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Professinal English Textbook

for

General Engineering Students

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Preface

دانستن زبان انگلیسی تخصصی برای هر دانشجوی مهندسی از اهمیت زیادی برخوردار است. هر دانشجو باید بتواند حد اقل متون انگلیسی عمومی مربوط به رشته تحصیلی خود را به راحتی خوانده و مفاهیم مربوطه را درک کند. حتی فراتر از خواندن و درک مفاهیم باید بتواند در محاوره، مطالب گفته شده را درک کرده و پاسخ صحیح و مناسب ارائه دهد. در محل کار بسیار اتفاق می افتد که یک دانش آموخته مهندسی با همتای خود در یک شرکت بین المللی مذاکره داشته باشد. گاه ندانستن معنای یک کلمه یا اصطلاح فنی ممکن است مذاکرات را طولانی کرده و یا با شکست مواجه کند. گاه همین مشکل، فرصت های ارزنده ای را به تهدید تبدیل می کند. لذا برای موفقیت در کار حرفه ای، آموزش زبان تخصصی در برنامه آموزشی رشته های مهندسی گنجانده شده است.

طبیعی است دانستن تمام لغت ها و مفاهیم تخصصی هر رشته مهندسی نیاز به ممارست و مطالعه گسترده دارد. اما آشنایی با برخی از مفاهیم و اصطلاحات می تواند برای رفع نیاز های معمولی مفید بوده و کلیدی برای درک بقیه لغات و اصطلاحات فنی مربوط به آن رشته باشد. به همین دلیل نوعا در برنامه دوره های کارشناسی مهندسی دو واحد درسی برای زبان تخصصی در نظر گرفته شده است. در صورت آموزش صحیح مفاهیم و لغات ارائه شده، دانشجو خواهد توانست با مطالعه شخصی قابلیت خود را در این زمینه به حد مطلوب برساند.

در رشته مهندسی مدیریت اجرایی، که از ابتکارات بخش فنی و مهندسی دانشگاه پیام نور است، دو واحد درسی برای زبان تخصصی در نظر گرفته شده است. با توجه به اینکه مهندسی مدیریت اجرایی تلفیقی از رشته های مهندسی صنایع، مهندسی مکانیک، مهندسی برق، مهندسی عمران و مهندسی کامپیوتر است، زبان تخصصی آن نیز باید تلفیقی از مفاهیم این رشته های مهندسی باشد. با تلاش انجام شده متن ۱۱ درس در نظر گرفته شده که مفاهیمی از کلیه رشته های مربوطه را در بر می گیرد. یک درس در مورد نوشتن مقاله علمی (درس سوم) و یک درس نیز در مورد یکی از دانشمندان مسلمان که از مفاخر علم مهندسی مکانیک در زمان خودش بوده است (درس چهارم) ارائه شده است.

در فایل همراه کتابچه، قابلیت هایی برای یادگیری سریع تر مطالب توسط دانشجو در نظر گرفته شده است از جمله:

۱- با اشاره (همراه با کنترل) به اصطلاحات فنی در متن اصلی کتاب، توضیحاتی از قسمت فرهنگ لغات (Vocabulary) در مورد آن ظاهر می شود و با اشاره به همان عبارت در بخش فرهنگ لغات، به محل صفحه متن باز می گردد.

۲- با اشاره (همراه با کنترل) به علائم مشخصی در شروع هر پاراگراف متن، فایل صوتی مربوط به همان پاراگراف فعال شده و از طریق بلندگو های رایانه پخش می شود.

۳- همین خصوصیت برای اصطلاحات فنی ارائه شده در بخش فرهنگ لغات نیز در نظر گرفته شده است.

۴- در انتهای هر درس تعدادی سئوال تستی در نظر گرفته شده است که دانشجو با مراجعه به آنها می توانند میزان یادگیری خود را محک بزنند.

۵- با اشاره (همراه با کنترل) به علامت خاص ابتدای هر سئوال پاسخ صحیح آن مشخص می شود.

امید است دانشجویان این رشته با استفاده از کتاب حاضر بتوانند قابلیت های زبان تخصصی خود را تقویت کرده و در آینده به مهندسان مفیدی برای جامعه صنعتی کشور تبدیل شوند.

بهمن ماه ۱۳۹۱
علی قاضی زاده
عضو هیات علمی بخش فنی و مهندسی
دانشگاه پیام نور

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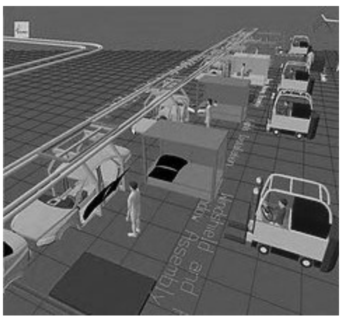
١. Computer Integrated Manufacturing

١.١ Introduction

■ **Computer Integrated Manufacturing** (CIM) is a method of manufacturing in which the entire production process is controlled by computer. The traditional separated process methods are joined through a computer by CIM. This integration allows the processes to exchange information with each other. It also gives the processes the ability to initiate actions. Through this integration, the manufacturing can be faster and with fewer errors, although the main advantage is the ability to create automated manufacturing processes. Typically CIM relies on closed-loop control processes, based on real-time input from sensors. It is also known as *flexible design and manufacturing*.



A Manufacturing Systems Integration Program (NIST ٢٠٠٨).

١. Computer Integrated Manufacturing ٢

The term "Computer Integrated Manufacturing" is both a method of manufacturing and the name of a computer automated system in which individual engineering, production, marketing, and support functions of a manufacturing enterprise are organized. In a CIM system, functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are linked through the computer with factory floor functions. Example of factory floor functions are materials handling and management. In this way, CIM provides direct control and monitoring of all process operations.

As a method of manufacturing, three components distinguish CIM from other manufacturing methodologies:

- Means for data storage, retrieval, manipulation and presentation
- Mechanisms for sensing state and modifying processes
- Algorithms for uniting the data processing component with the sensor/modification component

CIM is an example of the implementation of Information and Communication Technology (ICT) in manufacturing. CIM implies that there are at least two computers exchanging information, e.g. the controller of an arm robot and a microcontroller of a CNC machine.

Many factors are involved when considering a CIM implementation. They are the production volume, the experience of the company or personnel to make the integration, the level of the integration into the product itself, and the integration of the production processes. CIM is most useful where a high level of ICT is used in the company or facility, such as CAD/CAM systems.

۱.۲ Computer Integrated Manufacturing Topics

Key Challenges

■ There are three major challenges in development of a smoothly operating Computer Integrated Manufacturing system:

- **Integration of components from different suppliers:** When different machines, such as CNCs, conveyors and robots using different communications protocols are integrated.

- **Data integrity:** The higher the degree of automation, the more critical is the integrity of the data used to control machines. While the CIM system saves on labor of operating the machines, it requires extra human labor in ensuring that there are proper safeguards for the data signals that are used to control the machines.

- **Process control:** Computers may be used to assist the human operators of the manufacturing facility, but there must always be a competent engineer on hand to handle circumstances which could not be foreseen by the designers of the control software.

Subsystems in Computer Integrated Manufacturing

A Computer Integrated Manufacturing system is not the same as a "lights out" factory, which would run completely independent of human intervention, although it is a big step in that direction. Part of the system involves flexible manufacturing, where the factory can be quickly modified to produce different products, or where the volume of products can be changed quickly with the aid of computers. Some or all of the following subsystems may be found in a CIM operation:

١- Computer aided techniques, for example:

- CAD (Computer Aided Design)
- CAE (Computer Aided Engineering)
- CAM (Computer Aided Manufacturing)
- CAPP (Computer Aided Process Planning)
- CAQ (Computer Aided Quality Assurance)
- PPC (Production Planning and Control)
- ERP (Enterprise Resource Planning)
- A business system integrated by a common database.

٢- Devices and equipment required, for example:

- CNC machine tools
- DNC machine tools
- PLCs
- Robotics
- Computers
- Software
- Controllers
- Networks
- Interfacing
- Monitoring equipment

٣- Technologies, for example:

- FMS

- ASRS (Automated Storage and Retrieval Systems)
- AGV (Automated Guided Vehicles)
- Robotics
- Automated conveyance systems

٤- Others:

- Lean Manufacturing

١.٣ Computer Integrated Manufacturing Open System Architecture

■ Computer Integrated Manufacturing Open System Architecture CIMOSA, is a ١٩٩٠s European proposal for an open system architecture for CIM developed by the AMICE Consortium as a series of ESPRIT projects. The goal of CIMOSA is to help companies to manage change and integrate their facilities and operations to face world wide competition. It provides a consistent architectural framework for both enterprise modeling and enterprise integration as required in CIM environments.

CIMOSA provides a solution for business integration with four types of products:

- The CIMOSA Enterprise Modeling Framework, which provides a reference architecture for enterprise architecture
- CIMOSA IIS, a standard for physical and application integration
- CIMOSA Systems Life Cycle, a life cycle model for CIM development and deployment
- Inputs to standardization, basics for international standard development

CIMOSA has coined the term business process and introduced the process-based approach for integrated enterprise modeling, ignoring organizational boundaries, as opposed to function or activity-based approaches. Also CIMOSA has introduced the idea of Open System Architecture (OSA) for CIM made of vendor-independent, standardised CIM modules. OSAs are described in terms of their function, information, resource, and organizational aspects. This should be designed with structured engineering methods and made operational in a modular and evolutionary architecture for operational use.

Vocabulary:

◙ **National Institute of Standards and Technology** (**NIST**), known between ١٩٠١ and ١٩٨٨ as **National Bureau of Standards** (**NBS**), is a measurement standards laboratory which is a non-regulatory agency of the United States Department of Commerce. The official mission of the institute is: To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways enhance economic security and improve quality of life.

◙ **Information and communication technologies** (**ICT**) is an umbrella term that covers all advanced technologies in manipulating and communicating information.

◙ **Society of Manufacturing Engineers** is the world's leading professional society advancing manufacturing knowledge and influencing more than half a million manufacturing practitioners annually.

◙ **<u>Data integrity</u>** is a term used in computer science and telecommunications that can mean ensuring data is "whole" or complete, the condition in which data is identically maintained during any operation (such as transfer, storage or retrieval), the preservation of data for their intended use, or, relative to specified operations, the a priori expectation of data quality. Put simply, data integrity is the assurance that data is consistent and correct.

◙ **<u>Process control</u>** is a statistics and engineering discipline that deals with architectures, mechanisms, and algorithms for controlling the output of a specific process.

◙ **<u>Flexible manufacturing system</u>** (**FMS**) is a manufacturing system in which it has flexibilities that allows the system to react in the case of changes, whether it is predicted or unpredicted.

◙ **<u>Computer-aided design</u>** (**CAD**) is the use of computer technology for the design of objects, real or virtual. CAD often involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD often must convey also symbolic information such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

◙ **<u>Computer aided engineering</u>** (**CAE**) is the use of information technology to support engineers in tasks such as analysis, simulation, design, manufacture, planning, diagnosis, and repair.

◙ **<u>Computer aided manufacturing</u>** (**CAM**) is the use of computer-based software tools that assist engineers and machinists in manufacturing or prototyping product components. Its primary purpose is to create a faster production process and components with more precise dimensions and material consistency. In some cases, this system utilized only the required amount of raw material (thus minimizing waste), while simultaneously reducing energy consumption.

◙ **Computer Aided Process Planning** (**CAPP**) is the use of computer technology to aid in the process planning of a part or product, in manufacturing. CAPP is the link between CAD and CAM in that it provides for the planning of the process to be used in producing a designed part.

◙ **Computer Aided Quality assurance** **(CAQ)** is the engineering application of computers and computer controlled machines for the definition and inspection of the products' quality. This includes: measuring equipment management, goods inward inspection, vendor rating, attribute chart, statistical process control (SPC), and documentation.

◙ **Project management software** is a term covering many types of software, including scheduling, cost control and budget management, resource allocation, collaboration software, communication, quality management and documentation or administration systems, which are used to deal with the complexity of large projects.

◙ **Enterprise Resource Planning** (**ERP**) is a company-wide computer software system used to manage and coordinate all the resources, information, and functions of a business from a shared data storage.

◙ **Computer Numerical Control** (**CNC**) refers to the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to manually controlled via handwheels or levers, or mechanically automated via cams alone.

◙ **Direct Numerical Control**, also known as **Distributed Numerical Control**, (both DNC) is a common manufacturing term for networking CNC machine tools. On some CNC machine controllers, the available memory is too small to contain the machining program (for example machining complex surfaces), so in this case the program is stored in a separate computer and sent Direct to the machine, one block at a time.

◙ **programmable logic controller** (**PLC**) or **programmable controller** is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures.

◙ **Robot** is a virtual or mechanical artificial agent. In practice, it is usually an electro-mechanical machine which is guided by computer or electronic programming, and is thus able to do tasks on its own.

◙ **Automated Storage and Retrieval System** (**ASRS** or **AS/RS**) refers to a variety of computer-controlled methods for automatically placing and retrieving loads from specific storage locations.

◙ **Automated Guided Vehicle** or **Automatic Guided Vehicle** (AGV) is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. They are most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Application of the automatic guided vehicle has broadened during the late ۲۰th century and they are no longer restricted to industrial environments.

◙ **Lean manufacturing** or **lean production**, which is often known simply as "**Lean**", is a production practice. It considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination.

◙ **ESPRIT** (**European Strategic Program on Research in Information Technology**) was a series of integrated programmes of IT research and development projects and industrial technology transfer measures. It was a European Union initiative managed by the Directorate General for Industry (DG III) of the European Commission. Five ESPRIT programes (ESPRIT ۰ to ESPRIT ٤) ran consecutively from ۱۹۸۳ to ۱۹۹۸.

◙ **Enterprise modelling** is the abstract representation, description and definition of the structure, processes, information and resources of an identifiable business, government body, or other large organization.

◙ **Enterprise integration** is a technical field of enterprise architecture, which has solutions for system interconnection, electronic data interchange, product data exchange and distributed computing environments.

◙ **Enterprise architecture** refers to many things. Like architecture in general, it can refer to a description, a process or a profession. To some, "enterprise architecture" refers either to the structure of a business, or the documents and diagrams that describe that structure.

◙ **Business process** or **business method** is a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or customers. It often can be visualized with a flowchart as a sequence of activities.

Questions:

♦ ١. What is the advantages, and disadvantages of CIM manufacturing system?

a) The manufacturing can be slower with fewer errors however it is more expensive than traditional methods of manufacturing.

b) The manufacturing can be faster and with fewer errors, also it can create automated manufacturing processes.

c) The manufacturing can be slower but with fewer errors and it can not create automated manufacturing processes.

d) The manufacturing can be faster and with fewer errors but it can not create automated manufacturing processes.

♦ ٢. What is the role of the computer in CIM?

a) It helps to execute the repetitive activities easier and faster.

b) It links the non funltional areas, such as materials handling, to factory floor functions, such as design.

c) It helps to execute the non repetitive activities easier and faster.

d) It links the funltional areas, such as design, to factory floor functions, such as materials handling.

♦ ٣. How many factors cited in the text to consider when CIM is implemented?

a) ٢

b) ٤

c) ٣

d) ١

♦ ٤. Which answers is not a major chalange regarding to a smoothly operating CIM?

a) Integration of components from different suppliers
b) Data integrity
c) Process plan
d) Process control

♦ ٥. Which answer explain the "flexible manufacturing" more completely?

a) The factory can be quickly modified to produce different products.
b) When the volume of the products can be changed quickly with the help of the computer.
c) a and b are correct.
d) Nether a, nor b are correct.

♦ ٦. Name three computer aided techniques.

a) CAD, ERN, and PPC
b) CAD, CAPP, and CAR
c) CAD, CAN, and PPC
d) CAD, CAPP, and PPC

♦ ٧. Name three devices and equipments required for CIM.

a) CNC, DNC, and PLD
b) CNC, PLD, and Monitoring Equipments
c) CNC, DNC, and Computers
d) DNC, PLD, and Monitoring Equipments

♦ ٨. Name three technologies required for CIM implementation.

a) FMS, ASRP, and Automated Conveyance Systems
b) FMS, ASRP, and Robotics
c) FMS, AGV, and Automated Conveyance Systems
d) FMS, Robotics, and Automated Conveyance Systems

♦ ۹. What are the types of products included in the CIMOSA business integraton?

a) Modeling Framework, Systems Life Cycle, a Standard for Physical and Application Integration, and Inputs to Standardization

b) Modeling Framework, Systems management, and Inputs to Standardization

c) Modeling Framework, Systems Life Cycle, , a Standard for Physical and Application Integration and Inputs to Normalization

d) Creativity Method, Systems Life Cycle, and Inputs to Normalization

♦ ۱۰. Name two of the innovations introduced in CIMOSA.

a) Process-based Approach for Integrated Enterprise Modeling, and Organizational Boundaries

b) Enterprise Modeling, and Organizational Boundaries

c) Process-based Approach for Integrated Enterprise Modeling, and OSA for CIM

d) Enterprise Modeling, and OSA for CIM

۲. Innovation

A personification of innovation as represented by a statue in The American Adventure in the World Showcase pavilion of Walt Disney World's Epcot.

۲.۱ Definition

■ Innovation refers to a new way of doing something. It may refer to incremental and emergent or radical and revolutionary changes in thinking, products, processes, or organizations. Following Schumpeter (۱۹۳٤), contributors to the scholarly literature on innovation typically distinguish between invention, an idea made manifest, and innovation, ideas applied successfully in practice. In many fields, something new must be substantially different to be innovative, not an insignificant change, e.g., in the arts, economics, business and government policy. In economics the change must increase value, customer value, or producer value. The goal of innovation is positive change, to make someone or something better. Innovation leading to increased productivity is the fundamental source of increasing wealth in an economy.

Innovation is an important topic in the study of economics, business, design, technology, sociology, and engineering. Colloquially, the word "innovation" is often synonymous with the output of the process. However, economists tend to focus on the process itself, from the origination of an idea to its transformation into something useful, to its implementation; and on the system within which the process of innovation unfolds. Since innovation is also considered a major driver of the economy, especially when it leads to increasing productivity, the factors that lead to innovation are also considered to be critical to policy makers. In particular, followers of innovation economics stress using public policy to spur innovation and growth. Those who are directly responsible for application of the innovation are often called pioneers in their field, whether they are individuals or organisations.

■ In the organizational context, innovation may be linked to performance and growth through improvements in efficiency, productivity, quality, competitive positioning, market share, etc. All organizations can innovate, including for example hospitals, universities, and local governments. While innovation typically adds value, it may also have a negative or destructive effect as new developments clear away or change old organizational forms and practices. Organizations that do not innovate effectively may be destroyed by those that do. Hence innovation typically involves risk.

A key challenge in innovation is maintaining a balance between process and product innovations where process innovations tend to involve a business model which may develop shareholder satisfaction through improved efficiencies while product innovations develop customer support however at the risk of costly R&D that can erode shareholder return. In summary, innovation can be described as the result of some amount of time and effort into researching (R) an idea, plus some larger amount of time and effort into developing (D) this idea, plus some very large amount of time and effort into commercializing (C) this idea into a market place with customers.

۲.۲ Conceptualizing Innovation

■ Innovation has been studied in a variety of contexts, including in relation to technology, commerce, social systems, economic development, and policy construction. There are, therefore, naturally a wide range of approaches to conceptualizing innovation in the scholarly literature. Fortunately, however, a consistent theme may be identified: innovation is typically understood as the successful introduction of something new and useful, for example introducing new methods, techniques, or practices or new or altered products and services.

Distinguishing from Invention and other concepts

"An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice"

In business, innovation can be easily distinguished from invention. Invention is the conversion of cash into ideas. Innovation is the conversion of ideas into cash. This is best described by comparing Thomas Edison with Nikola Tesla. Thomas Edison was as innovator because he made money from his ideas. Nikola Tesla was an inventor. Tesla spent money to create his inventions but was unable to monetize them.

