designed building currently being built
- Topped-out - a fully designed building that has reached its highest point
- Complete/built - a fully designed building that has been fully built, excluding future expansions

Demand curve with external costs; if social costs are not accounted for price is too low to cover all costs and hence quantity produced is unnecessarily high (because the producers of the good and their customers are essentially underpaying the total, real factors of production.)

The graph shows the effects of a negative externality. For example, the steel industry is assumed to be selling in a competitive market – before pollution-control laws were imposed and enforced (e.g. under laissez-faire). The marginal private cost is less than the marginal social or public cost by the amount of the external cost, i.e., the cost of air pollution and water pollution. This is represented by the vertical distance between the two supply curves. It is assumed that there are no external benefits, so that social benefit equals individual benefit.

If the consumers only take into account their own private cost, they will end up at price Pp and quantity Qp, instead of the more efficient price Ps and quantity Qs. These latter reflect the idea that the marginal social benefit should equal the marginal social cost, that is that production should be increased only as long as the marginal social benefit exceeds the marginal social cost. The result is that a free market is inefficient since at the quantity Qp, the social benefit is less than the social cost, so society as a whole would be better off if the goods between Qp and Qs had not been produced. The problem is that people are buying and consuming too much steel.

This discussion implies that negative externalities (such as pollution) are more than merely an ethical problem. The problem is one of the disjuncture between marginal private and social costs that is not solved by the free market. It is a problem of societal communication and coordination to balance costs and benefits. This also implies that pollution is not something solved by competitive markets. Some collective solution is needed, such as a court system to allow parties affected by the pollution to be compensated, government intervention banning or discouraging pollution, or economic incentives such as green taxes.

External benefits

Supply curve with external benefits; when the market does not account for additional social benefits of a good both the price for the good and the quantity produced are lower than the market could bear.

The graph shows the effects of a positive or beneficial externality. For example, the industry supplying smallpox vaccinations is assumed to be selling in a competitive market. The marginal private benefit of getting the vaccination is less than the marginal social or public benefit by the amount of the external benefit (for example, society as a whole is increasingly protected from smallpox by each vaccination, including those who refuse to participate). This marginal external benefit of getting a smallpox shot is represented by the vertical distance between the two demand curves. Assume there are no external costs, so that social cost equals individual cost.

If consumers only take into account their own private benefits from getting vaccinations, the market will end up at price Pp and quantity Qp as before, instead of the more efficient price Ps and quantity Qs. These latter again reflect the idea that the marginal social benefit should equal the marginal social cost, i.e., that production should be increased as long as the marginal social benefit exceeds the marginal social cost. The result in anunfettered market is inefficient since at the quantity Qp, the social benefit is greater than the societal cost, so society as a whole would be better off if more goods had been produced. The problem is that people are buying too few vaccinations.

The issue of external benefits is related to that of public goods, which are goods where it is difficult if not impossible to exclude people from benefits. The production of a public good has beneficial externalities for all, or almost all, of the public. As with external costs, there is a problem here of societal communication and coordination to balance benefits and costs. This also implies that vaccination is not something solved by competitive markets.

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NIILM University

9, Km Milestone, NH-65, Kaithal - 136027, Haryana
Website: www.niilmuniversity.in