■ It is useful, when conceptualising innovation, to consider whether other words suffice. Invention – the creation of new forms, compositions of matter, or processes – is often confused with innovation. An improvement on an existing form, composition or processes might be an invention, an innovation, both or neither if it is not substantial enough. It can be difficult to differentiate change from innovation. According to business literature, an idea, a change or an improvement is only an innovation when it is put to use and effectively causes a social or commercial reorganization.

Innovation occurs when someone uses an invention or an idea to change how the world works, how people organize themselves, or how they conduct their lives. In this view innovation occurs whether or not the act of innovating succeeds in generating value for its champions. Innovation is distinct from improvement in that it permeates society and can cause reorganization. It is distinct from problem solving and may cause problems. Thus, in this view, innovation occurs whether it has positive or negative results.

So far there is no evidence where innovation has been measured scientifically. Scientists around the world are still working on methods to accurately measure innovation in terms of cost, effort or resource savings. Some of the innovations have become successful because of the way people look at things and need for change from the old ways of doing things.

۲.۳ Innovation in Organizations

■ A convenient definition of innovation from an organizational perspective is given by Luecke and Katz (۲۰۰۳), who wrote:

"Innovation . . . is generally understood as the successful introduction of a new thing or method . . . Innovation is the embodiment,

combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services.

Innovation typically involves creativity, but is not identical to it: innovation involves acting on the creative ideas to make some specific and tangible difference in the domain in which the innovation occurs. For example, Amabile et al. (۱۹۹٦) propose:

"All innovation begins with creative ideas . . . We define innovation as the successful implementation of creative ideas within an organization. In this view, creativity by individuals and teams is a starting point for innovation; the first is necessary but not sufficient condition for the second".

For innovation to occur, something more than the generation of a creative idea or insight is required: the insight must be put into action to make a genuine difference, resulting for example in new or altered business processes within the organization, or changes in the products and services provided.

A further characterization of innovation is as an organizational or management process. For example, Davila et al. (۲۰۰٦), write:

"Innovation, like many business functions, is a management process that requires specific tools, rules, and discipline."

From this point of view the emphasis is moved from the introduction of specific novel and useful ideas to the general organizational processes and procedures for generating, considering, and acting on such insights leading to significant organizational improvements in terms of improved or new business products, services, or internal processes.

Through these varieties of viewpoints, creativity is typically seen as the basis for innovation, and innovation as the successful implementation of creative ideas within an organization (c.f. Amabile et al. ۱۹۹٦ p.۱۱٥٥). From this point of view, creativity may be displayed by individuals, but innovation occurs in the organizational context only.

■ It should be noted, however, that the term 'innovation' is used by many authors rather interchangeably with the term 'creativity' when discussing individual and organizational creative activity. As Davila et al. (۲۰۰٦) comment,

"Often, in common parlance, the words creativity *and* innovation *are used interchangeably. They shouldn't be, because while creativity implies coming up with ideas, it's the "bringing ideas to life" . . . that makes innovation the distinct undertaking it is."*

The distinctions between creativity and innovation discussed above are by no means fixed or universal in the innovation literature. They are however observed by a considerable number of scholars in innovation studies.

۲.٤ Economic Conceptions of Innovation

■ Joseph Schumpeter defined economic innovation in The Theory of Economic Development, ۱۹۳٤, Harvard University Press, Boston as follows:

۱. The introduction of a new good — that is one with which consumers are not yet familiar — or of a new quality of a good.

۲. The introduction of a new method of production, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially.

۳. The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.

٤. The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.

٥. The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position

Innovation is also studied by economists in a variety of other contexts, for example in theories of entrepreneurship or in Paul Romer's New Growth Theory.

Vocabulary:

◙ **Innovation economics** is an economic doctrine that reformulates the traditional model of economic growth so that knowledge, technology, entrepreneurship, and innovation are positioned at the center of the model rather than seen as independent forces that are largely unaffected by policy.

◙ **Productivity** is a measure of output from a production process, per unit of input. For example, labor productivity is typically measured as a ratio of output per labor-hour, an input.

◙ A **business model** is a framework for creating economic, social, and/or other forms of value. The term business model is thus used for a broad range of informal and formal descriptions to represent core aspects of a business, including purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies.

◙ The phrase **research and development** (also **R and D** or, more often, **R&D**), according to the Organization for Economic Co-operation and Development, refers to "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications".

◙ **Creativity** is a mental and social process involving the generation of new ideas or concepts, or new associations of the creative mind between existing ideas or concepts. Creativity is fueled by the process of either conscious or unconscious insight.

◙ **Entrepreneurship** is the practice of starting new organizations or revitalizing mature organizations, particularly new businesses generally in response to identified opportunities. Entrepreneurship is often a difficult undertaking, as a vast majority of new businesses fail.

Questions:

♦ ۱. Describe innovation in a few words.

a) It means inventing something.
b) It is a new way of doing something.
c) It means manifesting an idea.
d) It is a new way of describing something.

♦ ۲. What is the meaning of the innovation in economics?

a) It is a negative change i.e. to make something better.
b) The change must increase value, customer value or producer value.
c) It is a positive change i.e. to make something more expensive.
d) The change must decrease value, customer value or producer value.

♦ ۳. What is the view point of economists about innovation?

a) Tend to focus on the process itself, from the origination of an idea to its implementation.
b) Tend to focus on the system within which the process of innovation unfolds.
c) Both a, and b are correct.
d) Nether a, nor b are correct.

♦ ٤. Why the factors that lead to innovation are also considered to be critical to policy makers?

a) Since innovation always leads to increasing productivity.

b) Since innovation never leads to increasing productivity.

c) Since innovation is also considered a major driver of the economy.

d) Since innovation is also considered a minor driver of the economy.

♦ ٥. Who is often called a pioneer in his field?

a) The one who is directly responsible for application of an innovation.

b) The one who is directly responsible for proposing the idea of an innovation.

c) The one who is responsible for registration of an innovation.

d) The one who is responsible for registration of an innovation idea.

♦ ٦. The author believes that what kind of organizations can be innovative?

a) Those organizations that have big market share can be innovative.

b) Those organizations that have competitive advantages can be innovative.

c) All kind of organizations can not be innovative.

d) All kind of organizations can be innovative.

♦ ٧. Why innovation typically involves risk?

a) Because organizations that do not innovate effectively may be destroyed by those that do.

b) Because organizations that do innovate may spend a lot of money and destroyed by those that do not.

c) Because organizations that do

d) Because organizations that do

innovate effectively may be destroyed by those that do not.

innovate may spend a lot of money and cannot resist at a compatetive market.

♦ ۸. What is the key challenge in innovation?

a) It is to implement process and product innovations as much as possible.

b) It is to implement either process or product innovations as much as possible.

c) It is to maintain a balance between process and product innovations.

d) It is to maintain a balance between process and product during innovation.

♦ ۹. According to Schumpeter's definition of economic innovation, which one is not an economic innovation?

a) Introduction of a new good or of a new quality of a good.

b) The closing of an old market.

c) Introduction of a new method of production

d) The opening of a new market.

♦ ۱۰. What is the meaning of entrepreneurship?

a) It means the starting of a new business in response to identified opportunity.

b) It means the starting of a new organization.

c) It means the creation of a new opportunity for a business.

d) It means the revitalizing mature organization.

۳. Scientific Writing

۳.۱ Overview

■ Many people find it difficult to write a scientific paper. The aim of this article is to help even the most uncertain writers to produce a clear and well presented piece of writing. The layout for a scientific paper is normally:

- A title
- An abstract
- An introduction (which is made up of a brief literature review)
- Materials and methods
- Experimental
- Results
- Conclusions
- Acknowledgements
- List of references

۳.۲ How to Start a Scientific Paper

■ Specialized scientific reviews and books may provide a good introduction to the subject. They will also contain additional references, some of which may be published in journals that are available in the local libraries. A good knowledge of existing information is essential for anyone in scientific research. Sir Isaac Newton said: *I can see further because I stand on the shoulders of giants.*

٣. Scientific Writing ……………………………………………… ٢٦

Scientists have saved some of the labour of observation and experiment by accepting information already in the literature as a starting point. However statements in published articles are not necessarily true, and are seldom the whole truth because:

- Subjects have seldom been studied exhaustively.
- Recent advances in technique or design of experiments may lead to additional observations.
- These may lead to a different interpretation of results.
- New enquiry may be needed.

A scientist should critically review the available literature, and determine any modifications that might be necessary. The relative usefulness of various types of paper and publication is important. In general, the low numbered references are useful as background reading and to provide an overview of the subject. The higher numbered sources, particularly ٨, ٩, ١٠ and ١١, provide accurate and up-to-date information.

Sources of information

There are a large number of sources of information that can be used to find the relevant information. These sources of information can be used to write an essay or to write a scientific paper. Some of them are less reliable than others. Information from popular sources tends to be less reliable than information direct from scientific papers because it is second or third hand. The list below indicates the usefulness of the various sources available: From ١ the most popular to ١١ most scientific, up to date and reliable:

١. The World Wide Web
٢. Scientific textbooks
٣. Newspaper articles, articles on science subjects in popular journals

٤. On-line journals (not refereed)

٥. Popular science journals, e.g. New Scientist http://www.newscientist.com

٦. Review articles in scientific journals (e.g. Nutrition Abstracts and Reviews or in 'Trends' journals such as Trends in Plant Science) http://www.trends.com

٧. Grey literature (i.e. information not readily available), for example, conference proceedings, research reports, and annual reports

٨. Abstracting journals, e.g. Grassland and Forage Abstracts, Veterinary Bulletin http://www.cabi.org; databases containing annotated bibliographies (e.g. by CABI) http://www.cabi.org, on-line-searching of database titles and current contents

٩. Science citation index

١٠. Higher degree theses

١١. Scientific papers in scientific journals (including refereed on-line journals)

۳.۳ Titles for Essays and Scientific Papers

■ The title should indicate what the essay contains and be as concise as possible. The title should be a concise summary of the paper. Include important nouns or key words and then join together within the title. Examples 'The limitations of maize (corn) as an energy source in diets for children', 'The feeding of rice straw and sorghum tops with molasses and urea to cattle', Key words: Maize, corn, humans, diets, rice straw, sorghum, molasses, urea, and cattle When an essay or a paper is being written, an author should constantly refer back to the title to ensure that what is being written is encompassed by the title. J. Oliver, in his book on scientific writing (written in the ١٩٦٠s), quotes an example where he was looking for paper on 'Acknowledgements'. He could not find it in the indexes because the paper was entitled *Independence in Publication*. In other words the keyword 'acknowledgements' was missing from the title. This type of problem is less likely to arise today because most searches today are made electronically on databases. These searches include searches of keyword words included in the abstract as well as those in the title. It is highly probable that the word acknowledgments would have occurred in the abstract and he would have found the paper for which he was looking. Unconscious humour or inaccuracies should also be avoided in titles, e.g. one quoted by J. Oliver: *Freezing and storage of human semen in ۵۰ healthy medical students.* (It is to be hoped that the medical students remained healthy and fertile after such an experiment).

Types of title that can be used for scientific papers:

Various types of title can be used for a paper:

Indicative title: Indicative titles indicate the subject matter of a paper but give no indication of any results obtained or conclusions drawn e.g. "*The effectiveness of bed nets in controlling mosquitoes at different seasons of the year".*

Informative titles: Informative titles give an indication of results achieved and conclusions drawn as well as the subject matter of the paper e.g. "*Bed nets control mosquitoes most effectively when used in the rainy season."*

Question-type titles: This type of title obviously asks a question. e.g. "*When are bed nets most effective when used to control mosquitoes?"*

Main-subtitle (series) type: This type of title indicates that the article is a series of papers on one subject. This approach is not liked by editors of scientific journals because if they accept the first paper they will be duty bound to accept sequels. e.g. "*The effect of bed nets on mosquitoes: ۱.Their effectiveness when used only in the rainy* *season."*

Hanging titles: Called a hanging title because it appears to be the first in a series without actually saying so .e.g. "*The effect of bed nets on mosquitoes: Their effectiveness when used only in the rainy season.*"

How to write titles:

■ Ensure that the title:

- Describes the contents of the paper.
- Is accurate, concise and specific.
- Has as many key words as possible and is modelled on the style adopted by the publication for which you are writing.
- Is as easy to understand as possible.

The title should not:

- Contain a full stop, unless it is an informative title
- Contain unnecessary words such as "Some notes on …", or "An investigation into ..."
- Contain abbreviations, formulas and acronyms
- Promise more than is in the paper
- Be too general

In most cases when writing a title of a scientific paper the title should be followed by the author's name and full address of the institution where the work was carried out. If an author has moved, his/her new address should be added as a footnote.

۳.٤ How to Write Abstracts

■ The abstract should be used to bridge the gap between the title with a few words and a paper of several pages. Remember that the abstract will be read by more people than the paper itself. There are two types of abstracts:

An informative abstract: An informative abstract contains a summary of all the main points that are in the essay or paper. To prepare an informative abstract an author should read the essay or paper, making notes as he or she progresses.

An indicative abstract: An abstract for a book is normally written as an indicative one. In other words it tells you what subject matter the book covers and is not a summary of all its contents. Abstracts should not contain: References to tables or figures, because these appear only in the paper; abbreviations or acronyms unless they are standard or explained; References to literature cited; any conclusions that are not in the paper itself.

٣.٥ Introduction

■ An introduction to a scientific paper should normally not exceed ٤٠٠ words (check the requirements of the Journal to which you intend to submit your paper) and it should:

- Cover the background to the subject to be investigated.
- Give a brief resume of what is the state of present knowledge about the subject to be investigated quoting the appropriate references.
- Identify gaps in existing knowledge.
- Explain the reason for the current investigation.

٣.٦ Materials and Methods

■ This section should deal with four main topics:

- Equipment and materials used
- Experimental design
- Observations made
- Methods of analysis used

٣.٧ Results

■ This section should contain:

- The information which the investigation has provided.
- Tables and graphs which summarise the data collected.
- Text used to draw attention to the main features presented in the tables and graphs.

The data presented in tables, and graphs should be understandable without reference to the text and the text should be clear without reference to the tables and graphs.

۳.۸ Discussion and Conclusions

■ This section should summarise the main findings of the experiments undertaken. It should:

- Compare these results with the results of other workers in the same field.
- Draw reasoned conclusions.
- Compare these conclusions with those drawn by other workers.
- Indicate the practical implications of the findings.
- Iindicate what further research is needed .

۳.۹ Acknowledgements

■ These should be clear and any help of academic, scientific or technical nature should be acknowledged. But if the acknowledgement is overdone there is a danger that the reader will wonder what contribution the author made to the paper. For example: 'I wish to thank Dr. Bahmani, who not only suggested most of the experimental design but also greatly helped with the interpretation of the results, Dr Ershad, who contributed greatly to the writing of the paper and Mr A. Keramat who carried out most of the experimental work'.

۳.۱۰ Tables and Graphs in Scientific Papers

■ Tables should be numbered in a continuous sequence through the essay. Each table must be referred to in the text, but it may also have a heading clearly showing its content. The units of any numbers in the table must be clearly stated. If the table was synthesized from data published in previous publications these references must be cited. The inclusion of a large number of tables makes the text difficult to read and should be avoided. Sometimes data can be more clearly presented as graphs rather than tables. If it is necessary to include tables which are relevant but not essential for an understanding of the text they should be put in an appendix. Tables should be clearly understandable without reference to the text and vice versa. The text should be used to explain the main parts of a table. Graphs and other figures should also be numbered sequentially. Each must have a self-explanatory heading, and must be referred to in the text. The axes of graphs should be clearly labelled and must give the units.

۳.۱۱ Citation of Reference in the Text

■ Reference may be cited in two ways. Either *"Brown, Smith and Jones (۲۰۰٦ and Abdulahi (۱۹۹۸) confirmed these results..."* or *"These results were confirmed by similar experiments (Brown, Smith and Jones, ۲۰۰٥; Abdulahi, ۲۰۰٦)"*. The names of all the authors (but not their initials) should be given the first time the reference is cited in the text. For subsequent citations, if there are four or more authors an abbreviation of the forms *"Brown et al. (۲۰۰۱)..."* should be used. Where more than one reference is used for the same author in one year, lower case letters should be used to distinguish between them, for example, "*McLean (۲۰۰۲b)*".

۳.۱۲ List of References and End of Paper

■ The reference section contains a list of all the references cited in the text. References should be arranged in alphabetical order (according to the name of the first author). Each reference to an article should contain the following:

- Name (or names) of author(s), (each) followed by initials
- Year of publication in parenthesis
- Title of article
- Title of journal, either in full or abbreviated according to the World List of Scientific Periodicals
- Volume of journal, underlined
- Number of first and last pages of articles.

For example:

Hutber A.M. and Kitching R.P. (۲۰۰۰). The role of management segregations in the control of intra-herd foot and mouth disease. *Tropical Animal Health and Production,* ۳۲: ۲۸۵-۲۹٤

Each reference to a book should contain:

- Name (s) and year, as mentioned above
- Title of book (the most important words in the title should be given in capital letters e.g. Milk and Beef Production in the Tropics)
- Publisher and place of publication e.g. Oxford University Press, London

Each reference to an article which is published in a book or Conference Proceedings should also contain the title of the book and its editor. For example:

Chalmers, E.E. (۲۰۰٤). Advantages and disadvantages of nomadism with particular reference to the Republic of Sudan. *In: Beef Cattle Production in Developing Countries (ed. Smith, A.J.),* pp. ۳۸۸-۳۹۷. Centre for Tropical Veterinary Medicine, Edinburgh.

Attention should be paid to uniformity of punctuation. Please check the list of references, since it is very frustrating for the reader to find that references in the text are not included, or that they are wrongly quoted. Make sure that references in the text are in the reference list. Programs such as Word, Papyrus, and Endnote can assist with this chore and that of putting references in order.

Vocabulary:

◙ **Scientific writing** is writing about science.

◙ **Observation** is either an activity of a living being, such as a human, consisting of receiving knowledge of the outside world through the senses, or the recording of data using scientific instruments. The term may also refer to any data collected during this activity.

◙ An **experiment** is a methodical procedure carried out with the goal of verifying, falsifying, or establishing the validity of a hypothesis. Experiments provide insight into cause-and-effect by demonstrating what outcome occurs when a particular factor is manipulated.

◙ The **World Wide Web** (abbreviated as WWW or W۳,[۲] commonly known as the Web), is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can view web pages that may contain text, images, videos, and other multimedia, and navigate between them via hyperlinks.

Questions:

♦ ۱. Which one recalls the layout of a scientific paper in a proper order?

a) A title, an abstract, an introduction, materials and methods, experimental, conclusions, and list of references

b) A title, an abstract, an introduction, materials and methods, conclusions, experimental, acknowledgments, results, and list of references

c) A title, an introduction, results, conclusions, acknowledgments, and list of references

d) A title, an abstract, an introduction, materials and methods, experimental, results, conclusions, acknowledgments, and list of references

♦ ۲. How should someone start a scientific paper?

a) By critically reviewing the information already in the literature on the subject of his or her interest as a starting point

b) By accepting information already in the literature on the subject of his or her interest as true and the whole true

c) By rewriting the information referenced in the literature on the subject of his or her interest as a starting point

d) By not accepting information already in the literature on the subject of his or her interest as true and the whole true

♦ ۳. Why some of the sources of information are less reliable than others?

a) Because they may are reported by different researchers.

b) Because they may are reported by unothorized writers.

c) Because they may not be first hand.

d) Because they may not verified by different researchers

♦ ٤. Which one put the scientific source of information in order from most popular to most reliable?

a) The world wide web, scientific tetbooks, review articles in scientific journals, abstracting journals, and scientific papsers in scientific journals

b) Scientific tetbooks, review articles in scientific journals, abstracting journals, the world wide web, and scientific papsers in scientific journals

c) The world wide web, review articles in scientific journals, abstracting journals, scientific tetbooks, and scientific papsers in scientific journals

d) The world wide web, scientific papsers in scientific journals, , abstracting journals, scientific tetbooks, and review articles in scientific journals

♦ ٥. The title of a scientific writing should

a) Indicate what the essay contains.

b) Be as concise as possible.

c) Include important nouns or key words.

d) All three are correct.

♦ ٦. Which one explanes one of the types of title?

a) This type of titles indicates the most important part of the research work.

b) This type of titles gives an indication of results achieved and conclusions drawn as well as the subject matter of the paper.

c) This type of titles indicates the most popular part of the research

d) This type of title has a hanging question.

work.

♦ ۷. What is the role of abstract in a scientific writing?

a) It contains a few of the main points that are in the essay or paper

b) It shows the subject of a paper or a summary of the content of a book.

c) It bridges the gap between the title and a paper of several pages.

d) It bridges the gap between the summary and conclusion of a paper.

♦ ۸. What should be mentioned in the introduction of a scientific paper?

a) Cover the background to the subject of the previous paper published by the author.

b) Give a brief resume of what is the state of present knowledge about the subject matter of the paper.

c) Cover the background to the subject of the future paper that will be published by the author.

d) Identificy differences in existing experimental investigations.

♦ ۹. Which section should deal with experimental design and observation made?

a) Equipment and Materials

b) Results

c) Materials and Methods

d) Introduction

♦ ۱۰. Where should the results compared with the results of other workers in the same field?

a) In the materials and methods section

b) In the results section

c) In the experimental data section

d) In the discussion and conclusions section

٣. Scientific Writing ٣٨

♦ ١١. Which one is not correct about acknowledgement?

a) It should be clear and precise.
b) It should always be overdone.
c) It should cover the finantial supporter of the research work.
d) It should cover the professor who has directed the research work.

♦ ١٢. How should be the header of the tables and graphs?

a) It should not show its sourc of information.
b) It should not be simple and brief.
c) It should clearly show its contents.
d) It should refer to the text itself.

♦ ١٣. What is not correct about list of references?

a) It is not necessary to pay attention to uniformity of punctuation.
b) It should be arranged in alphabetical order according to the name of the first author.
c) All the referecnes in the text should appear in the reference list.
d) It should not be wrongly quoted.

٤. A Muslim Polymath

Title: al-Jazari
Born: ١١٣٦CE
Died: ١٢٠٦CE
Era: Islamic golden age
Main interest(s): scholar, inventor, mechanical engineer, craftsman, artist, and mathematician

٤.١ Summary

al-Jazari was a Muslim polymath: a scholar, inventor, mechanical engineer, craftsman, artist, and mathematician from Jazirat ibn Umar (current Cizre), who lived during the Islamic Golden Age (Middle Ages). He is best known for writing the al-Jami bain al-ilm wa al-amal al-nafi fi ṣinaat al-ḥiyal (The Book of Knowledge of Ingenious Mechanical Devices) in ١٢٠٦, where he described ١٠٠ mechanical devices, some ٨٠ of which are trick vessels of various kinds, along with instructions on how to construct them.

٤.٢ Biography

Little is known about al-Jazari, and most of that comes from the introduction to his Book of Knowledge of Ingenious Mechanical Devices. He was named after the area in which he was born (the city of Jazirat ibn Umar). Like his father before him, he served as chief engineer at the Artuklu Palace, the residence of the Mardin branch of the Turkish Artuqid dynasty which ruled across eastern Anatolia as vassals of the Zangid rulers of Mosul and later Ayyubid general Saladin. He was born in the city of Tor, now located in the district of Cizre in south-Eastern Turkey.

al-Jazari was part of a tradition of craftsmen and was thus more of a practical engineer than an inventor who appears to have been "more interested in the craftsmanship necessary to construct the devices than in the technology which lay behind them" and his machines were usually" assembled by trial and error rather than by theoretical calculation." His Book of Knowledge of Ingenious Mechanical Devices appears to have been quite popular as it appears in a large number of manuscript copies, and as he explains repeatedly, he only describes devices he has built himself.

Some of his devices were inspired by earlier devices, such as one of his monumental water clocks, which was based on that of a Pseudo-Archimedes. He also cites the influence of the Banu Musa brothers for his fountains, al-Asturlabi for the design of a candle clock, and Hibat Allah ibn al-Husayn (d. ١١٣٩) for musical automata. Al-Jazari goes on to describe the improvements he made to the work of his predecessors, and describes a number of devices, techniques and components that are original innovations which do not appear in the works by his processors.

While many of al-Jazari's inventions may now appear to be trivial, the most significant aspect of al-Jazari's machines are the mechanisms, components, ideas, methods, and design features which they employ.

٤.٣ Mechanisms and methods

Camshaft

The camshaft, a shaft to which cams are attached, was first introduced in ١٢٠٦ by al-Jazari, who employed them in his automata water clocks (such as the candle clock) and water-raising machines. The cam and camshaft later appeared in European mechanisms from the ١٤th century.

Crankshaft and crank-slider mechanism

The eccentrically mounted handle of the rotary handmill in ٥th century BC Spain that spread across the Roman Empire constitutes a crank. The earliest evidence of a crank and connecting rod mechanism dates to the ٣rd century AD Hierapolis sawmill in the Roman Empire. The crank also appears in the mid-٩th century in several of the hydraulic devices described by the Banū Mūsā brothers in their Book of Ingenious Devices.

In ١٢٠٦, al-Jazari invented an early crankshaft, which he incorporated with a crank-connecting rod mechanism in his twin-cylinder pump. Like the modern crankshaft, Al-Jazari's mechanism consisted of a wheel setting several crank pins into motion, with the wheel's motion being circular and the pins moving back-and-forth in a straight line. The crankshaft described by al-Jazari transforms continuous rotary motion into a linear reciprocating motion, and is central to modern machinery such as the steam engine, internal combustion engine and automatic controls.

He used the crankshaft with a connecting rod in two of his water-raising machines: the crank-driven saqiya chain pump and the double-action reciprocating piston suction pump. His water pump also employed the first known crank-slider mechanism.

٤.٤ Design and construction methods

English technology historian Donald Routledge Hill writes: We see for the first time in al-Jazari's work several concepts important for both design and construction: the lamination of timber to minimize warping, the static balancing of wheels, the use of wooden templates (a kind of pattern), the use of paper models to establish designs, the calibration of orifices, the grinding of the seats and plugs of valves together with emery powder to obtain a watertight fit, and the casting of metals in closed mold boxes with sand.

Escapement mechanism in a rotating wheel

Al-Jazari invented a method for controlling the speed of rotation of a wheel using an escapement mechanism.

Mechanical controls

According to Donald Routledge Hill, al-Jazari described several early mechanical controls, including "a large metal door, a combination lock and a lock with four bolts."

Segmental gear

A segmental gear is "a piece for receiving or communicating reciprocating motion from or to a cogwheel, consisting of a sector of a circular gear, or ring, having cogs on the periphery, or face." Professor Lynn Townsend White, Jr. wrote:
Segmental gears first clearly appear in al-Jazari, in the West they emerge in Giovanni de Dondi's astronomical clock finished in ١٣٦٤,

and only with the great Science engineer Francesco di Giorgio (١٥٠١) did they enter the general vocabulary of European machine design.

٤.٥ Water-raising machines

Al-Jazari invented five machines for raising water, as well as watermills and water wheels with cams on their axle used to operate automata, in the ١٢th and ١٣th centuries, and described them in ١٢٠٦. It was in these water-raising machines that he introduced his most important ideas and components.

Saqiya chain pumps

The first known use of a crankshaft in a chain pump was in one of al-Jazari's saqiya machines. The concept of minimizing intermittent working is also first implied in one of al-Jazari's saqiya chain pumps, which was for the purpose of maximizing the efficiency of the saqiya chain pump.

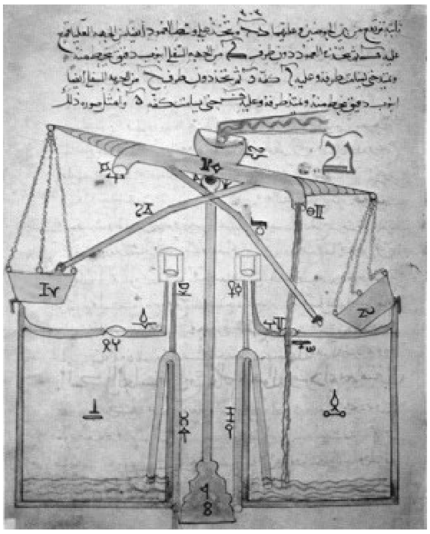


Diagram of a hydropowered water-raising machine from The Book of Knowledge of Ingenious Mechanical Devices by Al-Jazari in ١٢٠٦.

Al-Jazari also constructed a water-raising saqiya chain pump which was run by hydropower rather than manual labour, though the Chinese were also using hydropower for chain pumps prior to him. Saqiya machines like the ones he described have been supplying water in Damascus since the ١٣th century up until modern times, and were in everyday use throughout the medieval Islamic world.

Double-action suction pump with valves and reciprocating piston motion

Citing the Byzantine siphon used for discharging Greek fire as an inspiration, al-Jazari went on to describe the first suction pipes, suction pump, double-action pump, and made early uses of valves and a crankshaft-connecting rod mechanism, when he invented a twin-cylinder reciprocating piston suction pump. This pump is driven by a water wheel, which drives, through a system of gears, an oscillating slot-rod to which the rods of two pistons are attached. The pistons work in horizontally opposed cylinders, each provided with valve-operated suction and delivery pipes. The delivery pipes are joined above the center of the machine to form a single outlet into the irrigation system. This water-raising machine had a direct significance for the development of modern engineering. This pump is remarkable for three reasons

١. The first known use of a true suction pipe (which sucks fluids into a partial vacuum) in a pump.

٢. The first application of the double-acting principle.

٣. The conversion of rotary to reciprocating motion, via the crank-connecting rod mechanism.

al-Jazari's suction piston pump could lift ١٣.٦ metres of water with the help of delivery pipes. This was more advanced than the suction pumps that appeared in ١٥th-century Europe, which lacked delivery pipes. It was not, however, any more efficient than a noria commonly used by the Muslim world at the time.

Water supply system

al-Jazari developed the earliest water supply system to be driven by gears and hydropower, which was built in ١٣th century Damascus to supply water to its mosques and Bimaristan hospitals. The system had water from a lake turn a scoop-wheel and a system of gears which transported jars of water up to a water channel that led to mosques and hospitals in the city.

٤.٦ Automata

al-Jazari built automated moving peacocks driven by hydropower. He also invented the earliest known automatic gates, which were driven by hydropower. He also created automatic doors as part of one of his elaborate water clocks, He also invented water wheels with cams on their axle used to operate automata. According to Encyclopædia Britannica, the Italian Renaissance inventor Leonardo da Vinci may have been influenced by the classic automata of al-Jazari.

Mark E. Rosheim summarizes the advances in robotics made by Arab engineers, especially al-Jazari, as follows:

- Unlike the Greek designs, these Muslims examples reveal an interest, not only in dramatic illusion, but in manipulating the environment for human comfort. Thus, the greatest contribution the Muslims made, besides preserving, disseminating and building on the work of the Greeks, was the concept of practical application. This was the key element that was missing in Greek robotic science.
- The Muslims, on the other hand, displayed an interest in creating human-like machines for practical purposes but lacked, like other preindustrial societies, any real impetus to pursue their robotic science.

Drink-serving waitress

One of al-Jazari's humanoid automata was a waitress that could serve water, tea or drinks. The drink was stored in a tank with a reservoir from where the drink drips into a bucket and, after seven minutes, into a cup, after which the waitress appears out of an automatic door serving the drink.

Hand-washing automaton with flush mechanism

al-Jazari invented a hand washing automaton incorporating a flush mechanism now used in modern flush toilets. It features a female humanoid automaton standing by a basin filled with water. When the user pulls the lever, the water drains and the female automaton refills the basin.

Peacock fountain with automated servants

al-Jazari's "peacock fountain" was a more sophisticated hand washing device featuring humanoid automata as servants which offer soap and towels. Mark E. Rosheim describes it as follows:

Pulling a plug on the peacock's tail releases water out of the beak; as the dirty water from the basin fills the hollow base a float rises and actuates a linkage which makes a servant figure appear from behind a door under the peacock and offer soap. When more water is used, a second float at a higher level trips and causes the appearance of a second servant figure — with a towel!

Musical robot band

al-Jazari's work described fountains and musical automata, in which the flow of water alternated from one large tank to another at hourly or half-hourly intervals. This operation was achieved through his innovative use of hydraulic switching.

al-Jazari created a musical automaton, which was a boat with four automatic musicians that floated on a lake to entertain guests at royal drinking parties. Professor Noel Sharkey has argued that it is quite likely that it was an early programmable automata and has produced a possible reconstruction of the mechanism; it has a programmable drum machine with pegs (cams) that bump into little levers that operated the percussion. The drummer could be made to play different rhythms and different drum patterns if the pegs were moved around.

٤.٧ Clocks

al-Jazari constructed a variety of water clocks and candle clocks. These included a portable water-powered scribe clock, which was a meter high and half a meter wide, reconstructed successfully at the Science Museum (London) in ١٩٧٦ Al-Jazari also invented monumental water-powered astronomical clocks which displayed moving models of the Sun, Moon, and stars.

Candle clocks

al-Jazari described the most sophisticated candle clocks known to date. One of al-Jazari's candle clocks is described as follows:

The candle, whose rate of burning was known, bore against the underside of the cap, and its wick passed through the hole. Wax collected in the indentation and could be removed periodically so that it did not interfere with steady burning. The bottom of the candle rested in a shallow dish that had a ring on its side connected through pulleys to a counterweight. As the candle burned away, the weight pushed it upward at a constant speed. The automata were operated from the dish at the bottom of the candle. No other candle clocks of this sophistication are known.

al-Jazari's candle clock also included a dial to display the time and, for the first time, employed a bayonet fitting, a fastening mechanism still used in modern times.

Elephant clock

The elephant clock was described by al-Jazari in ١٢٠٦ is notable for several innovations. It was the first clock in which an automaton reacted after certain intervals of time (in this case, a humanoid robot striking the cymbal and a mechanical robotic bird chirping) and the first water clock to accurately record the passage of the temporal hours to match the uneven length of days throughout the year.

Castle clock

al-Jazari's largest astronomical clock was the "castle clock", which was a complex device that was about ١١ feet (٣.٤ m) high, and had multiple functions besides timekeeping. It included a display of the zodiac and the solar and lunar orbits, and an innovative feature of the device was a pointer in the shape of the crescent moon which travelled across the top of a gateway, moved by a hidden cart, and caused automatic doors to open, each revealing a mannequin, every hour. Another innovative feature was the ability to re-program the length of day and night in order to account for their changes throughout the year. Another feature of the device was five automaton musicians who automatically play music when moved by levers operated by a hidden camshaft attached to a water wheel. Other components of the castle clock included a main reservoir with a float, a float chamber and flow regulator plate and valve trough, two pulleys crescent disc displaying the zodiac, and two falcon automata dropping balls into vases.

Weight-driven water clocks

al-Jazari invented water clocks that were driven by both water and weights. These included geared clocks and a portable water-powered scribe clock, which was a meter high and half a meter wide. The scribe with his pen was synonymous to the hour hand of a modern clock. al-Jazari's famous water-powered scribe clock was reconstructed successfully at the Science Museum (London) in ١٩٧٦.

٤.٨ Miniature paintings

Alongside his accomplishments as an inventor and engineer, al-Jazari was also an accomplished artist. In The Book of Knowledge of Ingenious Mechanical Devices, he gave instructions of his inventions and illustrated them using miniature paintings, a medieval style of Islamic art.

Vocabulary:

◙ A **polymath** is a person whose expertise spans a significant number of different subject areas. In less formal terms, a polymath (or polymathic person) may simply be someone who is very knowledgeable.

◙ **Craftsman** may refer to artisan, a skilled manual worker who makes items that may be functional or strictly decorative.

◙ The **Islamic Golden Age** is an Abbasid historical period lasting until the Mongol conquest of Baghdad in ١٢٥٨. The Islamic Golden Age was inaugurated by the middle of the ٨th century by the ascension of the Abbasid Caliphate and the transfer of the capital from Damascus to Baghdad.

◙ **Trick vessels** are vessels "with a twist". The aim is to either drink or pour from a container without spilling any of the liquid.

◙ A **camshaft** is a shaft to which a cam is fastened or of which a cam forms an integral part.

◙ The **crankshaft**, sometimes abbreviated to crank, is the part of an engine that translates reciprocating linear piston motion into rotation.

Questions:

♦ ١. Where was al-Jazari from?

a) A Kordish city called Cizre.
b) An unknown Europian city.
c) A Turkish city called Jazira ibn Umar
d) An unknown city from Arab countries.

♦ ٢. How manu devices he has built himself?

a) ١٠٠
b) More than ١٠٠
c) ٨٠
d) Less than ٨٠

♦ ٣. How can we explain his approach to engineering?

a) He was more interested in the theoretical calculation.
b) He was more of a practical engineer.
c) He was more interested in the technology which lay behind his machines.
d) He was more of an inventor.

♦ ٤. What is the most significant aspect of al-Jazari's machines?

a) Mechanisms
b) Components
c) Ideas, methods, and design features
d) a, b, and c are correct

♦ ٥. What are the most significant mechanisms and methods employed by al-Jazari?

a) Camshaft, Flywheel, and crank-slider mechanism
b) Camshaft, Crankshaft, and crank-slider mechanism
c) Camshaft, Flywheel, and four link mechanism
d) Camshaft, Crankshaft, and four link mechanism

♦ ٦. What are the concepts important for design and construction employed for the first time in al-jazari's work?

a) The static balancing of wheels
b) The use of paper model to communicate manufacturing methods
c) The dynamic balancing of wheels
d) The casting of metals in open mold boxes with wood

♦ ٧. What kind of control he applied to a large metal door, a combination lock, and a lock with four bolts?

a) Combination of electrical and electronic control
b) Combination of mechanical and electronic control
c) Electrical control
d) Mechanical control

♦ ٨. How long did the segmental gears entered the general vocabulary of Europian machine design after its invention by al-Jazari?

a) About ٢ century
b) About ٣ century
c) About ٤ century
d) About ٥ century

♦ ٩. How many machines was invented by al-Jazari for raising water, watermills and water wheels with cams on their axle?

a) ٢
b) ٣
c) ٤
d) ٥

♦ ١٠. What invention has been used by al-Jazari in his Saqiya chain pumps?

a) The use of a crankshaft in a chain pump
b) The cocept of minimizing intermittent working
c) Neither a, nor b are correct.
d) Both a, and b are correct.

♦ ١١. Where did he construct a water-raising saqiya chain pump?

a) In Damascus
b) In Baghdad
c) In Ankara
d) In Aten

♦ ١٢. Which one of al-Jazari's invention has a direct significance for the development of modern engineering?

a) His piston suction pump
b) His chain pipe system
c) One of his water-raising machine
d) His segmental gears

♦ ١٣. How does al-Jazari's water supply system work?

a) It was driven by gears and crankshaft.
b) It was driven by hydropower and water clock.
c) It was driven by gears and hydropower.
d) It was driven by hydropower and water clock.

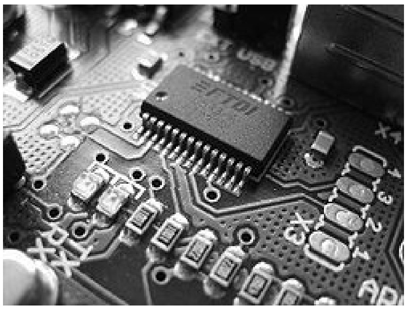
♦ ١٤. Where did he apply his automatic doors?

a) In one of his water clocks.
b) In one of his saqya chain pumps
c) In all of his water clocks.
d) In all of his saqya chain pumps

♦ ١٥. In what area of slamic art Al-Jazari was an expert?

a) sculpture
b) Painting
c) Fine art
d) Miniature paintings

٥. Electronics



Surface mount electronic components

٥.١ Deffinition

■ **Electronics** is a branch of science and technology that deals with the controlled flow of electrons. The ability to control electron flow is usually applied to information handling or device control. Electronics is distinct from electrical science and technology, which deals with the generation, distribution, control and application of electrical power. This distinction started around ١٩٠٦ with the invention by Lee De Forest of the triode, which made electrical amplification possible with a non-mechanical device. Until ١٩٥٠ this field was called "radio technology" because its principal application was in design and theory of radio transmitters, receivers and vacuum tubes.

Most electronic devices today use semiconductor components to perform electron control. The study of semiconductor devices and related technology is considered a branch of physics, whereas the design and construction of electronic circuits to solve practical problems come under electronics engineering. This article focuses on engineering aspects of electronics.

۵.۲ Electronic Devices and Components

■ An electronic component is any physical entity in an electronic system used to affect the electrons or their associated fields in a desired manner consistent with the intended function of the electronic system. Components are generally intended to be connected together, usually by being soldered to a printed circuit board (PCB), to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator). Components may be packaged singly or in more complex groups as integrated circuits. Some common electronic components are capacitors, resistors, diodes, transistors, etc.

Types of circuits

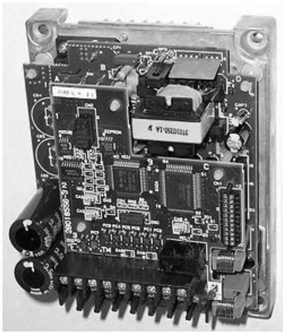
Circuits and components can be divided into two groups: analog and digital. A particular device may consist of circuitry that has one or the other or a mix of the two types

Analog circuits

Most analog electronic appliances, such as radio receivers, are constructed from combinations of a few types of basic circuits. Analog circuits use a continuous range of voltage as opposed to discrete levels as in digital circuits.

The number of different analog circuits so far devised is huge, especially because a 'circuit' can be defined as anything from a single component, to systems containing thousands of components.

Analog circuits are sometimes called linear circuits although many non-linear effects are used in analog circuits such as mixers, modulators, etc. Good examples of analog circuits include vacuum tube and transistor amplifiers, operational amplifiers and oscillators. One rarely finds modern circuits that are entirely analog. These days analog circuitry may use digital or even microprocessor techniques to improve performance. This type of circuit is usually called "mixed signal" rather than analog or digital.



Hitachi J١٠٠ adjustable frequency drive chassis.

Sometimes it may be difficult to differentiate between analog and digital circuits as they have elements of both linear and non-linear operation. An example is the comparator which takes in a continuous range of voltage but only outputs one of two levels as in a digital circuit. Similarly, an overdriven transistor amplifier can take on the characteristics of a controlled switch having essentially two levels of output.

Digital Circuits

■ Digital circuits are electric circuits based on a number of discrete voltage levels. Digital circuits are the most common physical representation of Boolean algebra and are the basis of all digital computers. To most engineers, the terms "digital circuit", "digital system" and "logic" are interchangeable in the context of digital circuits. Most digital circuits use two voltage levels labeled "Low"(٠) and "High"(١). Often "Low" will be near zero volts and "High" will be at a higher level depending on the supply voltage in use. Ternary (with three states) logic has been studied, and some prototype computers made.

Computers, electronic clocks, and programmable logic controllers (used to control industrial processes) are constructed of digital circuits. Digital Signal Processors are another example.

Heat dissipation and thermal management

Heat generated by electronic circuitry must be dissipated to prevent immediate failure and improve long term reliability. Techniques for heat dissipation can include heat sinks and fans for air cooling, and other forms of computer cooling such as water cooling. These techniques use convection, conduction, & radiation of heat energy.

Noise

Noise is associated with all electronic circuits. Noise is defined as unwanted disturbances superposed on a useful signal that tend to obscure its information content. Noise is not the same as signal distortion caused by a circuit. Noise may be electromagnetically or thermally generated, which can be decreased by lowering the operating temperature of the circuit. Other types of noise, such as shot noise cannot be removed as they are due to limitations in physical properties.

۵.۳ Electronics Theory

■ Mathematical methods are integral to the study of electronics. To become proficient in electronics it is also necessary to become proficient in the mathematics of circuit analysis.

Circuit analysis is the study of methods of solving generally linear systems for unknown variables such as the voltage at a certain node or the current through a certain branch of a network. A common

analytical tool for this is the SPICE circuit simulator.
Also important to electronics is the study and understanding of electromagnetic field theory.

٥.٤ Computer Aided Design

■ Today's electronics engineers have the ability to design circuits using premanufactured building blocks such as power supplies, semiconductors (such as transistors), and integrated circuits. Electronic design automation software programs include schematic capture programs and printed circuit board design programs. Popular names in the EDA software world are NI Multisim, Cadence (ORCAD), Eagle PCB and Schematic, Mentor (PADS PCB and LOGIC Schematic), Altium (Protel), LabCentre Electronics (Proteus) and many others.

٥.٤ Construction Methods

■ Many different methods of connecting components have been used over the years. For instance, early electronics often used point to point wiring with components attached to wooden breadboards to construct circuits. Cordwood construction and wire wraps were other methods used. Most modern day electronics now use printed circuit boards made of materials such as FR٤, or the cheaper (and less hard-wearing) Synthetic Resin Bonded Paper characterised by its light yellow-to-brown colour. Health and environmental concerns associated with electronics assembly have gained increased attention in recent years, especially for products destined to the European Union, with its Restriction of Hazardous Substances Directive (RoHS) and Waste Electrical and Electronic Equipment Directive (WEEE), which went into force in July ٢٠٠٦.

Vocabulary:

◙ A **triode** is an electronic amplification device having three active electrodes. The term most commonly applies to a vacuum tube (or valve in British English) with three elements: the filament or cathode, the grid, and the plate or anode. The triode vacuum tube is the first electronic amplification device.

◙ Generally, an **amplifier** or simply **amp**, is any device that changes, usually increases, the amplitude of a signal. The relationship of the input to the output of an amplifier—usually expressed as a function of the input frequency—is called the transfer function of the amplifier, and the magnitude of the transfer function is termed the gain.

◙ A **vacuum tube**, **electron tube** (in North America), **thermionic valve**, or **valve** (elsewhere, especially in Britain) is a device used to amplify, switch, otherwise modify, or create an electrical signal by controlling the movement of electrons in a low-pressure space.

◙ A **semiconductor** is a material that has an electrical resistivity between that of a conductor and an insulator. An external electrical field changes a semiconductor's resistivity.

◙ An **electronic circuit** is a closed path or paths formed by the interconnection of electronic components through which an electric current can flow.

◙ A **printed circuit board**, or **PCB**, is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive *substrate*.

◙ A **switch** is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts.

◙ A **ternary computer** (also **trinary computer**) is a computer that uses ternary logic (three possible values) instead of the more common binary logic (two possible values) in its calculations.

◙ A **programmable logic controller** (**PLC**) or **programmable controller** is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures.

◙ A **digital signal processor** (**DSP**) is a specialized microprocessor with optimized architecture for fast operational needs of Digital Signal Processing,

◙ **Shot noise** is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement.

◙ SPICE **(Simulation Program with Integrated Circuit Emphasis)** is a general-purpose analog electronic circuit simulator. It is a powerful program that is used in IC and board-level design to check the integrity of circuit designs and to predict circuit behavior.

◙ The **electromagnetic field** is a physical field produced by electrically charged objects. It affects the behavior of charged objects in the vicinity of the field. Light is the electromagnetic field in a certain frequency range.

◙ An **integrated circuit** (also known as **IC**, **microcircuit**, **microchip**, **silicon chip**, or **chip**) is a miniaturized electronic circuit (consisting mainly of semiconductor devices, as well as passive components) that has been manufactured in the surface of a thin substrate of semiconductor material.

◙ **Electronic Design Automation** (**EDA**) is the category of tools for designing and producing electronic systems ranging from printed circuit boards (PCBs) to integrated circuits. This is sometimes referred to as ECAD (electronic computer-aided design) or just CAD.

◙ **Schematic capture** or **schematic entry** is a step in the design cycle of electronic design automation (EDA) at which the electronic diagram, or electronic schematic of the designed electronic circuit is created by a designer. This is done interactively with the help of a schematic capture tool also known as schematic editor.

◙ A **printed circuit board**, or **PCB**, is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive *substrate*.

◙ **NI Multisim** or formerly **MultiSIM** is an electronic Schematic Capture and simulation program which is part of a suite of circuit design programs, along with NI Ultiboard. Multisim is one of the few circuit design programs to employ the original Berkeley SPICE based software simulation.

◙ **<u>OrCAD</u>** is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics and diagrams, and for their simulation.

◙ A **<u>printed circuit board</u>**, or **PCB**, is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive *substrate*.

◙ **<u>FR-٤</u>**, an abbreviation for Flame Retardant ٤, is a type of material used for making a printed circuit board (PCB). It describes the board substrate, with no copper layer. The FR-٤ used in PCBs is typically UV stabilized with a tetrafunctional epoxy resin system.

◙ The **Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment** ٢٠٠٢/٩٥/EC; commonly referred to as the **<u>Restriction of Hazardous Substances Directive</u>** or **RoHS**) was adopted in February ٢٠٠٣ by the European Union.

◙ The **<u>Waste Electrical and Electronic Equipment Directive</u>** (WEEE Directive) is the European Community directive ٢٠٠٢/٩٦/EC on waste electrical and electronic equipment (WEEE) which, together with the RoHS Directive ٢٠٠٢/٩٥/EC, became European Law in February ٢٠٠٣, setting collection, recycling and recovery targets for all types of electrical goods.

Questions:

♦ ١. What is the definition of electronics?

a) Is a branch of science and technology that deals with the controlled flow of electrons.

b) It is usually applied to information handling and generation of electrical power

c) Is a branch of science and technology that deals with the generation, distribution, control and application of electrical power.

d) It is usually applied to device control and control of electrical power

♦ ٢. Which option is correct about semiconductor components?

a) The study of semiconductor device and related technology is a branch of physics.

b) The study of semiconductor device and related technology is a branch of electronics.

c) The design and construction of electronic circuts to solve practical problems comes under physics.

d) The design and construction of electronic circuts to solve practical problems comes under electrical engineering.

♦ ٣. What is an integrated circuit board?

a) It is a PCB with an eceltronic circuit that intendef for a general function.

b) It is a PCB with an eceltronic circuit that intendef for a particular function.

c) It is a PCB that its component is packaged together or in less complex group.

d) It is a PCB that its component is packaged singly or in more complex group.

٦. Quality Assurance

٦.١ Definition

■ **Quality assurance**, or **QA** for short, refers to planned and systematic production processes that provide confidence in a product's suitability for its intended purpose. It is a set of activities intended to ensure that products (goods and/or services) satisfy customer requirements in a systematic, reliable fashion. QA cannot absolutely guarantee the production of *quality* products, unfortunately, but makes this more likely.

Two key principles characterise QA: "fit for purpose" (the product should be suitable for the intended purpose) and "right first time" (mistakes should be eliminated). QA includes regulation of the quality of raw materials, assemblies, products and components; services related to production; and management, production and inspection processes.

It is important to realize also that *quality* is determined by the intended users, clients or customers, not by society in general: it is not the same as 'expensive' or 'high quality'. Even goods with low prices can be considered quality items if they meet a market need.

٦. Quality Assurance …...………………………………………… ٦٦

٦.٢ History

Early efforts to control the quality of production:

■ When the first specialized craftsmen started manufacturing tools and materials for others to purchase and use, the principle of quality was simple: "let the buyer beware".

Early civil engineering projects needed to be built from specifications, for example the four sides of the base of the Great Pyramid of Giza were required to be perpendicular to within ٣.٥ arcseconds.

During the Middle Ages, guilds adopted responsibility for quality control of their members, setting and maintaining certain standards for guild membership.

Royal governments purchasing material were interested in quality control as customers. For this reason, King John of England appointed William Wrotham to report about the construction and repair of ships.

Prior to the extensive division of labor and mechanization resulting from the Industrial Revolution, it was possible for workers to control the quality of their own products. Working conditions then were arguably more conducive to professional pride.

The Industrial Revolution led to a system in which large groups of people performing a similar type of work were grouped together under the supervision of a foreman who was appointed to control the quality of work manufactured.

Wartime Production

■ Around the time of World War I, manufacturing processes typically became more complex with larger numbers of workers being supervised. This period saw the widespread introduction of mass production and piecework, which created problems as workmen could now earn more money by the production of extra products, which in turn led to bad workmanship being passed on to the assembly lines.

To counter bad workmanship, full time inspectors were introduced into the factory to identify, quarantine and ideally correct product quality failures. Quality control by inspection in the ١٩٢٠s and ١٩٣٠s led to the growth of quality inspection functions, separately organised from production and big enough to be headed by superintendents.

The systematic approach to quality started in industrial manufacture during the ١٩٣٠s, mostly in the USA, when some attention was given to the cost of scrap and rework. With the impact of mass production, which was required during the Second World War, it became necessary to introduce a more appropriate form of quality control which can be identified as Statistical Quality Control, or SQC. Some of the initial work for SQC is credited to Walter A. Shewhart of Bell Labs, starting with his famous one-page memorandum of ١٩٢٤.

SQC came about with the realization that quality cannot be fully inspected into an important batch of items. By extending the inspection phase and making inspection organizations more efficient, it provides inspectors with control tools such as sampling and control charts, even where ١٠٠ per cent inspection is not practicable. Standard statistical techniques allow the producer to sample and test a certain proportion of the products for quality to achieve the desired level of confidence in the quality of the entire batch or production run.

Postwar

■ In the period following World War II, many countries' manufacturing capabilities that had been destroyed during the war were rebuilt. The U.S. sent General Douglas MacArthur to oversee the re-building of Japan. During this time, General MacArthur involved two key individuals in the development of modern quality concepts: W. Edwards Deming and Joseph Juran. Both individuals promoted the collaborative concepts of quality to Japanese business and technical groups, and these groups utilized these concepts in the redevelopment of the Japanese economy.

Although there were many individuals trying to lead United States industries towards a more comprehensive approach to quality, the U.S. continued to apply the QC concepts of inspection and sampling to remove defective product from production lines, essentially ignoring advances in QA for decades.

٦.٣ Quality Assurance Versus Quality Control

■ Quality control emphasizes testing of products to uncover defects, and reporting to management who make the decision to allow or deny the release. Whereas quality assurance attempts to improve and stabilize production, and associated processes, to avoid, or at least minimize, issues that led to the defects in the first place. To prevent mistakes from arising, several QA methodologies are used. However, QA does not necessarily eliminate the need for QC: some product parameters are so critical that testing is still necessary. QC activities are treated as an integral part of the overall QA processes.

٦.٤ Failure Testing

■ A valuable process to perform on a whole consumer product is failure testing or stress testing. In mechanical terms this is the operation of a product until it fails, often under stresses such as increasing vibration, temperature, and humidity. This exposes many unanticipated weaknesses in a product, and the data are used to drive engineering and manufacturing process improvements. Often quite simple changes can dramatically improve product service, such as changing to mold-resistant paint or adding lock-washer placement to the training for new assembly personnel.

٦.٥ Statistical Control

■ Many organizations use statistical process control to bring the organization to Six Sigma levels of quality, in other words, so that the likelihood of an unexpected failure is confined to six standard deviations on the normal distribution. This probability is less than four one-millionths. Items controlled often include clerical tasks such as order-entry as well as conventional manufacturing tasks.

Traditional statistical process controls in manufacturing operations usually proceed by randomly sampling and testing a fraction of the output. Variances in critical tolerances are continuously tracked and where necessary corrected before bad parts are produced.

٦.٦ Total Quality Management

■ Deep analysis of QA practices and premises used about them is the most necessary inspection control of all in cases, where, despite statistical quality control techniques or quality improvements implemented, sales decrease.

The major problem which leads to a decrease in sales was that the specifications did not include the most important factor, "What the specifications have to state in order to satisfy the customer requirements?".

The major characteristics, ignored during the search to improve manufacture and overall business performance were:

- Reliability
- Maintainability
- Safety
- Strength

As the most important factor had been ignored, a few refinements had to be introduced:

١. Marketing had to carry out their work properly and define the customer's specifications.
٢. Specifications had to be defined to conform to these requirements.
٣. Conformance to specifications i.e. drawings, standards and other relevant documents, were introduced during manufacturing, planning and control.
٤. Management had to confirm all operators are equal to the work imposed on them and holidays, celebrations and disputes did not affect any of the quality levels.
٥. Inspections and tests were carried out, and all components and materials, bought in or otherwise, conformed to the specifications, and

the measuring equipment was accurate, this is the responsibility of the QA/QC department.

٦. Any complaints received from the customers were satisfactorily dealt with in a timely manner.

٧. Feedback from the user/customer is used to review designs.

٨. Consistent data recording and assessment and documentation integrity.

٩. Product and/or process change management and notification.

If the specification does not reflect the true quality requirements, the product's quality cannot be guaranteed. For instance, the parameters for a pressure vessel should cover not only the material and dimensions but operating, environmental, safety, reliability and maintainability requirements.

٦.٧ Models and Standards

■ ISO ١٧٠٢٥ is an international standard that specifies the general requirements for the competence to carry out tests and or calibrations. There are ١٥ management requirements and ١٠ technical requirements. These requirements outline what a laboratory must do to become accredited. Management system refers to the organization's structure for managing its processes or activities that transform inputs of resources into a product or service which meets the organization's objectives, such as satisfying the customer's quality requirements, complying with regulations, or meeting environmental objectives.

The CMMI (Capability Maturity Model Integration) model is widely used to implement Quality Assurance (PPQA) in an organization. The

CMMI maturity levels can be divided in to ٥ steps, which a company can achieve by performing specific activities within the organization.

٦.٨ Company Quality

■ During the ١٩٨٠s, the concept of "company quality" with the focus on management and people came to the fore. It was realized that, if all departments approached quality with an open mind, success was possible if the management led the quality improvement process.

The company-wide quality approach places an emphasis on four aspects:

١. Elements such as controls, job management, adequate processes, performance and integrity criteria and identification of records

٢. Competence such as knowledge, skills, experience, qualifications

٣. Soft elements, such as personnel integrity, confidence, organizational culture, motivation, team spirit and quality relationships.

٤. Infrastructure (as it enhances or limits functionality)

The quality of the outputs is at risk if any of these aspects is deficient in any way.

The approach to quality management given here is therefore not limited to the manufacturing theatre only but can be applied to any business or non-business activity:

- Design work

- Administrative services
- Consulting
- Banking
- Insurance
- Computer software development
- Retailing
- Transportation
- Education

It comprises a quality improvement process, which is generic in the sense it can be applied to any of these activities and it establishes a behaviour pattern, which supports the achievement of quality.

This in turn is supported by quality management practices which can include a number of business systems and which are usually specific to the activities of the business unit concerned.

In manufacturing and construction activities, these business practices can be equated to the models for quality assurance defined by the International Standards contained in the ISO ۹۰۰۰ series and the specified Specifications for quality systems.

Still, in the system of Company Quality, the work being carried out was shop floor inspection which did not reveal the major quality problems. This led to quality assurance or total quality control, which has come into being recently.

٦.۹ Using Contractors and/or Consultants

■ It has become customary to use consultants and contractors when introducing new quality practices and methods, particularly where the relevant skills and expertise are not available within the organization. In addition, when new initiatives and improvements are required to boost the current quality system, or perhaps improve upon current manufacturing systems, the use of temporary consultants becomes a viable solution when allocating valuable resources.

There are various types of consultants and contractors available in the market; most will have the skills needed to facilitate improvement activities such as Quality Management Systems (QMS) auditing and procedural documentation writing. More experienced consultants are likely to have knowledge of specialized quality improvement activities such as CMMI, Six Sigma, Measurement Systems Analysis (MSA), Quality Function Deployment (QFD), Failure Mode and Effects Analysis (FMEA), Advance Product Quality Planning (APQP).

Vocabulary:

◙ **Quality** in business, engineering and manufacturing has a pragmatic interpretation as the *non-inferiority* or *superiority* of something. Quality is a perceptual, conditional and somewhat subjective attribute and may be understood differently by different people.

◙ A **specification** is an explicit set of requirements to be satisfied by a material, product, or service. Should a material, product or service fail to meet one or more of the applicable specifications, it may be referred to as being *out of specificiation*; the abbreviation **OOS** may also be used.

◙ The **Great Pyramid of Giza** (also called the **Pyramid of Khufu** and **Pyramid of Cheops**) is the oldest and largest of the three pyramids in the Giza Necropolis bordering what is now Cairo, Egypt, and is the only one of the Seven Wonders of the Ancient World that survives substantially intact.

◙ A **minute of arc** or **arcminute** **(MOA)** is a unit of angular measurement, equal to one sixtieth (۱/۶۰) of one degree. Since one degree is defined as one three hundred sixtieth (۱/۳۶۰) of a circle, ۱ minute of arc is ۱/۲۱,۶۰۰ of the amount of arc in a closed circle. It is used in those fields which require a unit for the expression of small angles, such as astronomy or marksmanship.

◙ A **guild** is an association of craftsmen in a particular trade. The earliest guilds were formed as confraternities of workers. They were organized in a manner something between a trade union, a cartel and a secret society.

◙ **Division of labour** or **specialisation** is the specialisation of cooperative labour in specific, circumscribed tasks and roles, intended to increase the productivity of labour.

◙ **Mechanization** or mechanisation is providing human operators with machinery that assist them with the muscular requirements of work. It can also refer to the use of machines to replace manual labor or animals.

◙ **Mass production** (also called **flow production**, **repetitive flow production**, **series production**, or **serial production**) is the production of large amounts of standardized products, including and especially on assembly lines.

◙ **Piece work** or **piecework** describes types of employment in which a worker is paid a fixed "piece rate" for each unit produced or action performed. Piece work is also a form of performance-related pay (PRP) and is the oldest form of performance pay.

◙ An **assembly line** is a manufacturing process in which parts (usually interchangeable parts) are added to a product in a sequential manner using optimally planned logistics to create a finished product much faster than with handcrafting-type methods.

◙ **Inspector** is both a police rank and an administrative position, both used in a number of contexts. However, it is not an equivalent rank in each police force.

◙ A **superintendent** is the contractor’s representative who is responsible for continuous field supervision, coordination, and completion of the work. The construction superintendent "runs" the job site.

◙ **Scrap** is a term used to describe recyclable materials left over from every manner of product consumption, such as parts of vehicles, building supplies, and surplus materials. Often confused with waste, scrap in fact has monetary value.

◙ **Statistical process control (SPC)** is an effective method of monitoring a process through the use of control charts. Control charts enable the use of objective criteria for distinguishing background variation from events of significance based on statistical techniques.

◙ **Control charts**, also known as *Shewhart charts* or *process-behaviour* charts, in statistical process control are tools used to determine whether a manufacturing or business process is in a state of statistical control or not.

◙ **<u>William Edwards Deming</u>** (October ١٤, ١٩٠٠ – December ٢٠, ١٩٩٣) was an American statistician, professor, author, lecturer, and consultant. Deming is widely credited with improving production in the United States during World War II, although he is perhaps best known for his work in Japan.

◙ **<u>Joseph Moses Juran</u>** (December ٢٤, ١٩٠٤ – February ٢٨, ٢٠٠٨) was a ٢٠th century management consultant who is principally remembered as an evangelist for quality and quality management, writing several influential books on those subjects.

◙ **<u>Quality control</u>** and **quality engineering** are used in developing systems to ensure products or services are designed and produced to meet or exceed customer requirements. Quality control is the branch of engineering and manufacturing which deals with assurance and failure testing in design and production of products or services, to meet or exceed customer requirements.

◙ **<u>Consumer</u>** is a broad label that refers to any individuals or households that use goods and services generated within the economy.

◙ **<u>Stress testing</u>** is a form of testing that is used to determine the stability of a given system or entity. It involves testing beyond normal operational capacity, often to a breaking point, in order to observe the results.

◙ **<u>Vibration</u>** refers to mechanical oscillations about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random such as the movement of a tire on a gravel road.

◙ **Process improvement** is a series of actions taken by a Process Owner to identify, analyze and improve existing processes within an organization to meet new goals and objectives.

◙ **Standard deviation** is a measure of the variability or dispersion of a statistical population, a data set, or a probability distribution.

◙ The **normal distribution** or **Gaussian distribution** is a continuous probability distribution that describes data that cluster around a mean or average.

◙ A **requirement** is a singular documented need of what a particular product or service should be or do. It is most commonly used in a formal sense in systems engineering or software engineering. It is a statement that identifies a necessary attribute, capability, characteristic, or quality of a system in order for it to have value and utility to a user.

◙ The **accuracy** of a measurement system is the degree of closeness of measurements of a quantity to its actual (true) value. The **precision** of a measurement system, also called reproducibility or repeatability, is the degree to which repeated measurements under unchanged conditions show the same results.

◙ A **complaint** is an expression of displeasure, such as poor service at a store, or from a local government, etc. Those who complain a lot are called winers.

◙ **Safety** is the state of being "safe", the condition of being protected against physical, social, spiritual, financial, political, emotional, occupational, psychological, educational or other types or consequences of failure, damage, error, accidents, harm or any other event which could be considered non-desirable.

◙ **Reliability engineering** is an engineering field, that deals with the study of reliability: the ability of a system or component to perform its required functions under stated conditions for a specified period of time. It is often reported in terms of a probability.

◙ **ISO/IEC ۱۷۰۲۵** is the main standard used by testing and calibration laboratories. Originally known as ISO/IEC Guide ۲۵, ISO/IEC ۱۷۰۲۵ was initially issued by the International Organization for Standardization in ۱۹۹۹.

◙ **International standards** are standards developed by international standards organizations. International standards are available for consideration and use, worldwide.

◙ **Calibration** is the validation of specific measurement techniques and equipment. At the simplest level, calibration is a comparison between measurements-one of known magnitude or correctness made or set with one device and another measurement made in as similar a way as possible with a second device.

◙ **Capability Maturity Model Integration** (CMMI) in software engineering and organizational development is a trademarked process improvement approach that provides organizations with the essential elements for effective process improvement. It can be used to guide process improvement across a project, a division, or an entire organization.

◙ **Organizational culture** is an idea in the field of Organizational studies and management which describes the psychology, attitudes, experiences, beliefs and values (personal and cultural values) of an organization. It has been defined as "the specific collection of values and norms that are shared by people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization."

◙ A **business** (also called a **firm**, or **enterprise**) is a legally recognized organization designed to provide goods and/or services to consumers.

◙ **Strategic Business Unit** or **SBU** is understood as a business unit within the overall corporate identity which is distinguishable from other business because it serves a defined external market where management can conduct strategic planning in relation to products and markets. When companies become really large, they are best thought of as being composed of a number of businesses (or SBUs).

◙ **ISO ٩٠٠٠** is a *family* of standards for quality management systems. ISO ٩٠٠٠ is maintained by ISO, the International Organization for Standardization and is administered by accreditation and certification bodies. The rules are updated, as the requirements motivate changes over time. Some of the requirements in ISO ٩٠٠١:٢٠٠٨ (which is one of the standards in the ISO ٩٠٠٠ family) include

- a set of procedures that cover all key processes in the business;
- monitoring processes to ensure they are effective;
- keeping adequate records;

- checking output for defects, with appropriate and corrective action where necessary;
- regularly reviewing individual processes and the quality system itself for effectiveness; and
- facilitating continual improvement

◙ A **consultant** is a professional who provides advice in a particular area of expertise such as management, accountancy, the environment, entertainment, technology, law (tax law, in particular), human resources, marketing, medicine, finance, life management, economics, public affairs, communication, engineering, sound system design, graphic design, or waste management.

◙ **Six Sigma** is a business management strategy, initially implemented by Motorola. As of ۲۰۰۹ it enjoys widespread application in many sectors of industry, although its application is not without controversy.

◙ A **Measurement System Analysis**, abbreviated **MSA**, is a specially designed experiment that seeks to identify the components of variation in the measurement.

◙ A **failure modes and effects analysis** **(FMEA)** is a procedure in operations management for analysis of potential failure modes within a system for classification by severity or determination of the effect of failures on the system. It is widely used in manufacturing industries in various phases of the product life cycle and is now increasingly finding use in the service industry.

◙ **Advanced Product Quality Planning** (or **APQP**) is a framework of procedures and techniques used to develop products in industry, particularly the automotive industry. It is quite similar to the concept of Design For Six Sigma (DFSS).

Questions:

٧. Nanomaterials

٧.١ Fundamental Concepts

■ **Nanomaterials** is a field which takes a materials science-based approach to nanotechnology. It studies materials with morphological features on the nanoscale, and especially those which have special properties stemming from their nanoscale dimensions. Nanoscale is usually defined as smaller than a one tenth of a micrometer in at least one dimension, though this term is sometimes also used for materials smaller than one micrometer.

An aspect of nanotechnology is the vastly increased ratio of surface area to volume present in many nanoscale materials which makes possible new quantum mechanical effects, for example the "quantum size effect" where the electronic properties of solids are altered with great reductions in particle size. This effect does not come into play by going from macro to micro dimensions. However, it becomes pronounced when the nanometer size range is reached. A certain number of physical properties also alter with the change from macroscopic systems. Novel mechanical properties of nanomaterials is a subject of nanomechanics research. Catalytic activities also reveal new behaviour in the interaction with biomaterials.

Nanotechnology can be thought of as extensions of traditional disciplines towards the explicit consideration of these properties. Additionally, traditional disciplines can be re-interpreted as specific applications of nanotechnology. This dynamic reciprocation of ideas

and concepts contributes to the modern understanding of the field. Broadly speaking, nanotechnology is the synthesis and application of ideas from science and engineering towards the understanding and production of novel materials and devices. These products generally make copious use of physical properties associated with small scales.
As mentioned above, materials reduced to the nanoscale can suddenly show very different properties compared to what they exhibit on a macroscale, enabling unique applications. For instance, opaque substances become transparent (copper); inert materials attain catalytic properties (platinum); stable materials turn combustible (aluminum); solids turn into liquids at room temperature (gold); insulators become conductors (silicon). Materials such as gold, which is chemically inert at normal scales, can serve as a potent chemical catalyst at nanoscales. Much of the fascination with nanotechnology stems from these unique quantum and surface phenomena that matter exhibits at the nanoscale.
Nanosize powder particles (a few nanometres in diameter, also called nanoparticles) are potentially important in ceramics, powder metallurgy, the achievement of uniform nanoporosity and similar applications. The strong tendency of small particles to form clumps ("agglomerates") is a serious technological problem that impedes such applications. However, a number of dispersants such as ammonium citrate (aqueous) and imidazoline or oleyl alcohol (nonaqueous) are promising solutions as possible additives for deagglomeration.

٧.٢ Tools and Techniques

■ The first observations and size measurements of nano-particles were made during the first decade of the ٢٠th century. They are mostly associated with the name of Zsigmondy who made detailed studies of gold sols and other nanomaterials with sizes down to ١٠ nm and less. He published a book in ١٩١٤. He used ultramicroscope that employs a *dark field* method for seeing particles with sizes much less than light wavelength.

There are traditional techniques developed during ۲۰th century in Interface and Colloid Science for characterizing nanomaterials. These are widely used for *first generation* passive nanomaterials specified in the next section.

These methods include several different techniques for characterizing particle size distribution. This characterization is imperative because many materials that are expected to be nano-sized are actually aggregated in solutions. Some of methods are based on light scattering. Other applies ultrasound, such as ultrasound attenuation spectroscopy for testing concentrated nano-dispersions and microemulsions.

There is also a group of traditional techniques for characterizing surface charge or zeta potential of nano-particles in solutions. This information is required for proper system stabilzation, preventing its aggregation or flocculation. These methods include microelectrophoresis, electrophoretic light scattering and electroacoustics. The last one, for instance colloid vibration current method is suitable for characterizing concentrated systems.

۷.۳ Materials Used in Nanotechnology

■ Materials referred to as "nanomaterials" generally fall into two categories: fullerenes, and inorganic nanoparticles.

Fullerenes: Buckminsterfullerene C٦۰, also known as the buckyball, is the smallest member of the fullerene family. The fullerenes are a class of allotropes of carbon which conceptually are graphene sheets rolled into tubes or spheres. These include the carbon nanotubes which are of interest both because of their mechanical strength and also because of their electrical properties.

٧. Nanomaterials ……...………………………………………. ٨٦

For the past decade, the chemical and physical properties of fullerenes have been a hot topic in the field of research and development, and are likely to continue to be for a long time. In April ٢٠٠٣, fullerenes were under study for potential medicinal use: binding specific antibiotics to the structure of resistant bacteria and even target certain types of cancer cells such as melanoma. The October ٢٠٠٥ issue of Chemistry and Biology contains an article describing the use of fullerenes as light-activated antimicrobial agents. In the field of nanotechnology, heat resistance and superconductivity are among the properties attracting intense research.

A common method used to produce fullerenes is to send a large current between two nearby graphite electrodes in an inert atmosphere. The resulting carbon plasma arc between the electrodes cools into sooty residue from which many fullerenes can be isolated.

There are many calculations that have been done using ab-initio Quantum Methods applied to fullerenes. Results of such calculations can be compared with experimental results.

Nanoparticles: Nanoparticles or nanocrystals made of metals, semiconductors, or oxides are of particular interest for their mechanical, electrical, magnetic, optical, chemical and other properties. Nanoparticles have been used as quantum dots and as chemical catalysts.

■ Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecular structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case. Size-dependent properties are observed such as quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials.

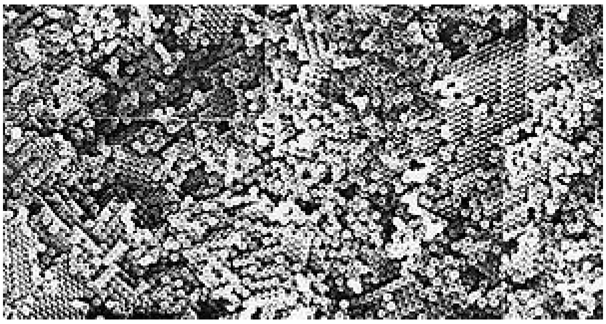
Nanoparticles exhibit a number of special properties relative to bulk material. For example, the bending of bulk copper (wire, ribbon, etc.) occurs with movement of copper atoms/clusters at about the ۵۰ nm scale. Copper nanoparticles smaller than ۵۰ nm are considered super hard materials that do not exhibit the same malleability and ductility as bulk copper. The change in properties is not always desirable. Ferroelectric materials smaller than ۱۰ nm can switch their magnetisation direction using room temperature thermal energy, thus making them useless for memory storage. Suspensions of nanoparticles are possible because the interaction of the particle surface with the solvent is strong enough to overcome differences in density, which usually result in a material either sinking or floating in a liquid. Nanoparticles often have unexpected visual properties because they are small enough to confine their electrons and produce quantum effects. For example gold nanoparticles appear deep red to black in solution.

The often very high surface area to volume ratio of nanoparticles provides a tremendous driving force for diffusion, especially at elevated temperatures. Sintering is possible at lower temperatures and over shorter durations than for larger particles. This theoretically does not affect the density of the final product, though flow difficulties and the tendency of nanoparticles to agglomerate do complicate matters. The surface effects of nanoparticles also reduces the incipient melting temperature.

۷.۴ Chemical Processing of Ceramics

Microstructural Uniformity:

■ In the processing of fine ceramics, the irregular particle sizes and shapes in a typical powder often lead to non-uniform packing morphologies that result in packing density variations in the powder compact. Uncontrolled agglomeration of powders due to attractive van der Waals forces can also give rise to in microstructural inhomogeneities.



Electron micrograph of a colloidal crystal composed of amorphous hydrated colloidal silica (particle diameter ٦٠٠ nm)

Differential stresses that develop as a result of non-uniform drying shrinkage are directly related to the rate at which the solvent can be removed, and thus highly dependent upon the distribution of porosity. Such stresses have been associated with a plastic-to-brittle transition in consolidated bodies, and can yield to crack propagation in the unfired body if not relieved.
In addition, any fluctuations in packing density in the compact as it is prepared for the kiln are often amplified during the sintering process, yielding inhomogeneous densification. Some pores and other structural defects associated with density variations have been shown to play a detrimental role in the sintering process by growing and thus limiting end-point densities. Differential stresses arising from inhomogeneous densification have also been shown to result in the propagation of internal cracks, thus becoming the strength-controlling flaws.

It would therefore appear desirable to process a material in such a way that it is physically uniform with regard to the distribution of components and porosity, rather than using particle size distributions which will maximize the green density. The containment of a uniformly dispersed assembly of strongly interacting particles in suspension requires total control over particle-particle interactions. Monodisperse colloids provide this potential.

Monodisperse powders of colloidal silica, for example, may therefore be stabilized sufficiently to ensure a high degree of order in the colloidal crystal or polycrystalline colloidal solid which results from aggregation. The degree of order appears to be limited by the time and space allowed for longer-range correlations to be established. Such defective polycrystalline colloidal structures would appear to be the basic elements of submicrometre colloidal materials science, and, therefore, provide the first step in developing a more rigorous understanding of the mechanisms involved in microstructural evolution in inorganic systems such as polycrystalline ceramics.

۷.۵ Safety of Manufactured Nanomaterials

■ Nanomaterials behave differently than other similarly-sized particles. It is therefore necessary to develop specialized approaches to testing and monitoring their effects on human health and on the environment. The OECD Chemicals Committee has established the Working Party on Manufactured Nanomaterials to address this issue and to study the practices of OECD member countries in regards to nanomaterial safety.

While nanomaterials and nanotechnologies are expected to yield numerous health and health care advances, such as more targeted methods of delivering drugs, new cancer therapies, and methods of early detection of diseases, they also may have unwanted effects.

Increased rate of absorption is the main concern associated with manufactured nanoparticles.

When materials are made into nanoparticles, their surface area to volume ratio increases. The greater specific surface area (surface area per unit weight) may lead to increased rate of absorption through the skin, lungs, or digestive tract and may cause unwanted effects to the lungs as well as other organs. However, the particles must be absorbed in sufficient quantities in order to pose health risks.

As the use of nanomaterials increases worldwide, concerns for worker and user safety are mounting. To address such concerns, the Swedish Karolinska Institute conducted a study in which various nanoparticles were introduced to human lung epithelial cells. The results, released in ٢٠٠٨, showed that iron oxide nanoparticles caused little DNA damage and were non-toxic. Zinc oxide nanoparticles were slightly worse. Titanium dioxide caused only DNA damage. Carbon nanotubes caused DNA damage at low levels. Copper oxide was found to be the worst offender, and was the only nanomaterial identified by the researchers as a clear health risk.

■ In October ٢٠٠٨, the Department of Toxic Substances Control (DTSC), within the California Environmental Protection Agency, announced its intent to request information regarding analytical test methods, fate and transport in the environment, and other relevant information from manufacturers of carbon nanotubes. The term "manufacturers” includes persons and businesses that produce nanotubes in California, or import carbon nanotubes into California for sale. The purpose of this information request will be to identify information gaps and to develop information about carbon nanotubes, an important emerging nanomaterial.

On January ٢٢, ٢٠٠٩, a formal information request letter was sent to manufacturers who produce or import carbon nanotubes in California, or who may export carbon nanotubes into the State. This letter constitutes the first formal implementation of the authorities placed into statute by AB ۲۸۹ (۲۰۰٦) and is directed to manufacturers of carbon nanotubes, both industry and academia within the State, and to manufacturers outside California who export carbon nanotubes to California. This request for information must be met by the manufacturers within one year.

Vocabulary:

◙ **Materials science** or **materials engineering** is an interdisciplinary field involving the properties of matter and its applications to various areas of science and engineering. This science investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties.

◙ **Nanotechnology**, shortened to "**nanotech**", is the study of the control of matter on an atomic and molecular scale. Generally nanotechnology deals with structures of the size ۱۰۰ nanometers or smaller, and involves developing materials or devices within that size. Nanotechnology is very diverse, ranging from extensions of conventional device physics, to completely new approaches based upon molecular self-assembly, to developing new materials with dimensions on the nanoscale, even to speculation on whether we can directly control matter on the atomic scale.

◙ **Quantum mechanics (QM)** is a set of principles describing physical reality at the atomic level of matter (molecules and atoms) and the subatomic (electrons, protons, and even smaller particles). These descriptions include the simultaneous wave-like and particle-like behavior of both matter and radiation.

◙ A **physical property** is any aspect of an object or substance that can be measured or perceived without changing its identity.

◙ **Nanomechanics** is a branch of nanoscience studying fundamental *mechanic*al (elastic, thermal and kinetic) properties of physical systems at the nanometer scale. Nanomechanics has emerged on the cross-road of classical mechanics, solid-state physics, statistical mechanics, materials science, and quantum chemistry. As an area of nanoscience, nanomechanics provides a scientific foundation of nanotechnology.

◙ The development of **biomaterials** is not a new area of science, having existed for around half a century. The study of biomaterials is called biomaterial science.

◙ **Catalysis** is the process in which the rate of a chemical reaction is either increased or decreased by means of a chemical substance known as a **catalyst**. Unlike other reagents that participate in the chemical reaction, a catalyst is not consumed by the reaction itself. The catalyst may participate in multiple chemical transformations.

◙ A **ceramic** is an inorganic, non-metallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have a crystalline or partly crystalline structure, or may be amorphous (e.g., a glass). Because most common ceramics are crystalline, the definition of ceramic is often restricted to inorganic crystalline materials, as opposed to the non-crystalline glasses.

◙ **Powder metallurgy** is a forming and fabrication technique consisting of three major processing stages. First, the primary material is physically powdered, divided into many small individual particles. Next, the powder is injected into a mold or passed through a die to produce a weakly cohesive structure (via cold welding) very near the dimensions of the object ultimately to be manufactured.

◙ The **ultramicroscope** is a system of illumination for extremely small objects such as colloidal particles, fog droplets, or smoke particles. The objects are held in liquid or gaseous suspension in an enclosure with a very absorbing dark background and illuminated with a convergent pencil of very bright light entering from one side and coming to focus in the field of view — the "Tyndall cone" familiar in experiements on scattering.

◙ **Interface and colloid science** is a branch of chemistry dealing with colloids, heterogeneous systems consisting of a mechanical mixture of particles between ۱ nm and ۱۰۰۰ nm dispersed in a continuous medium.

◙ The **particle size distribution (PSD)** of a powder, or granular material, or particles dispersed in fluid, is a list of values or a mathematical function that defines the relative amounts of particles present, sorted according to size. PSD is also known as **grain size distribution**.

◙ **Ultrasound attenuation spectroscopy** is a method for characterizing properties of fluids and dispersed particles. It is also known as acoustic spectroscopy.

◙ **<u>Microelectrophoresis</u>** is a method of studying electrophoresis of various dispersed particles using optical microscopy. This method provides image of moving particles, which is its unique advantage.

◙ **<u>Electrophoretic light scattering</u>** is based on dynamic light scattering. The frequency shift or phase shift of an incident laser beam depends on the dispersed particles mobility. In the case of *dynamic light scattering*, Brownian motion causes particle motion. In the case of *electrophoretic light scattering*, oscillating electric field performs the same function.

◙ **<u>Colloid vibration current</u>** is an electroacoustic phenomenon that arises when ultrasound propagates through a fluid that contains ions and either solid particles or emulsion droplets.

◙ **<u>Allotropy</u>** or **allotropism** is a behavior exhibited by certain chemical elements: these elements can exist in two or more different forms, known as *allotropes* of that element.

◙ **<u>Graphene</u>** is a one-atom-thick planar sheet of sp٢-bonded carbon atoms that are densely packed in a honeycomb crystal lattice. It can be viewed as an atomic-scale chicken wire made of carbon atoms and their bonds. The name comes from Graphite + -ene; graphite itself consists of many graphene sheets stacked together.

◙ **<u>Carbon nanotubes (CNTs)</u>** are allotropes of carbon with a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to ٢٨,٠٠٠,٠٠٠:١, which is significantly larger than any other material.

◙ An **antibiotic** is a substance or compound that kills or inhibits the growth of bacteria.

◙ **Melanoma** is a malignant tumor of melanocytes which are found predominantly in skin but also in the bowel and the eye (see uveal melanoma). It is one of the less common types of skin cancer but causes the majority (۷۵%) of skin cancer related deaths.

◙ **Superconductivity** is a phenomenon occurring in certain materials generally at very low temperatures, characterized by exactly zero electrical resistance and the exclusion of the interior magnetic field (the Meissner effect).

◙ **Plasma** is a partially ionized gas, in which a certain proportion of electrons are free rather than being bound to an atom or molecule.

◙ A **quantum dot** is a semiconductor whose excitons are confined in all three spatial dimensions. As a result, they have properties that are between those of bulk semiconductors and those of discrete molecules.

◙ The **quantum confinement** effect can be observed once the diameter of the particle is of the magnitude as the wavelength of electron wave function.

◙ The excitation of surface plasmons by light is denoted as a **surface plasmon resonance** (SPR) for planar surfaces or **localized surface plasmon resonance** (LSPR) for nanometer-sized metallic structures.

◙ **Superparamagnetism** is a form of magnetism, which appear in small ferromagnetic or ferrimagnetic nanoparticles. In small enough nanoparticles, magnetization can randomly flip direction under the influence of temperature.

◙ **Sintering** is a method for making objects from powder, by heating the material in a sintering furnace below its melting point (solid state sintering) until its particles adhere to each other. Sintering is traditionally used for manufacturing ceramic objects, and has also found uses in such fields as powder metallurgy.

◙ The **van der Waals force** (or **van der Waals interaction**), named after Dutch scientist Johannes Diderik van der Waals, is the attractive or repulsive force between molecules (or between parts of the same molecule) other than those due to covalent bonds or to the electrostatic interaction of ions with one another or with neutral molecules.

◙ A **colloidal crystal** is an ordered array of particles, analogous to a standard crystal whose repeating subunits are atoms or molecules.

◙ **Polycrystalline** materials are solids that are composed of many crystallites of varying size and orientation. The variation in direction can be random (called random texture) or directed, possibly due to growth and processing conditions. Fiber texture is an example of the latter.

◙ An **epithelium** is a tissue composed of cells that line the cavities and surfaces of structures throughout the body. Many glands are also formed from epithelial tissue.

◙ **Deoxyribonucleic acid (DNA)** is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses.

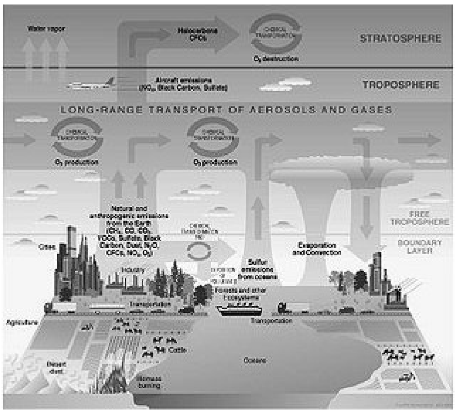
Questions:

۸. Scientific Modelling

۸.۱ Overview

■ **Scientific modelling** is the process of generating abstract, conceptual, graphical and/or mathematical models. Science offers a growing collection of methods, techniques and theory about all kinds of specialized scientific modelling. Also a way to read elements easily which have been broken down to the simplest form.

Modelling is an essential and inseparable part of all scientific activity, and many scientific disciplines have their own ideas about specific types of modelling. There is little general theory about scientific modelling, offered by the philosophy of science, systems theory, and new fields like knowledge visualization.



An example of scientific modelling. A schematic of chemical and transport processes related to atmospheric composition.

Modelling is a comparatively new area of activity involving the marriage of ideas from various disciplines, and is an essential and inseparable part of all scientific activity. The professional modeller, according to Silvert, brings special skills and techniques to bear in order to produce results that are insightful, reliable, and useful. Modelling techniques include statistical methods, computer simulation, system identification, and sensitivity analysis. None of these, however, is as important as the ability to understand the underlying dynamics of a complex system. These insights are needed to assess whether the assumptions of a model are correct and complete. The modeller must be able to recognize whether a model reflects reality, and to identify and deal with divergences between theory and data.

One of the main aims of scientific modelling is to apply quantitative reasoning to observations about the world, in the hope of seeing aspects that may have escaped the notice of others. There are many specific techniques that modellers use, which enables one to discover aspects of reality that may not be obvious to everyone. One of the essentials is the understanding of the role that assumptions play in the development of the model. The usual approach to model development is to characterize the system, make some assumptions about how it works and translate these into equations and a simulation program. After simulation one of the final steps is the validation; i.e. determining whether the results produced by the model can be trusted.

۸.۲ Scientific Modelling Basics

■ **Model**: A model in science is a physical, mathematical, or logical representation of a system of entities, phenomena, or processes. A model is a simplified abstract view of the complex reality. It may focus on particular views, enforcing the "divide and conquer" principle for a compound problem. Formally a model is an

interpretation which deals with empirical entities, phenomena, and physical processes in a mathematical or logical way.
For the scientist, a model is also a way in which the human thought processes can be amplified. Models that are rendered in software allow scientists to leverage computational power to simulate, visualize, manipulate and gain intuition about the entity, phenomenon or process being represented.

Modeling as a substitute for direct measurement and experimentation: Models are typically used when it is either impossible or impractical to create experimental conditions in which scientists can directly measure outcomes. Direct measurement of outcomes under controlled conditions will always be more accurate than modeled estimates of outcomes. When predicting outcomes, models use assumptions, while measurements do not. As the number of assumptions in a model increases, the accuracy and relevance of the model diminishes.

Modelling language: A modelling language is any artificial language that can be used to express information or knowledge or systems in a structure that is defined by a consistent set of rules. The rules are used for interpretation of the meaning of components in the structure. Examples of modelling languages are the Unified Modeling Language (UML) for software systems, IDEF for processes and the VRML for ۳-D computer graphics models designed particularly with the World Wide Web in mind.

Simulation: A simulation is the implementation of a model over time. A simulation brings a model to life and shows how a particular object or phenomenon will behave. It is useful for testing, analysis or training where real-world systems or concepts can be represented by a model.

Structure: Structure is a fundamental and sometimes intangible notion covering the recognition, observation, nature, and stability of patterns and relationships of entities. From a child's verbal description of a snowflake, to the detailed scientific analysis of the properties of magnetic fields, the concept of structure is an essential foundation of nearly every mode of inquiry and discovery in science, philosophy, and art.

Systems: A system is a set of interacting or interdependent entities, real or abstract, forming an integrated whole. The concept of an 'integrated whole' can also be stated in terms of a system embodying a set of relationships which are differentiated from relationships of the set to other elements, and from relationships between an element of the set and elements not a part of the relational regime.

■ **The process of generating a model:** Modelling refers to the process of generating a model as a conceptual representation of some phenomenon. Typically a model will refer only to some aspects of the phenomenon in question, and two models of the same phenomenon may be essentially different, that is in which the difference is more than just a simple renaming. This may be due to differing requirements of the model's end users or to conceptual or aesthetic differences by the modellers and decisions made during the modelling process. Aesthetic considerations that may influence the structure of a model might be the modeller's preference for a reduced ontology, preferences regarding probabilistic models vis-a-vis deterministic ones, discrete vs continuous time etc. For this reason users of a model need to understand the model's original purpose and the assumptions of its validity.

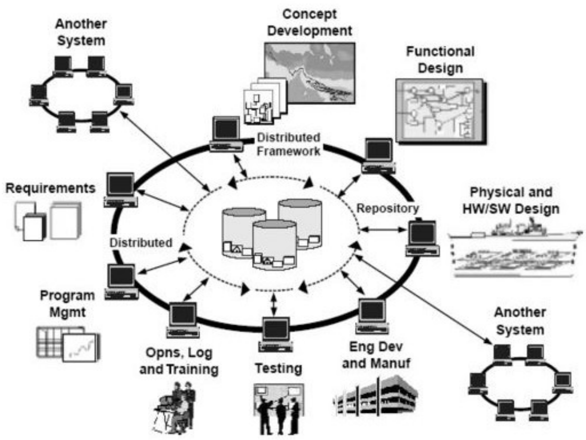
The process of evaluating a model: A model is evaluated first and foremost by its consistency to empirical data; any model inconsistent with reproducible observations must be modified or rejected. However, a fit to empirical data alone is not sufficient for a model to be accepted as valid. Other factors important in evaluating a model include:

- Ability to explain past observations
- Ability to predict future observations
- Cost of use, especially in combination with other models
- Refutability, enabling estimation of the degree of confidence in the model
- Simplicity, or even aesthetic appeal

People may attempt to quantify the evaluation of a model using a utility function.

Visualization: Visualization is any technique for creating images, diagrams, or animations to communicate a message. Visualization through visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of man. Examples from history include cave paintings, Egyptian hieroglyphs, Greek geometry, and Leonardo da Vinci's revolutionary methods of technical drawing for engineering and scientific purposes.

Modelling and Simulation: One application of scientific modelling is the field of "Modeling and Simulation", generally referred to as "M&S". M&S has a spectrum of applications which range from concept development and analysis, through experimentation, measurement and verification, to disposal analysis. Projects and programs may use hundreds of different simulations, simulators and model analysis tools.



Example of the integrated use of Modelling and Simulation in Defence life cycle management. The modelling and simulation in this image is represented in the center of the image with the three containers.

The figure shows how Modelling and Simulation is used as a central part of an integrated program in a Defence capability development process.

Vocabulary:

◙ **Scientific method** refers to a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. To be termed scientific, a method of inquiry must be based on gathering observable, empirical and measurable evidence subject to specific principles of reasoning.

◙ The term **theory** is reserved for ideas which meet baseline requirements about the kinds of empirical observations made, the methods of classification used, and the consistency of the theory in its application among members of the class to which it pertains.

◙ The **philosophy of science** is concerned with the assumptions, foundations, and implications of science. The field is defined by an interest in one of a set of "traditional" problems or an interest in central or foundational concerns in science.

◙ **Systems theory** is interdisciplinary theory about the nature of complex systems in nature, society, and science. More specifically, it is a framework by which one can investigate and/or describe any group of objects that work in concert to produce some result.

◙ **Knowledge visualization:** The use of visual representations to transfer knowledge between at least two persons aims to improve the transfer of knowledge by using computer and non-computer based visualization methods complementarily.

◙ **System identification** is a general term to describe mathematical tools and algorithms that build dynamical models from measured data.

◙ **Sensitivity analysis** **(SA)** is the study of how the variation (uncertainty) in the output of a mathematical model can be apportioned, qualitatively or quantitatively, to different sources of variation in the input of a model.

◙ An **assumption** is a proposition that is taken for granted, as if it were true based upon presupposition without preponderance of the facts.

◙ **Validation** & **Verification:** In engineering or as part of a quality management system, **validation** confirms that the needs of an *external* customer or user of a product, service, or system are met. **Verification** is usually an *internal* quality process of determining compliance with a regulation, standard, or specification. An easy way of recalling the difference between validation and verification is that validation is ensuring "you built the right product" and verification is ensuring "you built the product as intended." Validation is confirming that it satisfies stakeholder's or user's needs.

◙ **Divide and conquer** (**D&C**) is an important algorithm design paradigm based on multi-branched recursion. A divide and conquer algorithm works by recursively breaking down a problem into two or more sub-problems of the same (or related) type, until these become simple enough to be solved directly.

◙ **Unified Modeling Language** (**UML**) is a standardized general-purpose modeling language in the field of software engineering. The standard is managed, and was created by, the Object Management Group. UML includes a set of graphical notation techniques to create visual models of software-intensive systems.

◙ **IDEF** is a family of modeling languages in the field of systems and software engineering. They cover a wide range of uses, from functional modeling to data, simulation, object-oriented analysis/design and knowledge acquisition.

◙ **VRML** (**Virtual Reality Modeling Language**) known as the Virtual Reality Markup Language) is a standard file format for representing ۳ dimensional (۳D) interactive vector graphics, designed particularly with the World Wide Web in mind.

◙ The **World Wide Web** is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can view Web pages that may contain text, images, videos, and other multimedia and navigate between them using hyperlinks.

◙ **Ontology** is the philosophical study of the nature of being, existence or reality in general, as well as of the basic categories of being and their relations.

◙ **Utility** is a measure of the relative satisfaction from, or desirability of, consumption of various goods and services.

◙ **Egyptian hieroglyphs** was a formal writing system used by the ancient Egyptians that contained a combination of logographic and alphabetic elements.

Questions:

۹. Operations Research

۹.۱ Overview

■ **Operations research** (OR), as termed in the USA, Canada, South Africa and Australia, and **operational research**, as termed in Europe, is an interdisciplinary branch of applied mathematics that uses methods such as mathematical modeling, statistics, and algorithms to arrive at optimal or near optimal solutions to complex problems. It is typically concerned with determining the maxima (of profit, assembly line performance, crop yield, bandwidth, etc) or minima (of loss, risk, etc.) of some objective function. Operations research helps management achieve its goals using scientific methods.

The terms operations research and management science are often used synonymously. When a distinction is drawn, management science generally implies a closer relationship to the problems of business management. The field of operations research is closely related to Industrial engineering. Industrial engineers typically consider Operations Research (OR) techniques to be a major part of their toolset.

Some of the primary tools used by operations researchers are statistics, optimization, probability theory, queuing theory, game theory, graph theory, decision analysis, and simulation. Because of the computational nature of these fields, OR also has ties to computer

science, and operations researchers use custom-written and off-the-shelf software.
Operations research is distinguished by its frequent use to examine an entire management information system, rather than concentrating only on specific elements (though this is often done as well). An operations researcher faced with a new problem is expected to determine which techniques are most appropriate given the nature of the system, the goals for improvement, and constraints on time and computing power. For this and other reasons, the human element of OR is vital. Like any other tools, OR techniques cannot solve problems by themselves.

۹.۲ History

■ Some say that Charles Babbage (۱۷۹۱-۱۸۷۱) is the "father of operations research" because his research into the cost of transportation and sorting of mail led to England's universal "Penny Post" in ۱۸٤۰, and studies into the dynamical behaviour of railway vehicles in defence of the GWR's broad gauge. The modern field of operations research arose during World War II.
Modern operations research originated at the Bawdsey Research Station in the UK in ۱۹۳۷ and was the result of an initiative of the station's superintendent, A. P. Rowe. Rowe conceived the idea as a means to analyse and improve the working of the UK's early warning radar system, Chain Home (CH). Initially, he analyzed the operating of the radar equipment and its communication networks, expanding later to include the operating personnel's behaviour. This revealed unappreciated limitations of the CH network and allowed remedial action to be taken. After the war it began to be applied to similar problems in industry.

٩.٣ Second World War

■ During the Second World War close to ١,٠٠٠ men and women in Britain were engaged in operational research. About ٢٠٠ operational research worked for the British Army.
Patrick Blackett worked for several different organizations during the war. Early in the war while working for the Royal Aircraft Establishment (RAE) he set up a team known as the "Circus" which helped to reduce the number of anti-aircraft artillery rounds needed to shoot down an enemy aircraft from an average of over over ٢٠,٠٠٠ at the start of the Battle of Britain to ٤,٠٠٠ in ١٩٤١
In ١٩٤١ Blackett moved from the RAE to the Navy, first to the Royal Navy's Coastal Command, in ١٩٤١ and then early in ١٩٤٢ to the Admiralty. Blackett's team at Coastal Command's Operational Research Section (CC-ORS), included, two future Nobel prize winners, and many other people who went on to be preeminent in their fields, undertook a number of crucial analyses that aided the war effort. Britain introduced the convoy system to reduce shipping losses, but while the principle of using warships to accompany merchant ships was generally accepted, it was unclear whether it was better for convoys to be small or large. Convoys travel at the speed of the slowest member, so small convoys can travel faster. It was also argued that small convoys would be harder for German U-boats to detect. On the other hand, large convoys could deploy more warships against an attacker. Blackett's staff showed that the losses suffered by convoys depended largely on the number of escort vessels present, rather than on the overall size of the convoy. Their conclusion, therefore, was that a few large convoys are more defensible than many small ones.
While performing an analysis of the methods used by RAF Coastal Command to hunt and destroy submarines, one of the analysts asked

what colour the aircraft were. As most of them were from Bomber Command they were painted black for nighttime operations. At the suggestion of CC-ORS that a test was run to see if that was the best colour to camouflage the aircraft for daytime operations in the grey North Atlantic skies. Tests showed that aircraft painted white were on average not spotted until they were ۲۰% closer than those painted black. This change indicated that ۳۰% more submarines would be attacked and sunk for the same number of sightings.
Other work by the CC-ORS indicated that on average if the depth at which aerial delivered depth charges (DC's) was changed from ۱۰۰ feet to ۲۵ feet, the kill ratios would go up. This was because if a U-boat saw an aircraft only shortly before it arrived over the target then at ۱۰۰ feet the charges would do no damage, and if it saw the aircraft a long way from the target it had time to alter course under water so the chances of it being within the ۲۰ feet kill zone of the charges was small. It was more efficient to attack those submarines close to the surface who's location was known than those at a greater depth who's position could only be guessed. Before the change from ۱۰۰ feet to ۲۵ feet ۱% of submerged U-boats were sunk and ۱٤% damaged, after the change ۷% were sunk and ۱۱% damaged (if caught on the surface the numbers were ۱۱% sunk and ۱۵% damaged). Blackett observed "there can be few cases where such a great operational gain had been obtained by such a small and simple change of tactics.
Bomber Command's Operational Research Section (BC-ORS), analysed a report of a survey carried out by RAF Bomber Command. For the survey, Bomber Command inspected all bombers returning from bombing raids over Germany over a particular period. All damage inflicted by German air defenses was noted and the recommendation was given that armour be added in the most heavily

damaged areas. Their suggestion to remove some of the crew so that an aircraft loss would result in fewer personnel loss was rejected by RAF command. Blackett's team instead made the surprising and counter-intuitive recommendation that the armour be placed in the areas which were completely untouched by damage in the bombers which returned. They reasoned that the survey was biased, since it only included aircraft that returned to Britain. The untouched areas of returning aircraft were probably vital areas, which, if hit, would result in the loss of the aircraft.

When Germany organised its air defences into the Kammhuber Line, it was realised that if the RAF bombers were to fly in a bomber stream they could overwhelm the night fighters who flew in individual cells directed to their targets by ground controllers. It was then a matter of calculating the statistical loss from collisions against the statistical loss from night fighters to calculate how close the bombers should fly to minimise RAF losses.

The "exchange rate" ratio of output to input was a characteristic feature of operations research. By comparing the number of flying hours put in by Allied aircraft to the number of U-boat sightings in a given area, it was possible to redistribute aircraft to more productive patrol areas. Comparison of exchange rates established "effectiveness ratios" useful in planning. The ratio of ٦٠ mines laid per ship sunk was common to several campaigns: German mines in British ports, British mines on German routes, and United States mines in Japanese routes.

Operations research doubled the on-target bomb rate of B-٢٩s bombing Japan from the Marianas Islands by increasing the training ratio from ٤ to ١٠ percent of flying hours; revealed that wolf-packs of three United States submarines were the most effective number to

enable all members of the pack to engage targets discovered on their individual patrol stations; revealed that glossy enamel paint was more effective camouflage for night fighters than traditional dull camouflage paint finish, and the smooth paint finish increased airspeed by reducing skin friction.
On land, the operational research sections of the Army Operational Research Group (AORG) of the Ministry of Supply (MoS) were landed in Normandy in ١٩٤٤, and they followed British forces in the advance across Europe. They analysed, among other topics, the effectiveness of artillery, aerial bombing, and anti-tank shooting.

٩.٤ After World War II

■ After World War II, military operational research in the United Kingdom became known as "operational analysis" (OA) within the UK Ministry of Defence, where OR stands for "Operational Requirement". With expanded techniques and growing awareness, military OR or OA was no longer limited to only operations, but was extended to encompass equipment procurement, training, logistics and infrastructure.

٩.٥ Scope of Operations Research

■ Examples of applications in which operations research is currently used include:

- critical path analysis or project planning: identifying those processes in a complex project which affect the overall duration of the project
- designing the layout of a factory for efficient flow of materials
- constructing a telecommunications network at low cost while still guaranteeing quality of service (QoS) or Quality of Experience (QoE) if particular connections become very busy or get damaged

- road traffic management and 'one way' street allocations i.e. allocation problems.
- determining the routes of school buses (or city buses) so that as few buses are needed as possible
- designing the layout of a computer chip to reduce manufacturing time (therefore reducing cost)
- managing the flow of raw materials and products in a supply chain based on uncertain demand for the finished products
- efficient messaging and customer response tactics
- robotizing or automating human-driven operations processes
- globalizing operations processes in order to take advantage of cheaper materials, labor, land or other productivity inputs
- managing freight transportation and delivery systems
- scheduling:
  - personnel staffing
  - manufacturing steps
  - project tasks
  - network data traffic: these are known as queueing models or queueing systems.
  - sports events and their television coverage
- blending of raw materials in oil refineries
- determining optimal prices, in many retail and B۲B settings, within the disciplines of pricing science

Operations research is also used extensively in government where evidence-based policy is used.

۹. Operation Research ………………………………………… ۱۱۶

Vocabulary:

◙ A **mathematical model** uses mathematical language to describe a system.

◙ **Statistics** is a mathematical science pertaining to the collection, analysis, interpretation or explanation, and presentation of data.

◙ An **algorithm** is an effective method for solving a problem using a finite sequence of instructions.

◙ **maxima** and **minima**, known collectively as **extrema** (singular: extremum), are the *largest value* (maximum) or *smallest value* (minimum), that a function takes in a point either within a given neighbourhood (local extremum) or on the function domain in its entirety (global extremum).

◙ **Management science** **(MS)**, is an interdisciplinary branch of applied mathematics, engineering and sciences that uses various scientific research-based principles, strategies, and analytical methods including mathematical modeling, statistics and algorithms to improve an organization's ability to enact rational and meaningful management decisions by arriving at optimal or near optimal solutions to complex business problems.

◙ **Management** in all business and human organization activity is simply the act of getting people together to accomplish desired goals and objectives. Management comprises planning, organizing, staffing, leading or directing, facilitating and controlling or manipulating an organization (a group of one or more people or entities) or effort for the purpose of accomplishing a goal. Resourcing encompasses the deployment and manipulation of human resources, financial resources, technological resources, and natural resources.

◙ **Industrial engineering** is a branch of engineering that concerns the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, material and process.

◙ **Optimization**, or **mathematical programming**, refers to choosing the best element from some set of available alternatives.

◙ **Probability theory** is the branch of mathematics concerned with analysis of random phenomena.

◙ **Queueing theory** is the mathematical study of waiting lines (or *queues*).

◙ **Game theory** is a branch of applied mathematics that mathematically capture behavior in *strategic situations*, in which an individual's success in making choices depends on the choices of others.

◙ **graph theory** is the study of *graphs*: mathematical structures used to model pairwise relations between objects from a certain collection.

◙ **Decision Analysis** (DA) is the discipline comprising the philosophy, theory, methodology, and professional practice necessary to address important decisions in a formal manner.

◙ **Simulation** is the imitation of some real thing, state of affairs, or process. The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system.

◙ A **management information system** (**MIS**) is a subset of the overall internal controls of a business covering the application of people, documents, technologies, and procedures by management accountants to solve business problems such as costing a product, service or a business-wide strategy.

◙ An **early warning radar** is any radar system used primarily for the long-range detection of its targets, i.e., allowing defences to be alerted as *early* as possible before the intruder reaches its target, giving the defences the maximum time in-which to operate.

◙ **Anti-aircraft warfare**, or **air defence**, is any method of engaging hostile military aircraft in defence of ground objectives, ground or naval forces or denial of passage through a specific airspace region, area or anti-aircraft combat zone.

◙ The **Admiralty** was formerly the authority in the United Kingdom responsible for the command of the Royal Navy. Originally exercised by a single person, the office of Lord High Admiral was from the ۱۸th century onward almost invariably put "in commission", and was exercised by a Board of Admiralty.

◙ The **Nobel Prize** is a Swedish & International monetary prize, established by the ۱۸۹۵ will and estate of Swedish chemist and inventor Alfred Nobel.

◙ A **convoy** is a group of vehicles (of any type, but usually motor vehicles or ships) traveling together for mutual support and protection.

Often, a convoy is organized with armed defensive support, though it may also be used in a non-military sense, for example when driving through remote areas.

◙ The **critical path method** (**CPM**) or **critical path analysis**, is a mathematically based algorithm for scheduling a set of project activities. It is an important tool for effective project management.

◙ **Project plannning** is part of project management, which relates to the use of schedules such as Gantt charts to plan and subsequently report progress within the project environment.

◙ A **telecommunications network** is a network of telecommunications links and nodes arranged so that messages may be passed from one part of the network to another over multiple links and through various nodes.

◙ **Quality of service** is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed.

◙ **Quality of Experience** (**QoE**), some times also known as "Quality of User Experience," is a subjective measure of a customer's experiences with a vendor.

◙ An **integrated circuit** (also known as **IC**, **microcircuit**, **microchip**, **silicon chip**, or **chip**) is a miniaturized electronic circuit (consisting mainly of semiconductor devices, as well as passive components) that has been manufactured in the surface of a thin substrate of semiconductor material.

◙ A **supply chain** is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer.

◙ **Cargo** (or **freight**) refers to goods or produce transported, generally for commercial gain, by ship, aircraft, train, van or truck.

◙ **Scheduling** is the process of deciding how to commit resources between a variety of possible tasks.

◙ A **queueing model** is used to approximate a real queueing situation or system, so the queueing behaviour can be analysed mathematically.

◙ **Pricing Science** is the application of social and business science methods to the problem of setting prices.

◙ **Evidence-based policy** is public policy informed by rigorously established objective evidence.

Questions:

١٠. Electronic mail

١٠.١ Introduction

■ **Electronic mail**, often abbreviated as **email** or **e-mail**, is a method of exchanging digital messages, designed primarily for human use. E-mail systems are based on a store-and-forward model in which e-mail computer server systems accept, forward, deliver and store messages on behalf of users, who only need to connect to the e-mail infrastructure, typically an e-mail server, with a network-enabled device (e.g., a personal computer) for the duration of message submission or retrieval. Rarely is e-mail transmitted directly from one user's device to another's.

An electronic mail message consists of two components, the message *header*, and the message *body*, which is the email's content. The message header contains control information, including, minimally, an originator's email address and one or more recipient addresses. Usually additional information is added, such as a subject header field. Originally a text-only communications medium, email is extended to carry multi-media content attachments, which were standardized in with RFC ٢٠٤٥ through RFC ٢٠٤٩, collectively called, Multipurpose Internet Mail Extensions (MIME).

■ The foundation for today's global Internet e-mail service was created in the early ARPANET and standards for encoding of messages were proposed as early as, for example, in ١٩٧٣. An e-mail sent in the early ١٩٧٠s looked very similar to one sent on the Internet today. Conversion from the ARPANET to the Internet in the early ١٩٨٠s produced the core of the current service.

Network-based email was initially exchanged on the ARPANET in extensions to the File Transfer Protocol (FTP), but is today carried by the Simple Mail Transfer Protocol (SMTP), first published as Internet Standard ١٠ (RFC ٨٢١) in ١٩٨٢. In the process of transporting email messages between systems, SMTP communicates delivery parameters using a message *envelope* separately from the message (headers and body) itself.

Spelling:

There are several spelling variations that are occasionally the cause of vehement disagreement.

email is the form officially required by IETF Request for Comments and working groups and is also recognized in most dictionaries. **email** is a form still recommended by some prominent journalistic and technical style guides. Less common forms include *eMail* and simply *mail*.

Mail, was the form used in the original RFC. The service is referred to as *mail* and a single piece of electronic mail is called a *message*.

eMail, capitalizing only the letter *M*, was common among ARPANET users and early developers from Unix, CMS, AppleLink, eWorld, AOL, GEnie, and Hotmail.

EMail is a traditional form that has been used in RFCs for the "Author's Address", and is expressly required *"...for historical reasons..."*

١٠.٢ Origin

■ Electronic mail predates the inception of the Internet, and was in fact a crucial tool in creating the Internet.

MIT first demonstrated the Compatible Time-Sharing System (CTSS) in ۱۹۶۱. It allowed multiple users to log into the IBM ۷۰۹٤ from remote dial-up terminals, and to store files online on disk. This new ability encouraged users to share information in new ways. E-mail started in ۱۹٦٥ as a way for multiple users of a time-sharing mainframe computer to communicate. Although the exact history is murky, among the first systems to have such a facility were SDC's Q۳۲ and MIT's CTSS.

Host-based mailsystems

The original email systems allowed communication only between users who logged into the one host or "mainframe", but this could be hundreds or thousands of users within a company or university. By ۱۹٦٦, such systems allowed email between different companies as long as they ran compatible operating systems, but not to other dissimilar systems.

Examples include BITNET, IBM PROFS, Digital All-in-۱ and the original Unix mail.

LAN-based mailsystems

From the early ۱۹۸۰s networked personal computers on LANs became increasingly important - and server-based systems similar to the earlier mainframe systems developed, and again initially allowed communication only between users logged into the one server, but these also could generally be linked between different companies as long as they ran the same email system and (proprietary) protocol.

Examples include cc:Mail, WordPerfect Office, Microsoft Mail, Banyan VINES and Lotus Notes - with various vendors supplying gateway software to link these incompatible systems.

■ Attempts at Interoperability

- Novell briefly championed the open MHS protocol
- uucp was used as an open "glue" between differing mail systems
- The Coloured Book protocols on UK academic networks until ١٩٩٢
- X.٤٠٠ in the early ١٩٩٠s was mandated for government use under GOSIP but almost immediately abandoned by all but a few — in favour of Internet SMTP

The rise of ARPANET-based mail

The ARPANET computer network made a large contribution to the development of e-mail. There is one report that indicates experimental inter-system e-mail transfers began shortly after its creation in ١٩٦٩. Ray Tomlinson initiated the use of the "@" sign to separate the names of the user and their machine in ١٩٧١. The ARPANET significantly increased the popularity of e-mail, and it became the killer app of the ARPANET.

Most other networks had their own email protocols and address formats; as the influence of the ARPANET and later the Internet grew, central sites often hosted email gateways that passed mail between the Internet and these other networks. Internet email addressing is still complicated by the need to handle mail destined for these older networks. Some well-known examples of these were UUCP (mostly Unix computers), BITNET (mostly IBM and VAX mainframes at universities), FidoNet (personal computers), DECNET (various networks) and CSNet a forerunner of NSFNet.

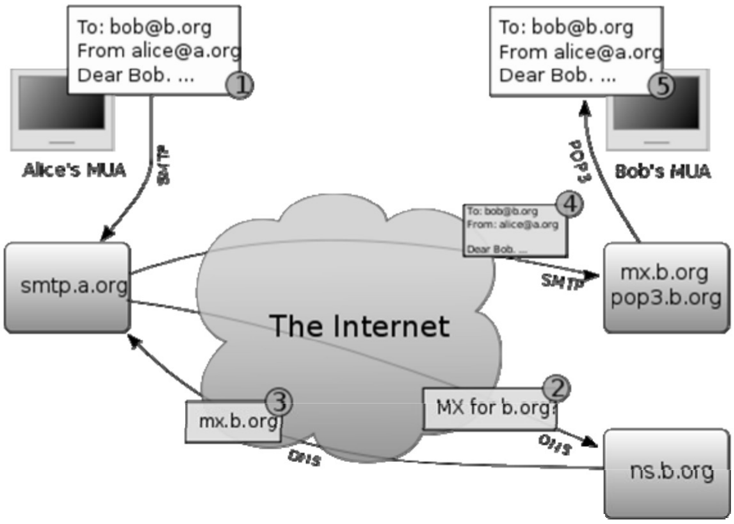
An example of an Internet email address that routed mail to a user at a UUCP host:

hubhost!middlehost!edgehost!user@uucpgateway.somedomain.example.com

This was necessary because in early years UUCP computers did not maintain (or consult servers for) information about the location of all hosts they exchanged mail with, but rather only knew how to communicate with a few network neighbors; email messages (and other data such as Usenet News) were passed along in a chain among hosts who had explicitly agreed to share data with each other.

۱۰.۳ Operation Overview

■ The following diagram shows a typical sequence of events that takes place when Alice composes a message using her mail user agent (MUA). She enters the e-mail address of her correspondent, and hits the "send" button.



۱. Her MUA formats the message in e-mail format and uses the Simple Mail Transfer Protocol (SMTP) to send the message to the local mail transfer agent (MTA), in this case smtp.a.org, run by Alice's Internet Service Provider (ISP).

۲. The MTA looks at the destination address provided in the

SMTP protocol (not from the message header), in this case bob@b.org. An Internet e-mail address is a string of the form localpart@exampledomain. The part before the @ sign is the **local part** of the address, often the username of the recipient, and the part after the @ sign is a domain name or a fully qualified domain name. The MTA resolves a domain name to determine the fully qualified domain name of the mail exchange server in the Domain Name System.

٣. The DNS server for the b.org domain, ns.b.org, responds with any MX records listing the mail exchange servers for that domain, in this case mx.b.org, a server run by Bob's ISP.

٤. smtp.a.org sends the message to mx.b.org using SMTP, which delivers it to the mailbox of the user bob.

٥. Bob presses the "get mail" button in his MUA, which picks up the message using the Post Office Protocol (POP٣).

That sequence of events applies to the majority of e-mail users. However, there are many alternative possibilities and complications to the e-mail system:

- Alice or Bob may use a client connected to a corporate e-mail system, such as IBM Lotus Notes or Microsoft Exchange. These systems often have their own internal e-mail format and their clients typically communicate with the e-mail server using a vendor-specific, proprietary protocol. The server sends or receives e-mail via the Internet through the product's Internet mail gateway which also does any necessary reformatting. If Alice and Bob work for the same company, the entire transaction may happen completely within a single corporate e-mail system.
- Alice may not have a MUA on her computer but instead may connect to a webmail service.
- Alice's computer may run its own MTA, so avoiding the

transfer at step ۱.

- Bob may pick up his e-mail in many ways, for example using the Internet Message Access Protocol, by logging into mx.b.org and reading it directly, or by using a webmail service.
- Domains usually have several mail exchange servers so that they can continue to accept mail when the main mail exchange server is not available.
- E-mail messages are not secure if e-mail encryption is not used correctly.

Many MTAs used to accept messages for any recipient on the Internet and do their best to deliver them. This was very important in the early days of the Internet when network connections were unreliable. If an MTA couldn't reach the destination, it could at least deliver it to a relay closer to the destination. The relay stood a better chance of delivering the message at a later time. However, this mechanism proved to be exploitable by people sending unsolicited bulk e-mail and as a consequence very few modern MTAs are open mail relays, and many MTAs don't accept messages from open mail relays because such messages are very likely to be spam.

۱۰.٤ Message Format

■ The Internet e-mail message format is defined in RFC ٥٣٢٢ and a series of RFCs, RFC ٢٠٤٥ through RFC ٢٠٤٩, collectively called, Multipurpose Internet Mail Extensions, or *MIME*. Although as of July ١٣, ٢٠٠٥, RFC ٢٨٢٢ is technically a proposed IETF standard and the MIME RFCs are draft IETF standards, these documents are the standards for the format of Internet e-mail. Prior to the introduction of RFC ٢٨٢٢ in ٢٠٠١, the format described by RFC ٨٢٢ was the standard for Internet e-mail for nearly ٢٠ years; it is still the official IETF standard. The IETF reserved the numbers ٥٣٢١ and ٥٣٢٢ for the updated versions of RFC ۲۸۲۱ (SMTP) and RFC ۲۸۲۲, as it previously did with RFC ۸۲۱ and RFC ۸۲۲, honoring the extreme importance of these two RFCs. RFC ۸۲۲ was published in ۱۹۸۲ and based on the earlier RFC ۷۳۳.

Internet e-mail messages consist of two major sections:

- Header — Structured into fields such as summary, sender, receiver, and other information about the e-mail.
- Body — The message itself as unstructured text; sometimes containing a signature block at the end. This is exactly the same as the body of a regular letter.

The header is separated from the body by a blank line.

Message header

Each message has exactly one header, which is structured into fields. Each field has a name and a value. RFC ۵۳۲۲ specifies the precise syntax.

Informally, each line of text in the header that begins with a printable character begins a separate field. The field name starts in the first character of the line and ends before the separator character ":". The separator is then followed by the field value (the "body" of the field). The value is continued onto subsequent lines if those lines have a space or tab as their first character. Field names and values are restricted to ۷-bit ASCII characters. Non-ASCII values may be represented using MIME encoded words.

Vocabulary:

◙ **Store and forward** is a telecommunications technique in which information is sent to an intermediate station where it is kept and sent at a later time to the final destination or to another intermediate station.

RFC ۸۲۲, defines a message representation protocol specifying considerable detail about US-ASCII message headers, and leaves the message content, or message body, as flat US-ASCII text.

◙ **Multipurpose Internet Mail Extensions** (**MIME**) is an Internet standard that extends the format of e-mail to support:

- Text in character sets other than ASCII
- Non-text attachments
- Message bodies with multiple parts
- Header information in non-ASCII character sets

◙ **File Transfer Protocol** (**FTP**) is a standard network protocol used to exchange and manipulate files over an Internet Protocol computer network, such as the Internet.

◙ **Simple Mail Transfer Protocol** (**SMTP**) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks and is the protocol in widespread use today.

◙ The **Internet Engineering Task Force** (**IETF**) develops and promotes Internet standards, cooperating closely with the W۳C and ISO/IEC standard bodies and dealing in particular with standards of the TCP/IP and Internet protocol suite. It is an open standards organization, with no formal membership or membership requirements.

◙ A **Request for Comments** (**RFC**) is a memorandum published by the Internet Engineering Task Force (IETF) describing methods, behaviors, research, or innovations applicable to the working of the Internet and Internet-connected systems.

◙ A **<u>style guide</u>** or **style manual** is a set of standards for design and writing of documents, either for general use or for a specific publication or organization.

◙ The **<u>Massachusetts Institute of Technology</u>** (**MIT**) is a private research university located in Cambridge, Massachusetts. MIT has five schools and one college, containing a total of ٣٢ academic departments, with a strong emphasis on scientific and technological research.

◙ The **<u>Compatible Time-Sharing System</u>**, or the **CTSS**, was one of the first time-sharing operating systems; it was developed at MIT's Computation Center. CTSS was first demonstrated in ١٩٦١, and was operated at MIT until ١٩٧٣.

◙ The **<u>IBM ٧٠٩٠</u>** was a second-generation transistorized version of the earlier IBM ٧٠٩ vacuum tube mainframe computers and was designed for "large-scale scientific and technological applications".

◙ **<u>Time-sharing</u>** is sharing a computing resource among many users by means of multiprogramming and multi-tasking.

◙ **<u>Mainframes</u>** are computers used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statistics, enterprise resource planning, and financial transaction processing.

◙ A **<u>local area network</u>** (**LAN**) is a computer network covering a small physical area, like a home, office, or small group of buildings, such as a school, or an airport.

◙ **Novell, Inc.** is a global software corporation based in the United States specializing in enterprise operating systems such as SUSE Linux Enterprise and Novell NetWare; identity, security and systems management solutions; and collaboration solutions.

◙ **Message Handling System** (**MHS**) is an important early email protocol developed by Novell.

◙ **UUCP** is an abbreviation for **Unix-to-Unix Copy Program**. The term generally refers to a suite of computer programs and protocols allowing remote execution of commands and transfer of files, email and netnews between computers. Specifically, uucp is one of the programs in the suite; it provides a user interface for requesting file copy operations.

◙ **Simple Mail Transfer Protocol** (**SMTP**) is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks. SMTP was first defined in RFC ۸۲۱ (STD ۱۵), and last updated by RFC ۵۳۲۱ (۲۰۰۸) which includes the extended SMTP (ESMTP) additions, and is the protocol in widespread use today. SMTP is specified for outgoing mail transport and uses port ۲۵.

◙ **Raymond Samuel Tomlinson** (born ۱۹٤۱, Amsterdam, New York) is a programmer who implemented an email system in ۱۹۷۱ on the ARPANet. Email had been previously sent on other networks such as AUTODIN. It was the first system able to send mail between users on different hosts connected to the ARPAnet (previously, mail could only be sent to others who used the same computer). To achieve this, he used the @ sign to separate the user from their machine, which has been used in email addresses ever since.

◙ A **killer application** (commonly shortened to **killer app**), in the jargon of computer programmers and video gamers, has been used to refer to any computer program that is so necessary or desirable that it proves the core value of some larger technology, such as computer hardware like a gaming console, operating system or other software. A killer app can substantially increase sales of the platform on which it runs.

◙ An **e-mail address** identifies a location to which e-mail messages can be delivered. An e-mail address on the modern Internet looks like, for example, `jsmith@example.com` and is usually read as "jsmith at example dot com".

◙ A **message transfer agent** or **mail transfer agent** (**MTA**) is a computer process or software agent that transfers electronic mail messages from one computer to another, in *single hop* application-level transactions. An MTA implements both the client (sending) and server (receiving) portions of the Simple Mail Transfer Protocol.

◙ An **Internet service provider** (**ISP**, also called **Internet access provider**, or **IAP**) is a company that offers its customers access to the Internet. The ISP connects to its customers using a data transmission technology appropriate for delivering Internet Protocol datagrams, such as dial-up, DSL, cable modem, wireless or dedicated high-speed interconnects.

◙ A **user** is a person who uses a computer or Internet service. A user may have a **user account** that identifies the user by a **username** (also **user name**), **screenname** (also **screen name**), or "handle", which is derived from the identical Citizen's Band radio term. To log in to an account, a user is typically required to authenticate himself with a password or other credentials for the purposes of accounting, security, logging, and resource management.

◙ A **domain name** is an identification label that defines a realm of administrative autonomy, authority, or control in the Internet, based on the Domain Name System (DNS).

◙ A **message transfer agent** or **mail transfer agent** (**MTA**) is a computer process or software agent that transfers electronic mail messages from one computer to another, in single hop application-level transactions. An MTA implements both the client (sending) and server (receiving) portions of the Simple Mail Transfer Protocol.

◙ The **Domain Name System** (**DNS**) is a hierarchical naming system for computers, services, or any resource connected to the Internet or a private network. It associates various information with domain names assigned to each of the participants.

◙ A **MX record** or **Mail Exchanger record** is a type of resource record in the Domain Name System (DNS) specifying how Internet e-mail should be routed using the Simple Mail Transfer Protocol (SMTP). Each MX record contains a **preference** and a **host name**, so that the collection of MX records for a given *domain name* point to the servers that should receive e-mail for that domain, and their priority relative to each other.

◙ The **Post Office Protocol** (**POP**) is an application-layer Internet standard protocol used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection.

◙ **<u>Microsoft Corporation</u>** is a multinational computer technology corporation that develops, manufactures, licenses, and supports a wide range of software products for computing devices. Headquartered in Redmond, Washington, USA, its most profitable products are the Microsoft Windows operating system and the Microsoft Office suite of productivity software.

◙ **<u>Webmail</u>** (or **Web-based e-mail**) is an e-mail service intended to be primarily accessed via a web browser, as opposed to through a desktop e-mail client.

◙ The **<u>Internet Message Access Protocol</u>** (**IMAP**) is one of the two most prevalent Internet standard protocols for e-mail retrieval, the other being the Post Office Protocol.

◙ **<u>Webmail</u>** (or **Web-based e-mail**) is an e-mail service intended to be primarily accessed via a web browser, as opposed to through a desktop e-mail client (such as Microsoft Outlook, Mozilla's Thunderbird, or Apple Inc.'s Mail). Very popular webmail providers include Gmail, Yahoo! Mail, Hotmail, and AOL.

◙ **<u>encryption</u>** is the process of transforming information (referred to as plaintext) using an algorithm (called cipher) to make it unreadable to anyone except those possessing special knowledge, usually referred to as a key.

◙ **<u>E-mail spam</u>**, also known as **junk email,** is a subset of spam that involves nearly identical messages sent to numerous recipients by email. A common synonym for spam is unsolicited bulk e-mail (UBE).

Questions:

۱۱. Strategic Planning

۱۱.۱ Dfinition

■ **Strategic planning** is an organization's process of defining its strategy, or direction, and making decisions on allocating its resources to pursue this strategy, including its capital and people. Various business analysis techniques can be used in strategic planning, including SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) and PEST analysis (Political, Economic, Social, and Technological analysis) or STEER analysis (Socio-cultural, Technological, Economic, Ecological, and Regulatory factors) and EPISTEL (Environment, Political, Informatic, Social, Technological, Economic and Legal).

Strategic planning is the formal consideration of an organization's future course. All strategic planning deals with at least one of three key questions:

"What do we do?"

"For whom do we do it?"

"How do we excel?"

In business strategic planning, the third question is better phrased "How can we beat or avoid competition?".

In many organizations, this is viewed as a process for determining where an organization is going over the next year or more -typically ۳ to ۵ years, although some extend their vision to ۲۰ years.

In order to determine where it is going, the organization needs to know exactly where it stands, then determine where it wants to go and how it will get there. The resulting document is called the "strategic plan."

It is also true that strategic planning may be a tool for effectively plotting the direction of a company; however, strategic planning itself cannot foretell exactly how the market will evolve and what issues will surface in the coming days in order to plan your organizational strategy. Therefore, strategic innovation and tinkering with the 'strategic plan' have to be a cornerstone strategy for an organization to survive the turbulent business climate.

۱۱.۲ Vision, Mission and Values

■ Vision: Defines the desired or intended future state of an organization or enterprise in terms of its fundamental objective and/or strategic direction. Vision is a long term view, sometimes describing a view of how the organization would like the world in which it operates to be. For example a charity working with the poor might have a vision statement which read "A world without poverty"

Mission: Defines the fundamental purpose of an organization or an enterprise, basically describing why it exists and what it does to achieve its Vision. A corporate Mission can last for many years, or for the life of the organization. It is not an objective with a timeline, but rather the overall goal that is accomplished over the years as objectives are achieved that are aligned with the corporate mission.

Values: Beliefs that are shared among the stakeholders of an organization. Values drive an organization's culture and priorities.

۱۱.۳ Methodologies

■ There are many approaches to strategic planning but typically a three-step process may be used:

Situation - evaluate the current situation and how it came about.

Target - define goals and/or objectives (sometimes called ideal state)

Path - map a possible route to the goals/objectives

One alternative approach is called *Draw-See-Think*

Draw - what is the ideal image or the desired end state?

See - what is today's situation? What is the gap from ideal and why?

Think - what specific actions must be taken to close the gap between today's situation and the ideal state?

Plan - what resources are required to execute the activities?

An alternative to the *Draw-See-Think* approach is called *See-Think-Draw*

See - what is today's situation?

Think - define goals/objectives

Draw - map a route to achieving the goals/objectives

In other terms strategic planning can be as follows:

Vision - Define the vision and set a mission statement with hierarchy of goals and objectives

SWOT - Analysis conducted according to the desired goals

Formulate - Formulate actions and processes to be taken to attain these goals

Implement - Implementation of the agreed upon processes

Control - Monitor and get feedback from implemented processes to fully control the operation

Situational analysis

When developing strategies, analysis of the organization and its environment as it is at the moment and how it may develop in the future, is important. The analysis has to be executed at an internal level as well as an external level to identify all opportunities and threats of the external environment as well as the strengths and

weaknesses of the organizations.
There are several factors to assess in the external situation analysis:
Markets (customers)
Competition
Technology
Supplier markets
Labor markets
The economy
The regulatory environment
It is rare to find all seven of these factors having critical importance. It is also uncommon to find that the first two - markets and competition - are not of critical importance.
Analysis of the external environment normally focuses on the customer. Management should be visionary in formulating customer strategy, and should do so by thinking about market environment shifts, how these could impact customer sets, and whether those customer sets are the ones the company wishes to serve.

۱۱.۳ Goals, Objectives, and Targets

■ Strategic planning is a very important business activity. It is also important in the public sector areas such as education. It is practiced widely informally and formally. Strategic planning and decision processes should end with objectives and a roadmap of ways to achieve those objectives.
The following terms have been used in strategic planning: desired end states, plans, policies, goals, objectives, strategies, tactics and actions. Definitions vary, overlap and fail to achieve clarity. The most common of these concepts are specific, time bound statements of intended future results and general and continuing statements of intended future results, which most models refer to as either goals or

objectives (sometimes interchangeably).

One model of organizing objectives uses hierarchies. The items listed above may be organized in a hierarchy of means and ends and **numbered** as follows: Top Rank Objective (TRO), Second Rank Objective, Third Rank Objective, etc. From any rank, the objective in a lower rank answers to the question "How?" and the objective in a higher rank answers to the question "Why?" The exception is the Top Rank Objective (TRO): there is no answer to the "Why?" question. That is how the TRO is defined.

People typically have several goals at the same time. "Goal congruency" refers to how well the goals combine with each other. Does goal A appear compatible with goal B? Do they fit together to form a unified strategy? "Goal hierarchy" consists of the nesting of one or more goals within other goal(s).

One approach recommends having short-term goals, medium-term goals, and long-term goals. In this model, one can expect to attain short-term goals fairly easily: they stand just slightly above one's reach. At the other extreme, long-term goals appear very difficult, almost impossible to attain. Strategic management jargon sometimes refers to "Big Hairy Audacious Goals" (BHAGs) in this context. Using one goal as a stepping-stone to the next involves goal sequencing. A person or group starts by attaining the easy short-term goals, then steps up to the medium-term, then to the long-term goals. Goal sequencing can create a "goal stairway". In an organizational setting, the organization may co-ordinate goals so that they do not conflict with each other. The goals of one part of the organization should mesh compatibly with those of other parts of the organization.

۱۱.۴ Mission Statements and Vision Statements

■ Organizations sometimes summarize goals and objectives into a

mission statement and/or a **vision statement** Others begin with a vision and mission and use them to formulate goals and objectives.

While the existence of a shared mission is extremely useful, many strategy specialists question the requirement for a written mission statement. However, there are many models of strategic planning that start with mission statements, so it is useful to examine them here.

A ***Mission statement*** tells you the fundamental purpose of the organization. It defines the customer and the critical processes. It informs you of the desired level of performance.

- A ***Vision statement*** outlines what the organization wants to be, or how it wants the world in which it operates to be. It concentrates on the future. It is a source of inspiration. It provides clear decision-making criteria.

An advantage of having a statement is that it creates value for those who get exposed to the statement, and those prospects are managers, employees and sometimes even customers.Statements create a sense of direction and opportunity.

Many people mistake vision statement for mission statement, and sometimes one is simply used as a longer term version of the other. The Vision should describe why it is important to achieve the Mission. A Vision statement defines the purpose or broader goal for being in existence or in the business and can remain the same for decades if crafted well. A Mission statement is more specific to what the enterprise can achieve itself. Vision should describe what will be achieved in the wider sphere if the organization and others are successful.

A mission statement can resemble a vision statement in a few companies, but that can be a grave mistake. It can confuse people. The mission statement can galvanize the people to achieve defined objectives, even if they are stretch objectives, provided it can be elucidated in SMART (Specific, Measurable, Achievable, Relevant and Time-bound) terms. A mission statement provides a path to realize the vision in line with its values. These statements have a direct bearing on the bottom line and success of the organization.

Which comes first? The mission statement or the vision statement? That depends. If you have a new start up business, new program or plan to re engineer your current services, then the vision will guide the mission statement and the rest of the strategic plan. If you have an established business where the mission is established, then many times, the mission guides the vision statement and the rest of the strategic plan. Either way, you need to know your fundamental purpose - the mission, your current situation in terms of internal resources and capabilities (strengths and/or weaknesses) and external conditions (opportunities and/or threats), and where you want to go - the vision for the future. It's important that you keep the end or desired result in sight from the start.

Features of an effective vision statement include:

- Clarity and lack of ambiguity
- Vivid and clear picture
- Description of a bright future
- Memorable and engaging wording
- Realistic aspirations
- Alignment with organizational values and culture

To become really effective, an organizational vision statement must (the theory states) become assimilated into the organization's culture. Leaders have the responsibility of communicating the vision regularly, creating narratives that illustrate the vision, acting as role-models by embodying the vision, creating short-term objectives compatible with the vision, and encouraging others to craft their own personal vision compatible with the organization's overall vision. In addition, mission statements need to be subjected to an internal assessment and an external assessment. The internal assessment should focus on how members inside the organization interpret their mission statement. The external assessment — which includes all of the businesses stakeholders — is valuable since it offers a different perspective. These discrepancies between these two assessments can give insight on the organization's mission statement effectiveness.

Another approach to defining Vision and Mission is to pose two questions. Firstly, "What aspirations does the organization have for the world in which it operates and has some influence over?", and following on from this, "What can (and /or does) the organization do or contribute to fulfill those aspirations?". The succinct answer to the first question provides the basis of the Vision Statement. The answer to the second question determines the Mission Statement.

Vocabulary:

◙ **SWOT Analysis** is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective.

◙ **PEST analysis** stands for "**P**olitical, **E**conomic, **S**ocial, and **T**echnological analysis" and describes a framework of macro-environmental factors used in the environmental scanning component of strategic management. The model has recently been further extended to STEEPLE and STEEPLED, adding education and demographics factors.It is a part of the external analysis when conducting a strategic analysis or doing market research and gives a certain overview of the different macroenvironmental factors that the company has to take into consideration. It is a useful strategic tool for understanding market growth or decline, business position, potential and direction for operations.

◙ **Stakeholder**: Stakeholder a person, group, organization, or system who affects or can be affected by an organization's actions

◙ A **customer**, also called *client*, *buyer*, or *purchaser*, is usually used to refer to a current or potential buyer or user of the products of an individual or organization, called the supplier, seller, or vendor.

◙ The **public sector** is a part of the state that deals with the delivery of goods and services by and for the government, whether national, regional or local/municipal. Examples of public sector activity range from delivering social security, administering urban planning and organizing national defenses.

◙ **Strategic or institutional management** is the conduct of drafting, implementing and evaluating cross-functional decisions that will enable an organization to achieve its long-term objectives.

◙ A **mission statement** is a short written statement for the purpose of a company or organization. Ideally, a mission statement guides the actions of the organization, spells out its overall goal, provides a sense of direction, and guides decision making for all levels of management.

◙ **SMART** / **SMARTER** is a mnemonic used in project management at the project objective setting stage. It is a way of evaluating the objectives or goals for an individual project. The term is also in common usage in performance management, whereby goals and targets set for employees must fulfill the criteria.

Questions: