

Unit I. Introduction:

EIA is an activity designed to identify and predict the impact of a project on biogeophysico-chemical Environment and on human health so as to recommend appropriate legislative measures, programs, and operational procedures to minimize the impact.

EIA is an exercise to be carried out before any project or major activity is undertaken to ensure that it will not in any way harm the environment on a short-term or long-term basis. Any developmental activity requires not only the analysis, the monetary costs and benefits involved and of the need of such a project but also most important, it requires a consideration and detailed assessment of the effect of a proposed development on the environment.

The Need for EIA:

EIA links environment with development for environmentally safe and sustainable development.

EIA provides a cost effective method to eliminate or minimize the adverse impact of developmental projects.

EIA enables the decision makers to analyse the effect of developmental activities on the environment well before the developmental project is implemented.

EIA encourages the adaptation of mitigation strategies in the developmental plan.

EIA makes sure that the developmental plan is environmentally sound and within the limits of the Capacity of assimilation and regeneration of the ecosystem.

Indian Policies Requiring EIA:

- Environment Impact Assessment in India is statutorily backed by the Environment Protection Act, 1986 which contains various provisions on EIA methodology and process.
- The Indian experience with Environmental Impact Assessment began over 20 years back. It started
- in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle.
- Till 1994, environmental clearance from the Central Government was an administrative decision and lacked legislative support.
- On 27 January 1994, the then Union Ministry of Environment and Forests, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification.

- The Ministry of Environment, Forests and Climate Change (MoEFCC) notified new EIA legislation in September 2006.
- The notification makes it mandatory for various projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance.
- However, unlike the EIA Notification of 1994, the new legislation has put the onus of clearing projects on the state government depending on the size/capacity of the project.

EIA Cycle and Procedures:

The EIA process in India is made up of the following phases:

- Screening
- Scoping and consideration of alternatives
- Baseline data collection
- Impact prediction
- Assessment of alternatives, delineation of mitigation measures and environmental impact statement
- Public hearing
- Decision making
- Monitoring the clearance conditions

Screening:

Screening is done to see whether a project requires environmental clearance as per the statutory notifications. Screening Criteria are based upon:

- Scales of investment;
- Type of development; and,
- Location of development.

A Project requires statutory environmental clearance only if the provisions of EIA notification and/or one or more statutory notification mentioned or cover it.

Scoping:

- Scoping is a process of detailing the terms of reference of EIA. It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.
- The Ministry of Environment and Forests has published guidelines for different sectors, which outline the significant issues to be addressed in the EIA studies. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria. After the areas, where the project could have significant impact, are

identified, the baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted.

Baseline Data:

- Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

Impact prediction:

Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

Air.

- changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources.
- effects on soils, materials, vegetation, and human health.

Noise.

- changes in ambient levels due to noise generated from equipment and movement of vehicles.
- effect on fauna and human health.

Water.

- availability to competing users.
- changes in quality.
- sediment transport.
- ingress of saline water.

Land.

- changes in land use and drainage pattern
- changes in land use and drainage pattern
- changes in shoreline/riverbank and their stability

Biological.

- deforestation/tree-cutting and shrinkage of animal habitat.
- impact on fauna and flora (including aquatic species if any) due to contaminants/pollutants
- impact on rare and endangered species, endemic species, and migratory path/route of animals.
- Impact on breeding and nesting grounds.

Socio-Economic.

- impact on the local community including demographic changes.
- Impact on economic status
- impact on human health.
- impact of increased traffic.

Assessment of alternatives, delineation of mitigation measures and environmental impact statement:-

- For every project, possible alternatives should be identified and environmental attributes compared. Alternatives should cover both project location and process technologies. Alternatives should consider 'no project' option also. Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.
- Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements. The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitoring should be included in the EMP.
- An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives. Uncertainties should be clearly reflected in the EIA report.

Public hearing:-

- Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.
- Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA.

The affected persons may include:

- bonafide local residents;
 - local associations;
 - environmental groups: active in the area
 - any other person located at the project site / sites of displacement
- They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board as per Schedule IV of Annex I.

Decision making:-

- Impact Assessment Authority along with the experts consults the project-incharge along with consultant to take the final decision, keeping in mind EIA and EMP (Environment Management Plan).

Monitoring the clearance conditions:-

- The various phases of implementation of the project are monitored.

Components of EIA:-

- The difference between Comprehensive EIA and Rapid EIA is in the time-scale of the data supplied. Rapid EIA is for speedier appraisal process. While both types of EIA require inclusion/ coverage of all significant environmental impacts and their mitigation, Rapid EIA achieves this through the collection of 'one season' (other than monsoon) data only to reduce the time required. This is acceptable if it does not compromise on the quality of decision-making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not.
- It is, therefore, clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

Air Environment.

- Determination of impact zone (through a screening model) and developing a monitoring network.
- Monitoring the existing status of ambient air quality within the impacted region (7-10 km from the periphery) of the proposed project site.
- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate.
- Identification, quantification and evaluation of other potential emissions (including those of vehicular traffic) within the impact zone and estimation of cumulative of all the emissions/impacts.
- Evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission and ambient air quality standards.
- Delineation of mitigation measures at source, path ways and receptor.

Noise Environment.

- Monitoring the present status of noise levels within the impact zone, and prediction of future noise levels resulting from the proposed project and related activities including increase in vehicular movement.
- Identification of impacts due to any anticipated rise in noise levels on the surrounding environment.
- Recommendations on mitigation measures for noise pollution.

Water Environment.

- Study of existing ground and surface water resources with respect to quantity and quality within the impact zone of the proposed project.
- Prediction of impacts on water resources due to the proposed water use/pumping on account of the project
- Quantification and characterisation of waste water including toxic organic, from the proposed activity
- Evaluation of the proposed pollution prevention and wastewater treatment system and suggestions on modification, if required
- Assessment of the feasibility of water recycling and reuse and delineation of detailed plan in this regard.

Land Environment.

- Studies on soil characteristics, existing land use and topography, landscape and drainage patterns within the impact zone
- Estimation of impacts of project on land use, landscape, topography, drainage and hydrology
- Estimation and Characterisation of solid wastes and delineation of management options for minimisation of waste and environmentally compatible disposal.

Roles in the EIA Process:-

EIA involves many parties, grouped by their role definition within the process. The following section outlines the basic responsibilities of various bodies:

The Project Proponent

The Environmental Consultants

The State Pollution Control Board / Pollution Control Committees (PCCs)

The Public

The Impact Assessment Agency

The Role of the Project Proponent.

The project proponent during the project planning stage decides the type of projects i.e. new establishment, expansion or modernisation. Later the project proponent needs to prepare the Detailed Project Report/Feasibility Report and submits the Executive Summary, which shall incorporate the project details, and findings of EIA study, which is to be made available to concerned public.

The proponent has to approach the concerned SPCB for NOC and holding the public hearing. After the public hearing the proponent submits application to IAA for environmental clearance.

Role of Environment Consultant.

Environmental consultant should be conversant with the existing legal and procedural requirements of obtaining environmental clearance for proposed project. The consultant should guide the proponent through initial screening of the project and establish whether EIA studies are required to be conducted and if so finalise the scope of such study. The consultant should also be fully equipped with required instruments and infrastructure for conducting EIA studies. The environmental consultant is responsible for supplying all the environment-related information required by the SPCB and IAA through the proponent. The consultant is also required to justify the findings in the EIA and EMP during the meeting with the expert groups at IAA.

The Role of the State Pollution Control Board (PCB) /Pollution Control Committee (PCC).

The State PCBs/PCCs are responsible for assessing the compatibility of a proposed development with current operational and prescribed standards. If the development is in compliance, the PCB will then issue its NOC. They shall also hold the public hearing as per the provisions of EIA notification. The details of public hearing shall be forwarded to IAA.

The Role of the Public.

The public also has an important role to play in EIA. The concerned persons will be invited through press advertisement to review information and provide their views on the proposed development requiring environmental clearance.

The Role of the Impact Assessment Agency (IAA).

Where a proponent is required to obtain environmental clearance, the IAA will evaluate and assess the EIA report. In this process the project proponent will be given a chance to present his proposal. If a project is accepted the IAA will also prepare a set of recommendations and conditions for its implementation based on this assessment.

Government of India Ministry of Environment and Forest Notification (2000),

Whereas a notification under clause (a) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 inviting objections from the public within sixty days from the date of publication of the said notification, against the intention of the Central Government to impose restrictions and prohibitions on the expansion and modernization of any activity or new projects being undertaken in any part of India unless environmental clearance has been accorded by the Central Government or the State Government in accordance with the procedure specified in that notification was published as SO No. 80(E) dated 28th January, 1993;

And whereas all objections received have been duly considered;

Now, therefore, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby directs that on and from the date of publication of this notification in the Official Gazette, expansion or modernization of any activity (if pollution load is to exceed the existing one, or new project listed in Schedule I to this notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central Government in accordance with the procedure hereinafter specified in this notification.

List of projects requiring Environmental clearance

1. Nuclear Power and related projects such as Heavy Water Plants, nuclear fuel complex, Rare Earths.
2. River Valley projects including hydel power, major Irrigation and their combination including flood control.
3. Ports, Harbours, Airports (except minor ports and harbours).
4. Petroleum Refineries including crude and product pipelines.
5. Chemical Fertilizers (Nitrogenous and Phosphatic other than single superphosphate).
6. Pesticides (Technical).
7. Petrochemical complexes (Both Olefinic and Aromatic) and Petrochemical intermediates such as DMT, Caprolactam, LAB etc. And production of basic plastics such as LLDPE, HDPE, PP, PVC.
8. Bulk drugs and pharmaceuticals.
9. Exploration for oil and gas and their production, transportation and storage.
10. Synthetic Rubber.
11. Asbestos and Asbestos products.
12. Hydrocyanic acid and its derivatives.
- 13 (a) Primary metallurgical industries (such as production of Iron and Steel, Aluminium, Copper, Zinc, Lead and Ferro Alloys). (b) Electric arc furnaces (Mini Steel Plants).
14. Chlor alkali industry.
15. Integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints.
16. Viscose Staple fibre and filament yarn.
17. Storage batteries integrated with manufacture of oxides of lead and lead antimony alloys.
18. All tourism projects between 200m—500 metres of High Water Line and at locations with an elevation of more than 1000 metres with investment of more than Rs.5 crores.
19. Thermal Power Plants.
20. Mining projects (major minerals) with leases more than 5 hectares.
21. Highway Projects except projects relating to improvement work including widening and strengthening of roads with marginal land acquisition along the existing alignments provided it does not pass through ecologically sensitive areas such as National Parks, Sanctuaries, Tiger Reserves, Reserve Forests
22. Tarred Roads in the Himalayas and or Forest areas.
23. Distilleries.
24. Raw Skins and Hides
25. Pulp, paper and newsprint.
26. Dyes.
27. Cement.
28. Foundries (individual)
29. Electroplating
30. Meta amino phenol

Application form,

1. (a) Name and Address of the project proposed :

(b) Location of the project:

Name of the Place:

District, Tehsil:

Latitude/Longitude:

Nearest Airport/Railway Station :

(c) Alternate sites examined and the reasons for selecting the proposed site:

(d) Does the site conform to stipulated land use as per local land use plan:

2. Objectives of the project:

3. (a) Land Requirement:

Agriculture Land:

Forest land and Density of vegetation.

Other (specify):

(b) (i) Land use in the Catchment within 10 kms radius of the proposed site:

(ii) Topography of the area indicating gradient, aspects and altitude:

(iii) Erodibility classification of the proposed land:

(c) Pollution sources existing in 10 km radius and their impact on quality of air, water and land:

(d) Distance of the nearest National Park/Sanctuary/Biosphere Reserve/Monuments/heritage site/Reserve Forest:

(e) Rehabilitation plan for quarries/borrow areas:

(f) Green belt plan:

(g) Compensatory afforestation plan:

4. Climate and Air Quality:

(a) Windrose at site:

(b) Max/Min/Mean annual temperature:

(c) Frequency of inversion:

(d) Frequency of cyclones/tornadoes/cloud burst:

(e) Ambient air quality data:

(f) Nature & concentration of emission of SPM, Gas (CO, CO₂, NO_x, CH_n etc.) from the project:

5. Water balance:

(a) Water balance at site:

(b) Lean season water availability;

Water Requirement:

(c) Source to be tapped with competing users (River, Lake, Ground, Public supply):

(d) Water quality:

(e) Changes observed in quality and quantity of groundwater in the last years and present charging and extraction details:

(f) (i) Quantum of waste water to be released with treatment details:

(ii) Quantum of quality of water in the receiving body before and after disposal of solid wastes:

(iii) Quantum of waste water to be released on land and type of land:

(g) (i) Details of reservoir water quality with necessary Catchment Treatment Plan:

(ii) Command Area Development Plan:

6. Solid wastes:

(a) Nature and quantity of solid wastes generated

(b) Solid waste disposal method:

7. Noise and Vibrations:

a. Sources of Noise and Vibrations:

b. Ambient noise level:

c. Noise and Vibration control measures proposed:

d. Subsidence problem, if any, with control measures:

8. Power requirement indicating source of supply: Complete environmental details to be furnished separately, if captive power unit proposed:

9. Peak labour force to be deployed giving details of:

Endemic health problems in the area due to waste water/air/soil borne diseases: Health care system existing and proposed:

10. (a) Number of villages and population to be displaced:

(b) Rehabilitation Master Plan:

11. Risk Assessment Report and Disaster Management Plan:

12. (a) Environmental Impact Assessment

(b) Environment Management Plan:

(c) Detailed Feasibility Report:

(d) Duly filled in questionnaire

Report prepared as per guidelines issued by the Central Government of India.

13. Details of Environmental Management Cell:

Composition of Expert Committee

1. The Committees will consist of experts in the following disciplines:

- i. Eco-system Management
- ii. Air/Water Pollution Control
- iii. Water Resource Management
- iv. Flora/Fauna conservation and management
- v. Land Use Planning
- vi. Social Sciences/Rehabilitation
- vii. Project Appraisal
- viii. Ecology
- ix. Environmental Health
- x. Subject Area Specialists
- xi. Representatives of NGOs/persons concerned with environmental issues.

2. The Chairman will be an outstanding and experienced ecologist or environmentalist or technical professional with wide managerial experience in the relevant development sector.

3. The representative of Impact Assessment Agency will act as a Member- Secretary.

4. Chairman and Members will serve in their individual capacities except those specifically nominated as representatives. 5. The Membership of a Committee shall not exceed 15.

Ecological sensitive places

- Eco-Sensitive Zones or Ecologically Fragile Areas are areas within 10 kms around Protected Areas, National Parks and Wildlife Sanctuaries.
- ESZs (Eco-Sensitive Zones) are notified by MoEFCC, (The Ministry of Environment, Forests and Climate Change) Government of India under Environment Protection Act 1986.
- In case of places with sensitive corridors, connectivity and ecologically important patches, crucial for landscape linkage, even area beyond 10 km width can also be included in the eco-sensitive zone.
- The basic aim is to regulate certain activities around National Parks and Wildlife Sanctuaries so as to minimise the negative impacts of such activities on the fragile ecosystem encompassing the protected areas.

International agreements

- With the introduction of forward-thinking concepts such as sustainable development along with a growing global awareness to protect the environment in recent decades, nation states feel an increasing need to participate in international treaties for environmental regulation. There is a particular concern with safeguarding steadily diminishing reserves of natural resources, which can be attained through cooperation among the countries. India is party to many such international agreements concerning the management of the environment. Some of the important agreements are as follows:

➤ **The Antarctic Treaty (Washington, 1959)**

The Antarctic Treaty was framed with the objective that the Antarctic shall continue to be a zone that shall be used for peaceful purposes only and shall not become an object of international discord. The treaty covers the area south of 60°S latitude and is known as the Antarctic Treaty Area (ATA) and imbibes the suspension of territorial claims, prohibition of all military activities in the region, freedom of scientific inquiry, and international co-operation in scientific activities. India signed into the Antarctic Treaty system in 1983 as a Consultative Party Member (CEL, undated).

➤ **Convention on International Trade in Endangered Species of wild fauna and flora (CITES), 1973**

CITES was signed in March 1973 for the regulation of international trade in endangered species of wild flora and fauna. India had signed the agreement in July 1976 and the Director, Wild Life Preservation is India designated CITES Management Authority (MoEF, 2018). Although CITES seeks to prevent and control trade in endangered species, it should not be interpreted as overall conservation of endangered species of flora and fauna.

➤ **Montreal Protocol on Substances that deplete the Ozone Layer (to the Vienna Convention for the Protection of the Ozone Layer), 1987**

Also known popularly as the Montreal Protocol, the protocol set targets aimed at a reduction in the production and consumption of ozone depleting substances (ODS) and came into force in 1989. The protocol also recognizes the obligations of nations in reducing emissions of ODS in terms of financial and technological abilities and identifies countries that are larger contributors than others. The Montreal protocol was adopted by India in September 1992. In order to supplement the protocol, the Ministry of Environment & Forests (MoEF), GoI has formed an Ozone Cell as well as constituted a steering committee on the Montreal Protocol in order to implement the India Country Program (World Bank, undated).

➤ **Basel Convention on Transboundary Movement of Hazardous Wastes, 1989**

Known popularly as the Basel Convention, the convention aims for a reduction in the transboundary movement of hazardous wastes. The Convention sees to it that creation of hazardous wastes is minimized. It also prohibits shipment of hazardous waste to countries unable to dispose of the hazardous waste in an environment-friendly manner. India ratified to the treaty in 1992 and included some provisions of the Basel Convention in The Indian Hazardous Waste Management Rules Act, 1989 (World Bank, undated).

➤ **UN Framework Convention on Climate Change (UNFCCC), 1992**

The UNFCCC aims to regulate greenhouse gas emissions through international co-operation and agreement to bring emissions to a level that that can offset the effects of global warming and climate change. India became a member of the convention in 1992 and went on to ratify it in 1993. As a developing nation (as per the UNFCCC at the time), India was not bound to commitments for mitigation of greenhouse gas emissions. This changed, however, with the Paris Agreement of 2015 whereby India has a commitment to participate in multilateral negotiations under the UNFCCC. In this India has shown leadership in moving ahead with policy frameworks that includes the National Environment Policy (NEP) and the National Action Plan on Climate Change (NAPCC).

➤ **Convention on Biological Diversity, 1992**

The Convention on Biological Diversity (CBD) provides a legally binding framework for the conservation of biodiversity, sustainability in use of biological resources and the equitable sharing of benefits and knowledge that arise in the case of the usage of biological resources. The convention was enforced in 1993 and a complex set of requirements was introduced for nations to ensure the preservation of biodiversity and natural habitats along with their sustainable use.

The Nagoya Protocol was adopted in 2010 to propagate the continued development of the access and benefit sharing framework in the Convention. The Article 6 of the CBD instructs parties to the convention to form national programs and strategies sustainable use and conservation of biodiversity. It also integrates them into national developmental plans and policies (MoEF, 2018). India passed the Biological Diversity Act, 2002 providing a legal framework for addressing biodiversity in the count. India has taken numerous other policy actions following the convention such as participating in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Trade Related Intellectual Property Rights (TRIPS), 1995 including biodiversity conservation in various national legislations.

➤ **Agenda 21**

Agenda 21 is a product of the Earth Summit organized by the United Nations (UN) that took place in Rio de Janeiro, Brazil in 1992 to include stakeholders in a non-binding action plan for achieving sustainable development. The stakeholders included local and national governments, business, international organizations, citizen groups and non-governmental organizations. The international community met again ten years later at the World Summit on Sustainable Development and reviewed developments to forge global partnerships for the implementation of Agenda 21 (World Bank, undated). India is signatory to Agenda 21 and has sought to align various parts of its development infrastructure such as energy, transport, industry, water facilities, climate change policy, forests, biodiversity, ecosystems, marine and coastal management, land policy, agriculture, urban governance and human resource development.

➤ **UN Convention on Desertification, 1994**

The UN Convention on desertification was formulated in 1994 and seeks a bottom-up approach to build international co-operation in combating desertification or addressing policy in regions prone to droughts. The participation of local users of land and non-governmental organization is sought in this convention within policy activities concerned with the regulations for and alleviation of desertification in terms of its related effects. South Asia has a Regional Action Program with seven countries signatory to the convention including India.

Cartagena Protocol on Biosafety

The Cartagena Protocol on Biosafety is a supplement to the Convention on Biological Diversity and provides an international regulatory framework for the safe use, transfer and handling of Living Modified Organisms (LMOs) i.e. genetically modified organisms resulting from biotechnology. The protocol came into force in January 2000 and was the first such protocol of its kind (MoEF, 2018). The protocol was negotiated under the Convention for Biological Diversity and aims to provide protection against the exploits of modern biotechnology. As a part of the Convention on Biological Diversity, India is party to what is also called the Cartagena Protocol on Biosafety as well. Prior Informed Consent, Rotterdam Convention Also known as the Rotterdam Convention, the treaty looks to promote shared responsibility in the trade of hazardous chemicals. It came into force in February 2004. The convention also looks to promote the environmentally safe use of the hazardous chemicals by supporting a national decision making process on their export and import by facilitating information exchange. India ratified the treaty in 2005 (MoEF, undated).

Unit .II. EIA Methodologies

In this Chapter some simple and widely used EIA methods are described along with criteria to be followed for choosing most appropriate method in a given situation.

Environmental attributes.

Many times an EIA analyst or the person charged with the preparation of an EIA report, is faced with a vast quantity of raw and usually unorganized data. Hence, each technique and method for the evaluation of impacts should have the following qualities and characteristics (I):

1. It should be systematic in approach;
2. It should be able to organize a large mass of heterogeneous data;
3. It should be able to quantify the impacts;
4. It should be capable of summarizing the data;
5. It should be able to aggregate the data into sets with the least loss of information because of the aggregations;
6. It should have a good predictive capability;
7. It should extract the salient features, and
8. It should finally be able to display the raw data and the derived information in a meaningful fashion

Criteria for the selection of EIA methodology.

- (a) **Simplicity:** The methodology should be simple so that the available manpower with limited background knowledge can grasp and adopt it without much difficulty.
- (b) **Manpower time and budget constraints:** The methodology should be applied by a small group with a limited budget and under time constraints.
- (c) **Flexibility:** The methodology should be flexible enough to allow for necessary Modifications and changes through the course of the study.

Impact identification,

- (a) **Comprehensiveness :** The methodology should be sufficiently comprehensive to contain all possible options and alternatives and should give enough information on them to facilitate proper decision-making.
- (b) **Specificity:** The methodology should identify specific parameters on which there would be significant impacts.
- (c) **Isolation of project impacts:** The methodology should suggest procedures for Identifying project impacts as distinguished from future environmental changes produced by other causes.
- (d) **Time and duration:** The methodology should be able to identify accurately the location and extent of the impacts on a temporal scale.

impact measurement

- **Commensurate units:** The methodology should have a commensurate set of units so that comparison can be made between alternatives and criteria.
- **Explicit indicators :** The methodology should suggest specific and measurable indicators to be used to qualify impacts on the relevant environmental parameters.
- **Magnitude:** The methodology should provide for the measurement of impact magnitude, defined as the degree of extensiveness of scale of the impact, as distinct from impact importance, defined as the weighting of the degree of significance of the impact.
- **Objective criteria:** It should be based on objective criteria and the criteria should be stated explicitly.

impact interpretation & Evaluation,

- **Significance:** The methodology should be able to assess the significance of measured impacts on a local, regional and national scale.
- **Explicit criteria :** The criteria and assumptions employed to determine impact Significance should be explicitly stated.
- **Portrayal of "with" and without 'situation:** The methodology should be able to Aggregate the vast amounts of information and raw input data.
- **Uncertainty:** Uncertainty of possible impacts is a very real problem in environmental impact assessment. The methodology should be able to take this aspect into account.
- **Risk:** The methodology should identify impacts that have low probability of occurrence but a high potential for damage and loss.
- **Depth of analysis:** The conclusions derived from the methodology should be able to provide sufficient depth of analysis and in still confidence in the users, including the general public.
- **Alterative comparison:** It should provide a sufficiently detailed and complete Comparison of the various alternatives readily available for the project under study.
- **Public involvement:** The methodology should suggest a mechanism for public involvement in the interpretation of the impacts and their significance.

Impact Communication

- **Affected parties:** The methodology should provide a mechanism for linking impacts to specific effected geographical or social groups.
- **Setting description:** It should provide a description of the project setting to aid the users in developing an adequately comprehensive overall perspective.
- **Summary format:** It should provide the results of the impact analysis summarized in a format that will give the users, who range from the lay public to the decision makers, sufficient details to understand it and have confidence in its assessment.
- **Key issue :** It should provide a format for highlighting the key issues and impacts identified in the analysis.
- **Compliance:** One of the most important factors in choosing a methodology is whether it is able to comply with the terms of referel1Ce established by the controlling agency.

Adhoc Methods

Ad hoc methods indicate broad areas of possible impacts by listing composite environmental parameters (Ex: flora and fauna) likely to be affected by the proposed activity. These methods involve assembling a team of specialists who identify impacts in their area of expertise. Here, each parameter is considered separately and the natures of impacts (long term or short term, reversible or irreversible) are considered. These methods give a rough assessment of total impact while giving the broad areas and the general nature of possible impacts. In this method, the assessor relies on an intuitive approach and makes a broad-based qualitative assessment. This method serves as a preliminary assessment and helps in identification of important areas like: Wildlife

1. Endangered species
2. Natural vegetation
3. Exotic vegetation
4. Grazing
5. Social characteristics
6. Natural drainage
7. Groundwater
8. Noise
9. Air quality
10. Visual description and services
11. Open space
12. Recreation
13. Health and safety
14. Economic values and
15. Public facilities

Types of Ad hoc method are:

- a) Opinion poll
- b) Expert opinion and
- c) Delphi methods

This method is very simple and can be performed without any training. It does not involve any relative weighting or any cause-effect relationship. It provides minimal guidance for impact analysis while suggesting broad areas for possible impacts. Moreover, it does not even state the actual impacts on specific parameters that will be affected.

The drawbacks of this method are listed below:

1. It gives no assurance that a comprehensive set of all relevant impacts have been studied.
2. Analysis using this method lacks consistency as it different criteria are selectively evaluated by different groups.

It is blatantly inefficient as it requires a considerable effort to identify and assemble a panel for each assessment

Matrices Method

This methodology provides a framework of interaction of different activities of a project with potential environmental impacts caused by them. A simple interaction matrix is formed when project actions are listed on one axis (usually vertical) and environmental impacts are listed along the other axis. This technique was pioneered by Leopold et al in 1971. It lists about 100 project actions and about 88 environmental characteristics and conditions. An example of this matrix is shown below:

Importance of Matrices

- Matrices are two dimensional tables.
- These facilitate the identification of impacts arising from the interaction between project activities and specific environmental components.
- The entries of the cell of the matrix can be either qualitative or quantitative estimates of impact.

Simple Matrix

Simple environmental impact matrix for the Phoenix Pulp Mill (*source: Lohani and Halim, 1983*).

Environmental Components	Project Activities								
	Plant Construction	Farming of Kenaf	Use of Pesticide Fertilizer	Transport of Raw Materials	Water Intake	Solid Waste	Effluent Discharge	Emissions	Employment
Surface Water Quality			x			x	x		x
Surface Water Hydrology					x				
Air Quality				x				x	
Fisheries			x				x		
Terrestrial Wildlife Habitat	x								
Terrestrial Wildlife	x								
Land Use Pattern		x							
Highways/Railways				x					
Water Supply			x				x		
Agriculture		x							
Housing									x
Health						x	x	x	
Socioeconomic									x

Leopold Matrices

- Identify all actions that are part of the proposed project
- Under the each of the proposed actions, place a slash at the inter-section with each item on the side of the matrix if an impact is possible.

	a	b	c	d
a	/	/	/	
a				
c				

- In the upper left hand corner of each box with a slash, place a number from 1 to 10 which indicates the MAGNITUDE of the possible impact.

- 10 represent the greatest magnitude of impact.
- 1 is the least magnitude of impact (no zeroes).
- Before each number place + (if the impact would be beneficial).
- In the lower right hand corner of the box place a number from 1 to 10 which indicates the IMPORTANCE of the possible impact (Eg. Regional vs. Local).
- 10 represents the greatest importance and 1 the least (no zeroes).

	a	b	c	d
a	-1 / 3	+5 / 8		
b				
c				

Advantages:

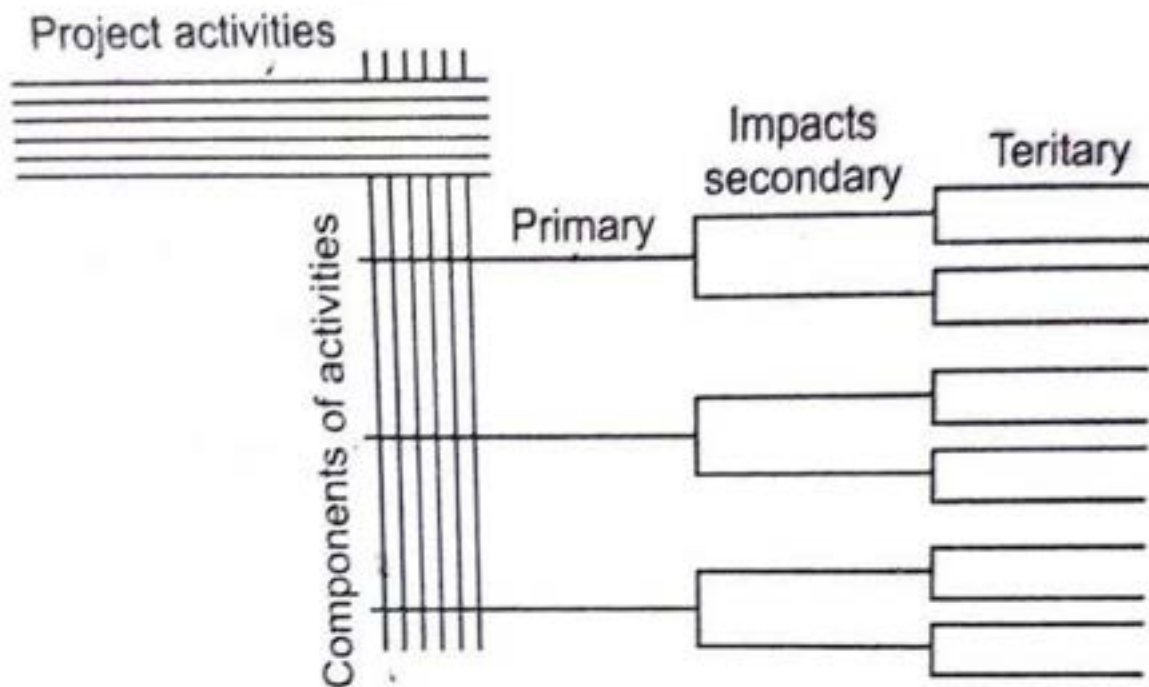
The matrix method is that it links action to impact
This is a very good method for displaying EIA result.

Disadvantages:

It is difficult to distinguish between direct and indirect impacts using this method.
There is potential for double-counting of impacts.
It is qualitative in nature and does not refer to quantity of impact.

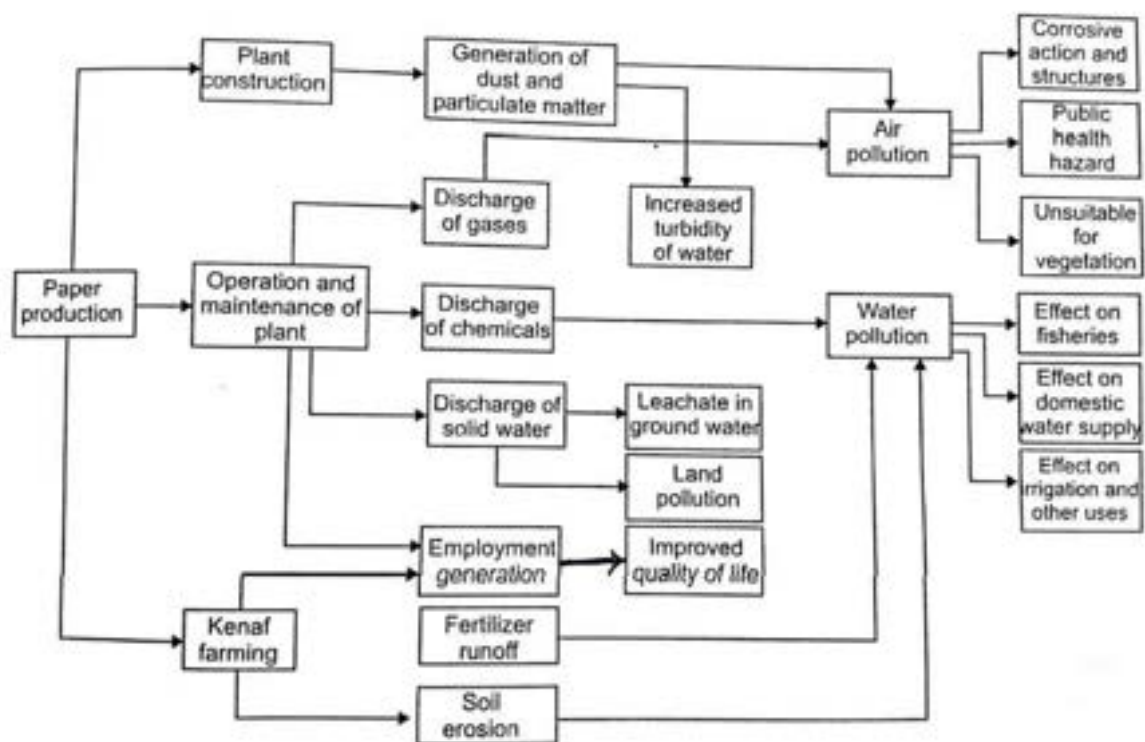
Network Method

1. This method uses the matrix approach and extends it to include both the primary as well as the secondary impacts.
2. It is shown in the form of a tree called impact tree. This diagram is also called as reference or sequence diagram.
3. Identification of direct, indirect along with short, long term impact is a crucial and basic step of making an impact tree.
4. The impact tree is used to identify cause-effect linkages.
5. The impact tree is a visual description of linkages.



Conceptual model of impact networks.

Example



Network of pulpmill impacts.

Advantages:

- It links action to impact.
- It is useful to check second order impacts in a simplified form.
- It handles direct and indirect impacts.

Disadvantages:

- It becomes overly complex if used beyond simplified version.
- It is completely qualitative in nature.

Overlays Method

1. Overlay methods involve preparation of a set of transparent maps, which represent the spatial distribution of environmental characteristics (e.g., Extent of dense forest area).
2. Information on wide range of variables will be collected for standard geographical units within the study area which will be recorded on series of maps typically one for each variable.
3. These maps will be overlaid to produce a composite.
4. The resulting composite maps characterize the area's physical, social, ecological, land use and other relevant characteristics relative to the location of the proposed development.

5. To evaluate the degree of associated impacts many project alternatives can be located on the final map and validity of the assessment will be related to the type and number of parameters chosen.

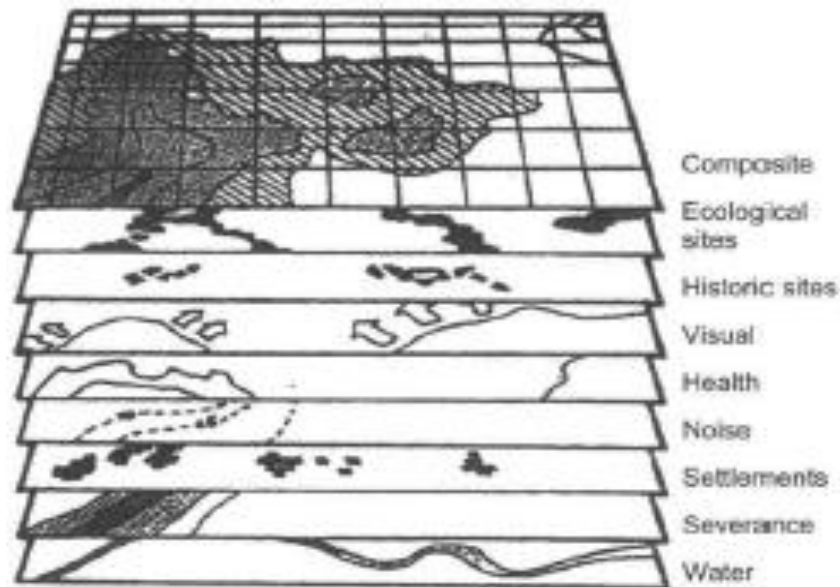


Fig. 2.8 Presentation of array of variables in overlay method.

Source: Wathern 1988

6. Normally to have some clarity the number of parameters that can be over layed in a transparency map is limited to 10.
7. These methods are widely used for assessing visually the changes in the landscape before and after the activity.
8. Secondly it can be used for preparing combined mapping with an analysis of sensitive areas or ecological carrying capacity.
9. As these methods are spatially oriented they can very clearly show the spatial aspects of cumulative impacts.
10. These maps are overlaid to produce a composite characterization of the regional environment.
11. Impacts are identified by noting the impacted environmental characteristics lying within the project boundaries.
12. The approach seems most useful as a method of screening alternative project sites or routes, before detailed impact analysis.
13. Overlays can be useful for industrial EIA of any project for comparing land capabilities existing and projected land uses, road route alternatives and other under parameters, and alternative levels of air quality conditions along with pollution control.

Advantages:

- It is easy to understand and use
- It has a good display
- It is good for setting site selection

Disadvantages

- The overlay method can accommodate both qualitative and quantitative data.
- The weakness of the overlay method is that it is only moderate comprehensive, because there is no mechanism that requires consideration of all potential impacts.
- There is no provision for quantification and measurement of the impacts nor is it assured that all impacts will be covered.
- The overlay approach is generally effective for selecting alternatives and identifying certain types of impacts; however, it cannot be used to quantify impacts to identify secondary and tertiary interrelationships.

Checklists methods:

Checklists are standard lists of the types of impacts associated with a particular type of project. Checklists methods are primarily for organizing information or ensuring that no potential impact is overlooked. They are a more formalized version of adhoc approaches in that specific areas of impact are listed and instructions are supplied for impact identification and evaluation. Sophisticated checklists include: 1) scaling checklists in which the listed impacts are ranked in order of magnitude or severity, and 2) weighting-scaling checklists, in which numerous environmental parameters are weighted (using expert judgment), and an index is then calculated to serve as a measure for comparing project alternatives.

There are four general types of checklists:

1. **Simple Checklist:** a list of environmental parameters with no guidelines on how they are to be measured and interpreted.
2. **Descriptive Checklist:** includes an identification of environmental parameters and guidelines on how to measure data on particular parameters.
3. **Scaling Checklist:** similar to a descriptive checklist, but with additional information on subjective scaling of the parameters.
4. **Scaling Weighting Checklist:** similar to a scaling checklist, with additional information for the subjective evaluation of each parameter with respect to all the other parameters.

Varying levels of information and expertise are required to prepare checklists. Simple checklists may require only a generalized knowledge of the environmental parameters likely to be affected, and access to an information base. Alternatively, simple checklist methods can be used to summarize the results of an EIA. Scaling weighted checklists are likely to require more expertise to prepare.

There are several major reasons for using checklists:

- they are useful in summarizing information to make it accessible to specialists from other fields, or to decision makers who may have a limited amount of technical knowledge;
- scaling checklists provide a preliminary level of analysis; and
- Weighting is a mechanism for incorporating information about ecosystem functions.

EIA review

The quality of environmental impact statements (EIS) is a subject of increasing concern. Review of EISs provides an important mechanism for checking the quality of documentation and, by extension, the effectiveness of the approach taken in the impact. Topic 1 introduced the concept of the full EIA review process. This Topic looks in detail at the EIA review process, and the tools and steps to achieve an unbiased review of an EIS.

Baseline Conditions

A description of the environment as it is currently and as it could be expected to develop if the project were not to proceed is very important. Some baseline data can be gathered from existing data sources, but some will need gathering and the methods used to obtain the information should be clearly identified. Baseline data should be gathered in such a way that the importance of the particular area to be affected can be placed into the context of the region or surroundings and that the effect of the proposed changes can be predicted.

Construction Stage Impacts, post project impacts.

The methodology used to define the project specifications should be clearly outlined, including details of consultation with expert bodies and the public, and reference to panels of experts, guidelines, checklists, matrices, previous best practice examples of environmental assessments on similar projects.

Consideration should be given to impacts which may be positive or negative, cumulative, short or long term, permanent or temporary, direct or indirect. The logic used to identify the key impacts for investigation and for the rejection of others should be clearly explained. The impacts of the development on human beings, flora and fauna, soil, water, air, climate, landscape, material assets, cultural heritage, or their interaction, should be considered.

UNIT- III

Environmental Management Plan

EMP preparation

- Every industrial development is associated with the positive and negative impacts on environmental components.
- Though the probable negative impacts cannot be nullified completely the much required developmental activities cannot be impeded. Environmental Impact Assessment helps in identifying potential environmental impacts of a proposed project activity.
- Based on the finding of the impact assessment, Environment Management Plan is devised to minimize the adverse impacts and enumerate various steps to be taken for improvement of the environment.
- Environmental Management Plan helps in formulation, implementation and monitoring of environmental parameters during & commissioning of project.
- Environment Management Plan (EMP) is the tool to ensure a safe and clean environment.
- A project may have identified proper mitigation measures but without a management plan to execute it, the desired results may not be obtained.
- The Environment Management Plan envisages proper implementation of mitigation measures to reduce the adverse impacts arising out of the project activities.

Monitoring Environmental Management Plan

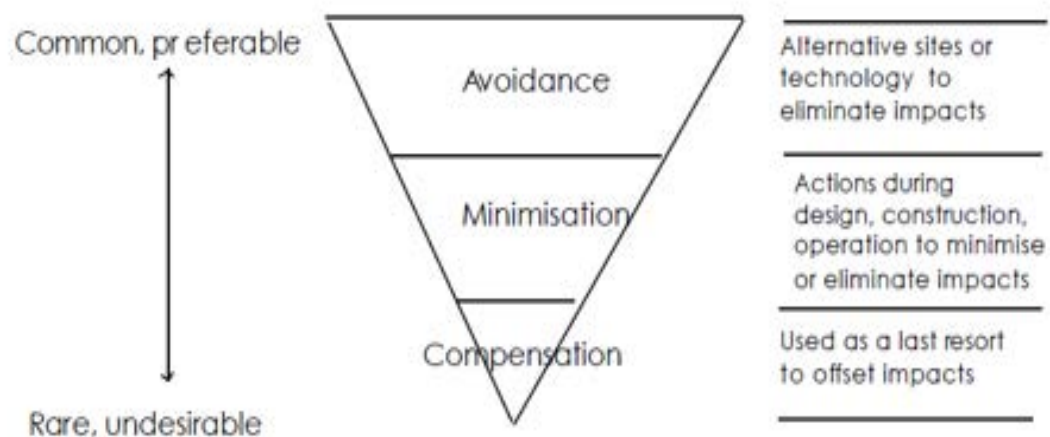
- The Environment Management Plan (EMP) would consist of all mitigation measures for each item wise activity to be undertaken during the construction, operation and the entire life cycle to minimize adverse environmental impacts resulting from the activities of the project.
- It would also delineate the environmental monitoring plan for compliance of various environmental regulations. It will state the steps to be taken in case of emergency such as accidents at the sites including fire.
- The Environment Management Plan (EMP) is aimed at mitigating the possible adverse impacts of a project and for ensuring to maintain the existing environmental quality.
- The Environment Management Plan (EMP) will be site specific plan developed to ensure that the project is implemented in an environmental sustainable manner where all contractors and sub contractors, including consultants, understand the potential environmental risks arising from the proposed project and take appropriate actions to properly manage the risk.
- The main objective of the Environmental Management Plan (EMP) is to identify the project specific activities that would have to be considered for investigation of the significant adverse impacts and the mitigation measures required.
- EMP will also ensure that the project implementation is carried out in accordance with the design by taking appropriate mitigate actions to reduce adverse environmental impacts during its life cycle.
- The plan will outline existing and potential problems that may adversely impact the environment and recommends corrective measures where required.
- Also, the plan will outline roles and responsibility of the key personnel and contractors who are charged with the responsibility to manage the project site. While evolving effective and feasible EMP, many parameters are considered on the basis of technological as well as economical aspects.

Identification of Significant or Unacceptable Impacts Requiring Mitigation

- The purpose of mitigation is to identify measures that safeguard the environment and the community affected by the proposal. Mitigation is both a creative and practical phase of the EIA process. It seeks to find the best ways and means of avoiding, minimising and remedying impacts.
- Mitigation measures must be translated into action in the correct way and at the right time if they are to be successful. This process is referred to as impact Management and takes place during project implementation. A written plan should be prepared for this purpose, and includes a schedule of agreed Actions.
- Mitigation is a critical component of the EIA process. It aims to prevent adverse impacts from happening and to keep those that do occur within an Acceptable level. Opportunities for impact mitigation will occur throughout The project cycle.
- The objectives of mitigation are to:
 - find better alternatives and ways of doing things;
 - enhance the environmental and social benefits of a proposal;
 - avoid, minimise or remedy adverse impacts; and
 - ensure that residual adverse impacts are kept within acceptable levels.
- Early links should be established between the EIA and project design teams to Identify mitigation opportunities and incorporate them into consideration of Alternatives and design options.
- In practice, mitigation is emphasised in the EIA process once the extent of the potential impact of a proposal is reasonably well understood.
- This typically takes place following impact identification and prediction, and recommended measures for mitigation will be an important part of the EIA report.
- Usually, these measures will be incorporated into the terms and conditions of project approval and implemented during the impact management stage of the EIA process.
- The objectives of impact management are to:
 - ensure that mitigation measures are implemented;
 - establish systems and procedures for this purpose;
 - monitor the effectiveness of mitigation measures; and
 - take any necessary action when unforeseen impacts occur.

Mitigation Plans and Relief & Rehabilitation

A three-step process of mitigation can be applied to relate the hierarchy of elements in Figure 1 to the stages of the EIA process when they are typically applied. Generally, as project design becomes more detailed, the opportunities for impact avoidance narrow and the concern is to minimise and compensate for unavoidable impacts. However, these distinctions are not rigid and opportunities for creative mitigation should be sought at all stages of EIA and project planning.



The elements of mitigation

Step One: Impact avoidance. This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts;
- avoiding areas that are environmentally sensitive; and
- putting in place preventative measures to stop adverse impacts from occurring, for example, release of water from a reservoir to maintain a fisheries regime.

Step Two: Impact minimisation. This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal;
- redesigning elements of the project; and
- taking supplementary measures to manage the impacts.

Step Three: Impact compensation. This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement and restocking fish;
- restoration of the affected site or environment to its previous state or better, as typically required for mine sites, forestry roads and seismic lines; and
- replacement of the same resource values at another location, for example, by wetland engineering to provide an equivalent area to that lost to drainage or infill.

Depending on the timing of the project cycle and the nature of impacts, a number of approaches can be taken to achieve the objectives of mitigation.

These include:

- developing environmentally better alternatives to the proposal;
- making changes to project planning and design;
- carrying out impact monitoring and management; and
- compensating for impacts by
 - monetary payment
 - in kind measures
 - site remediation bonds
 - a resettlement plan.

Major adverse impacts	Mitigating measure
Displacement of existing land uses	<p>Ensure that due consideration is given to the proper trade-offs between land values for housing and those of other uses, such as prime farmland, forests or natural habitats of value to society as a whole.</p> <p>Review existing planning and design standards to ensure that they are suited to local conditions and not unnecessarily wasteful of land.</p> <p>Make any necessary changes, for example by drafting new regulations</p>
Destruction of environmentally critical areas	<p>Ensure that regionally critical environmental sites, such as forested areas, major bodies and wetlands, habitats containing rare and endangered species, etc., are identified and not threatened by project location.</p> <p>Identify mitigation measures to avoid, reduce or compensate for environmental impacts and to enhance the environmental and community benefits of the proposal.</p>

Stipulating the Conditions:

Following are the general environmental safeguards /conditions stipulated by the government of India for implementation by the project proponents for maintaining the environmental and ecological balance in the concerned area:

- (i) Proper resettlement and rehabilitation of the project affected persons.
- (ii) Free fuel supply to be provided to the labour force at the project cost.
- (iii) Restoration of construction area to be ensured by levelling, filling of borrow pits and land escaping. Necessary soil conservation measures during construction of roads.
- (iv) Afforestation/compensatory afforestation.
- (v) Categorization of the sub-watersheds of the entire catchment contributing at the water storage/diversion site into various soil erosion classes following the Silt Yield Index (SYI) method of the All India Soil and Land Use Survey (AISLUS) and consider sub-watersheds falling under 'very high' and 'high' classes for developing catchment area treatment plan. The execution of the CAT plan at least over the directly raining catchment must be completed before filling up the reservoir or before water diversion starts, respectively, in the cases of reservoir and run-off-the-river schemes. The sub-watersheds under very high and high erosion categories that are outside the directly draining catchment may be brought under CAT in a phased manner within five years from the year when the reservoir is filled/water diversion starts, respectively, in reservoir/run-off-the-river schemes. The project budget may have adequate provision for planning and executing CAT activities.
- (vi) Adequate arrangement to prevent incidence of any endemic health problems due to water/soil borne diseases.
- (vii) Providing drinking water attracts Priority No. 1 under the National Water Policy (2002) of the Govt of India. In deference to this declared policy of the GoI and in view of the hardship faced by people in fetching safe drinking water, both in hills as well as in the plains, and also as a goodwill gesture to the community surrounding the project area, the applicant shall consider allocating certain amount of need based water from the water resource developed for the project for drinking water purpose. This will be in addition to the water allocated for drinking for the project staff, contractual work force, etc.
- (viii) A multidisciplinary Environmental Management Cell to be constituted by the State Govt. in consultation with the MOEF with inclusion of experts from the disciplines such as forestry, ecology, wildlife, social science etc. to oversee the effective implementation of suggested environmental measures.

(ix) Adequate and separate budget for the environmental management, including Plans for Biodiversity Management, Fisheries Management, Wildlife Management, Conservation/Rehabilitation of RET species, etc.

Monitoring Methods:

The purpose of monitoring is to compare pre- and post project conditions in the development site. It also compares the predicted and actual impacts. This is especially important in key impacts like water quality, air quality, soil fertility, endangered species, etc.

Impact/effect monitoring- This analyses the direct relationship between the environmental impact and the effect it causes. It includes magnitude, extent and intensity.

Baseline monitoring- This is one type of monitoring that is done *before* the commencement of the project. Baseline monitoring gives us data that is to be included as pre-project status of the site. For example, air quality baseline data monitoring requires the team to monitor the air at all strategic locations on the site for 14 consecutive days prior to the commissioning of the work. This allows them to obtain dust samples every 24 hours.

Mitigation monitoring- This is the monitoring of the effectiveness of the mitigation measures. It assesses all mitigation measures, be it implementation, design, technology, etc.

Compliance monitoring- This is an all-encompassing monitoring method where we assess if the predicted values are in compliance with the actual values. It could include mitigation monitoring and impact/effect monitoring within it.

Pre- Appraisal and Appraisal

(i).Appraisal means the detailed scrutiny by the Expert Appraisal Committee or State Level Expert Appraisal Committee of the application and other documents like DPR, the Final EIA and EMP Report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of environmental clearance. This appraisal shall be made by Expert Appraisal Committee or State Level Expert Appraisal Committee concerned in a transparent manner in a proceeding to which the applicant shall be invited for furnishing necessary clarifications in person or through an authorized representative.

On conclusion of this proceeding, the Expert Appraisal Committee or State Level Expert Appraisal Committee concerned shall make categorical recommendations to the regulatory authority concerned either for grant of prior environmental clearance on stipulated terms and conditions, or rejection of the application for prior environmental clearance, together with reasons for the same.

The EAC or the SEIAA, as is relevant, may also direct the applicant to re-do some of the components of the EIA study without changing the TOR or improve upon the EMP document if they are found wanting in certain respects.

(ii) The appraisal of all projects or activities which are not required to undergo public consultation, or submit an Environment Impact Assessment report, shall be carried out on the basis of the prescribed application Form 1, any other relevant validated information available and the site visit wherever the same is considered as necessary by the Expert Appraisal Committee or State Level Expert Appraisal Committee concerned.

(iii) The appraisal of an application shall be completed by the Expert Appraisal Committee or State Level Expert Appraisal Committee concerned within 60 days of the receipt of the final Environment Impact Assessment report, Environmental Management Plan and other documents or the receipt of Form 1, where public consultation is not necessary and the recommendations of the Expert Appraisal Committee or State Level Expert Appraisal Committee shall be placed before the competent authority for a final decision within the next 15 days. The prescribed procedure for appraisal is given in Appendix V ;-.

UNIT- IV

Environmental Legislation and Life cycle Assessment

Environmental laws and protection acts:

Environmental laws are an important part of any governance body. It comprises a set of laws and regulations concerning air quality, water quality, and other aspects of the environment.

The environmental laws in India are guided by environmental legal principles and focus on the management of specific natural resources, such as forests, minerals, or fisheries.

The environmental laws in India are a direct reflection of what was envisaged in the constitution. The need for protection and conservation of the environment and sustainable use of natural resources is reflected in the constitutional framework of India and also in the international commitments of India.

Constitutional provisions-powers and functions of Central and State government

At national level serious efforts have been made for the improvement and protection of environment by incorporating changes the constitution of India. Our constitution, originally, did not contain any direct provision regarding the protection of natural environment. However, after the United Nations Conference on Human Environment, held in Stockholm in 1972. Indian constitution was amended to include protection of the environment as a constitutional mandate.

The forty second amendment Clause (g) to Article 51A of the Indian constitution made it a fundamental duty to protect and improve the natural environment.

“It shall to be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and have compassion for living creatures.”

There is a directive, given to the State as one of the Directive Principles of State Policy regarding the protection and improvement of the environment. Article 48A states “The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country”.

The department of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985. This Ministry has overall responsibility for administering and enforcing environmental legislations and policies.

The constitutional provisions are backed by a number of legislations – Acts and rules. Most of our environmental legislations are Acts of the Parliament or the State Legislatures. These Acts generally delegate powers to regulating agencies, to make rules for the purpose of their implementation. The Environment Protection Act of 1986 (EPA) came into force soon after the Bhopal Gas Tragedy and is considered umbrella legislation as it fills many lacunae in the existing legislations. Thereafter, a large number of environmental legislations have been passed to deal with specific environmental problems. For example in the recent past the use of CNG for public transport vehicles has been made mandatory in Delhi. This has reduced air pollution in Delhi.

The Environment (Protection) Act 1986:

The most important legislation in this category is The Environment (Protection) Act of 1986. Through this Act Central Government gets full power for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating pollution. Details of this Act are given below:

In the wake of the Bhopal tragedy, the government of India enacted the Environment (Protection) Act of 1986. The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environment of 1972, in so far as they relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property. The Act is an “umbrella” for legislations designed to provide a framework for Central Government, coordination of the activities of various central and state authorities established under previous Acts, such as the Water Act and the Air Act.

In this Act, main emphasis is given to “Environment”, defined to include water, air and land and the inter-relationships which exist among water, air and land and human beings and other living creatures, plants, micro-organisms and property. “Environmental pollution” is the presence of pollutant, defined as any solid, liquid or gaseous substance present in such a concentration as may be or may tend to be injurious to the environment.

“Hazardous substances” include any substance or preparation, which may cause harm to human beings, other living creatures, plants, microorganisms, property or the environment.

The main provisions of this Act are given below:

Section 3 (1) of the Act empowers the centre to “take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution”. Specifically, the Central Government is authorized to set new national standards for the quality of the environment (ambient standards) as well as standards for controlling emissions and effluent discharges; to regulate industrial locations, to prescribe procedures for managing hazardous substances; to establish safeguards preventing accidents, and to collect and dismantle information regarding environmental pollution

- By virtue of this Act, Central Government has armed itself with considerable powers which include, coordination of action by state, planning and execution of nationwide programmes, laying down environmental quality standards, especially those governing emission or discharge of environmental pollutants, placing restriction on the location of industries and so on.
- The coverage of powers include handling of hazardous substances, prevention of environmental accidents, inspection of polluting units, research, establishment of laboratories, dissemination of information, etc.
- The Environment (Protection) Act was the first environmental legislation to give the Central Government authority to issue direct orders, included orders to close, prohibit or regulate any industry, operation or process or to stop or regulate the supply of electricity, water or any other service to an industry, operation and process. Another power granted to the Central Government was to ensure compliance with the Act which included the power of entry for examination, testing of equipment and other purposes and power to analyze the sample of air, water, soil or any other substance from any place.
- The Act explicitly prohibits discharges of environmental pollutants in excess of prescribed regulatory standards. There is also a specific prohibition against handling hazardous substances except those in compliance with regulatory procedures and standards. Persons responsible for discharge of pollutants in excess of prescribed standards must prevent or mitigate the pollution and must also to report the governmental authorities.
- The Act provides provision for penalties. Any person who fails to comply with any of the provisions of the Act, or the rules, orders, or directions issued under the Act shall be punished. For each failure or contravention the punishment included a prison term up to five years or fine up to Rs. 1 lakh, or both. The Act imposed an additional fine of up to Rs. 5,000 for every day of continuing violation. If a failure or contravention, occurs for more than one year after the date of conviction, an offender may punished with imprisonment term, which may be extend to seven years.
- The Environment (Protection) Act contains significant innovations for its enforcement, not contained in any other pollution control legislation at the time of the Act's adoption. Section 19 provides that any person, in addition to authorized government officials, may file a complaint with a court alleging an offence under the Act. This "Citizens' Suit" provision requires that the person has to give notice of not less than 60 days of the alleged offence of pollution to the Central Government or the competent authority. Under the Act, the Central Government may, by notification in the office Gazette, make rules for the enforcement of the Act.

The Water Act 1974:

The main objective of this act is to provide prevention and control of water pollution and maintaining or restoring of wholesomeness and purity of water (in the streams or wells or on land). Some important provisions of this Act are given below:

- The Act vests regulatory authority in State Pollution Control Boards and empowers these Boards to establish and enforce effluent standards for factories discharging pollutants into water bodies. A Central Pollution Control Board performs the same functions for Union Territories and formulates policies and coordinates activities of different State Boards.
- The State Pollution Control Boards control sewage and industrial effluent discharges by approving, rejecting or impose conditions while granting consent to discharge.
- The Act grants power to the Board to ensure compliance with the Act by including the power of entry for examination, testing of equipment and other purposes and power to take the sample for the purpose of analysis of water from any stream or well or sample of any sewage or trade effluents.
- Prior to its amendment in 1988, enforcement under the Water Act was achieved through criminal prosecutions initiated by the Boards, and through applications to magistrates for injunctions to restrain polluters. The 1988 amendment strengthened the Act's implementation the pollution provisions. Board may close a defaulting industrial plant or withdraw its supply of power or water by an administrative order; the penalties are more stringent, and a citizen's suit provision supports the enforcement machinery.

The Water (Prevention and Control of Pollution) Cess Act of 1977

The Water Cess Act was passed to generate financial resources to meet expenses of the Central and State Pollution Boards. The Act creates economic incentives for pollution control and requires local authorities and certain designated industries to pay a cess (tax) for water effluent discharge.

These revenues are used to implement the Water Act. The Central Government, after deducting the expenses of collection, pays the central board and the states such sums, as it seems necessary. To encourage capital investment in pollution control, the Act gives a polluter a 70% rebate of the applicable cess upon installing effluent treatment equipment.

The Air act 1981:

To implement the decisions taken at the United Nations Conference on the Human Environment held at Stockholm in June 1972, Parliament enacted the nationwide Air Act. The main objectives of this Act are to improve the quality of air and to prevent, control and abate air pollution in the country. Important provisions of this Act are given below:

- The Air Act's framework is similar to that of the Water Act of 1974. To enable an integrated approach to environmental problems, the Air Act expanded the authority of the central and state boards established under the Water Act, to include air pollution control.
- States not having water pollution boards were required to set up air pollution boards.
- Under the Air Act, all industries operating within designated air pollution control areas must obtain a "consent" (permit) from the State Boards.
- The states are required to prescribe emission standards for industry and automobiles after consulting the central board and noting its ambient air quality standards.
- Act granted power to the Board to ensure compliance with the Act including the power of entry for examination, testing of equipment and other purposes and power to take the sample for the purpose of analysis of air or emission from any chimney, fly ash or dust or any other outlet in such a manner as may be prescribed.
- Prior to its amendment in 1987, the Air Act was enforced through mild court-administered penalties on violations. The 1987 amendment strengthened the enforcement machinery and introduced stiffer penalties. Now, the boards may close down a defaulting industrial plant or may stop its supply of electricity or water. A board may also apply to the court to restrain emissions that exceed prescribed limits. Notably, the 1987 amendment introduced a citizen's suit provision into the Air Act and extended the Act to include noise pollution.

Wild Life act 1972:

In 1972, Parliament enacted the Wild Life Act (Protection) Act. The Wild Life Act provides for state wildlife advisory boards, regulations for hunting wild animals and birds, establishment of sanctuaries and national parks, regulations for trade in wild animals, animal products and trophies, and judicially imposed penalties for violating the Act. Harming endangered species listed in Schedule 1 of the Act is prohibited throughout India. Hunting species, like those requiring special protection (Schedule II), big game (Schedule III), and small game (Schedule IV), is regulated through licensing. A few species classified as vermin (Schedule V), may be hunted without restrictions. Wildlife wardens and their staff administer the act.

An amendment to the Act in 1982, introduced a provision permitting the capture and transportation of wild animals for the scientific management of animal population.

India is a signatory to the Convention of International Trade in Endangered Species of Fauna and Flora (CITES, 1976). Under this convention, export or import of endangered species and their products are governed by the conditions and stipulations laid down therein. Indian government has also started some conservation projects for individual endangered species like Hungal (1970), Lion (1972), Tiger (1973), Crocodiles (1974), Brown-antlered Deer (1981) and Elephant (1991-92).

Guidelines for control of noise:

Noise pollution could be controlled by either reducing the noise at the source or by preventing its transmission.

The first step in the prevention of noise pollution is to control the noise at source itself. for eg: Lubrication of machines reduce the noise produced, Tightening the loose nuts, Reducing the vibrations produced by machines etc...

Failing to control the noise at its source, the second step is to prevent its transmission for eg: keeping the noise machine covered in an enclosure so that the sound does not escape and reach the receivers, construction of noise barriers on road sides, sound proof the buildings by using heavy curtains on the windows, acoustical tiles on the ceiling and walls, by sealing the cracks in the walls to reduce the noise coming from outside.

If the noise levels are not able to bring down to the desired levels in some cases, the only alternative is to follow

- 1.Avoiding horns except in emergency situations.
- 2.Sound proof or eco-generators and Turning down the volume of stereos.
- 3.Conducting the awareness programs .

loss of biodiversity:

- The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.
- The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years.
- Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger.
- The last twenty years alone have witnessed the disappearance of 27 species.

The biological wealth of the planet has been declining rapidly. Important causes are:

Natural causes: like floods, earthquakes and other natural disasters.

Habitat loss and fragmentation: This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from tropical rain forests. Once covering more than 14 per cent of the earth's land surface, these rain forests now cover no more than 6 per cent.

Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are broken up into small fragments due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to decline of population. Habitat loss is caused by deforestation, over-population, pollution, global warming etc.

Over-exploitation: Over-hunting, over-fishing or over-collecting of a species can quickly lead to its decline. Changing consumption patterns of humans is often cited as the key reason for this unsustainable exploitation of natural resources. Many species extinctions in the last 500 years (Steller's sea cow, passenger pigeon) were due to overexploitation by humans.

solid and Hazardous waste management rules.

It is a waste that makes it dangerous to human health or the environment. Hazardous wastes can be liquids, solids, gases or sludges.

Hazardous waste is defined based on physical or chemical properties of toxicity, reactivity, ignitability, and corrosivity of wastes.

Toxic wastes: these are harmful when a toxic substance combines with groundwater.

reactive wastes: Lithium-sulphur batteries; gun powder; nitro-glycerine; explosives etc causes explosions, when heated or compressed or mixed with water.

Ignitable wastes: gasoline, paint thinners, alcohol, waste oils.

corrosive wastes: Acids, drums and barrels.

Hazardous waste is regulated under the Resource Conservation and Recovery Act (RCRA) - Subtitle C. The hazardous waste are listed into three categories:

The F- list (waste generate in non-specific units at source points) : Wastes generate during manufacturing of substances in industries such as solvents that have been used in cleaning operations.

The K – list (waste generate in specific units at source points): Wastes generate from specific industries such as petroleum refinery or pesticide manufacturing units.

The P – list and the U – list (discarded products): Wastes include specific commercial chemical products in an unused form. Some pesticides and some pharmaceutical products become hazardous waste when discarded. Wastes included on the P- and U-lists can be found in the regulations at 40 CFR - 261.33 .

Handling Rules: Where an accident occurs at the hazardous waste site or during transportation of hazardous wastes, the occupier or operator of a facility shall report immediately to the State Pollution Control Board about accident in.

Life cycle assessment:

Environmental assessment is a procedure that ensures that the environmental implications of decisions are taken into account before the decisions are made. Environmental assessment can be undertaken for individual projects, such as a dam, motorway, airport or factory, on the basis of Directive 2011/92/EU (known as 'Environmental Impact Assessment' – EIA Directive) or for public plans or programmes on the basis of Directive 2001/42/EC (known as 'Strategic Environmental Assessment' – SEA Directive). The common principle of both Directives is to ensure that plans, programmes and projects likely to have significant effects on the environment are made subject to an environmental assessment, prior to their approval or authorisation. Consultation with the public is a key feature of environmental assessment procedures.

Life cycle analysis

Life cycle assessment (LCA) involves the evaluation of some aspects - often the environmental aspects - of a product system through all stages of its life cycle. Sometimes also called "life cycle analysis", "life cycle approach", "cradle to grave analysis" or "Eco balance", it represents a rapidly emerging family of tools and techniques designed to help in environmental management and, longer term, in sustainable development.

Methodology

LCA methodologies were originally developed to create decision support tools for distinguishing between products, product systems, or services on environmental grounds (Throughout the chapter, the term "product" is used as a synonym for both products, product systems, and services). During the evolution of LCA, a number of related applications emerged, of which we give some examples below:

- Internal industrial use in product development and improvement
- Internal strategic planning and policy decision support in industry,
- External industrial use for marketing purposes, and
- Governmental policy making in the areas of eco labelling, green procurement and waste management opportunities.

The list is not exhaustive, but indicates that there is a wide variation of applications. This variation is also reflected in the level of sophistication and to some extent also in the choice of methodology

Management:

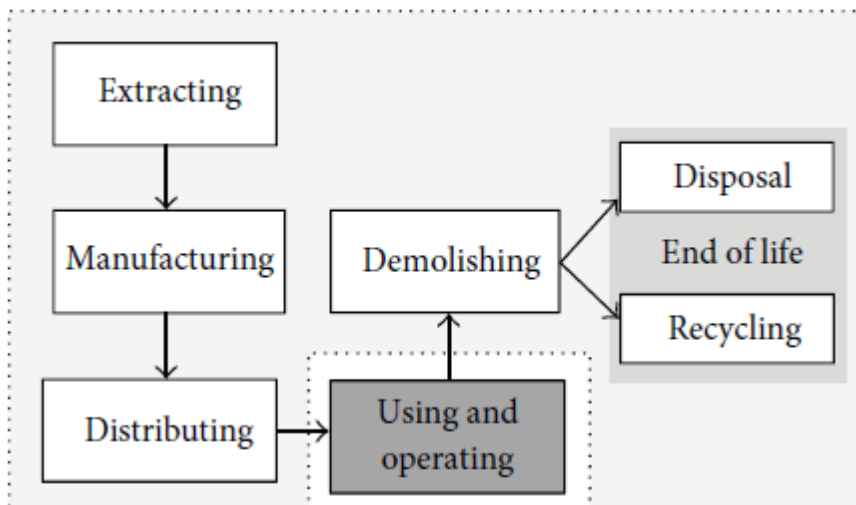
Among the newer concepts in LCA is "Life cycle management" (LCM), which is an integrated approach to minimising environmental burdens throughout the life cycle of a product, system or service. In some forms, LCM can provide a simplified set of LCA procedures suitable for small- and medium sized enterprises (SMEs).

Flow of materials-cost criteria-case studies.

The case study presented in this paper is the practical application of the LCA methodology in a real construction site in , analyzing the quantities of materials consumed and the basic considerations of the most critical inputs in this scenario, such as steel, ceramics, cement, and wood, through the same design and technical recommendations. It is in accordance with regulatory requirements and uses Semipro software and the LCA methodology, providing results that will be interpreted and analyzed.

Goal and Scope. The boundary established for the system under study was delimited by extracting, manufacturing, distributing, demolishing, and end of life, excluding all other steps. A significant period of time and impacts related to the consumption of energy and water in the use phase of buildings were excluded from the analysis. The functional unit is the set of features that should be the same when Comparing different design options, and for this study we defined a functional unit as one family unit of the five family units of the selected construction site. This functional unit has a living room, kitchen, utility area, bathroom, two bedrooms, garage, and a deep yard, with a total built area of around 56m² on average. The objective of this study is to analyze the environmental impacts of the selected functional unit using the LCA methodology to evidence and compare environmental impacts when using different construction materials.

Assessment Objectives. The goal of this assessment is to quantify the flows of materials and energy to the boundaries of a building system and measure these data in order to determine the impact on the environment. Attention is given to this assessment in the impacts that are often associated with construction activity, such as global warming, natural resource consumption, consumption of non-renewable energy, and harm to human health. Considering that environmental concern is a recent discipline, diffusion studies in this area are essential, especially in, this study has as a second goal to achieve a significant public interested in sustainability and eco design, presenting them



with quantitative results and possibilities of improvement in products and process. Overall, the results presented can be shared with all individuals and organizations interested in this area of study.

Scope. The analysis focused on the foundations of the structure, partition walls, jackets, window frames, and roof of the building in question. The subsystems and their associated materials are as follows:

(i) Foundations: reinforced concrete structure; materials used: cement and steel.

(ii) Structure: reinforced concrete structure; materials used: wood, cement, and steel.

(iii) Masonry: brick blocks and mortar applied; materials used: cement and ceramic.

(iv) Wall covering: tiles, flooring, and mortar applied; materials used: cement and ceramic.

(v) Frames: doors and wood windows; materials used: wood, cement, and steel.

(vi) Roofing: roof with two slopes on ceramic tiles and wooden structure; materials used: wood, ceramic, and steel.

the boundary established for the system under study was delimited by extracting, manufacturing, distributing, demolishing, and end of life, excluding all other steps. In order to have an objective analysis, infrastructure processes were not taken into account, such as the construction of factory or manufacturing equipment and vehicles necessary for the production, operation, and transport of materials.

The end-of-life phase is featured by disposal, because in Brazil most construction waste is disposed of in landfills.

UNIT- V

Case Studies:

Preparation of EIA for developmental projects:

- Development projects in the past were undertaken without any consideration to their environmental consequences.
- In view of the colossal damage to the environment, governments and public are now concerned about the environmental impacts of developmental activities.
- Thus, to assess the environmental impacts, the mechanism of EIA was introduced.
- EIA is a tool to anticipate the likely environmental impacts that may arise out of the proposed developmental activities and suggest mitigation measures and strategies.
- EIA was introduced in India in 1978, with respect to river valley projects.
- Later the EIA legislation was enhanced to include other developmental sections.
- EIA comes under Notification on Environmental Impact Assessment (EIA) of developmental projects 1994 under the provisions of Environment (Protection) Act, 1986.
- Besides EIA, the Government of India under Environment (Protection) Act 1986 issued a number of other notifications, which are related to environmental impact assessment.
- EIA is now mandatory for more than 30 categories of projects, and these projects get Environmental Clearance (EC) only after the EIA requirements are fulfilled.
- Environmental clearance or the 'go ahead' signal is granted by the Impact Assessment Agency in the Ministry of Environment and Forests, Government of India.

Factors to be considered in making assessment decisions:

- Collection of baseline data from primary and secondary sources;
- Prediction of impacts based on past experience and mathematical modelling;
- Evolution of impacts versus evaluation of net cost benefit;
- Preparation of environmental management plans to reduce the impacts to the minimum;
- Quantitative estimation of financial cost of monitoring plan and the mitigation measures.

Environment Management Plan

- Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan.

Environmental Appraisal

- An **Appraisal Committee** constituted by the **Ministry of Environment and Forests** will first scrutinized a project based on the data presented by the project authorities.
- If necessary, the MoEF may also hold consultations with the investors and experts on specific issues as and when necessary.
- After considering all the facets of a projects, environmental clearance is accorded subject to implementation of the stipulated environmental safeguards.
- In case of projects where the project proponents have submitted complete information, a decision is taken **within 90 days**.
- The six regional offices of the Ministry functioning at Shillong, Bhubaneshwar, Chandigarh, Bangalore, Lucknow and Bhopal undertake monitoring of cleared projects.

EIA of Coasts

- Coastal Zone Management Plans (CZMPs) are prepared by coastal states or Union Territories as per rules set by CRZ notification 1991.
- CZMPs are prepared based on identification and categorization of coastal areas for different activities and then submitted to the MoEF for approval.
- The ministry then forms a task force for examining their plans.

Single window clearance

- Environmental clearance + Forestry clearance.
- When a project requires **both environmental clearance** as well as approval under the **Forest (Conservation) Act, 1980**, proposals for both are required to be given simultaneously to the concerned divisions of the Ministry.
- The processing is done simultaneously for clearance or rejection.
- If the project does not involve diversion of forestland, the case is processed only for environmental clearance.

Water Resources Project:

Environmental impact assessment (EIA) is a decision making process that systematically evaluates the possible significant (negative or positive) effects that a proposed project action may exert on the natural, social and human environment of a particular geographic area .It is a process that analyzes and evaluates the impacts that human activities can have on the environment. Its purpose is to guarantee a sustainable development that is in harmony with human welfare and the conservation of ecosystems.

EIA is a decision-making process that evaluates the possible significant effects that a proposed project may exert on the environment.

EIA is the technical key to incorporating concepts such as the precaution principle and to preventing the loss of natural (and manmade) resources, which is evidently the main goal of sustainable development in decision-making.

The physical and biological effects of river development schemes arise from the obstacle the dam causes to the natural flow, the climate changes caused by the reservoir interacting with the overlying atmosphere, the effects of the structure on the water in and near the reservoir, and slides and ground tremors caused by the stored water.

Water use has been growing at more than twice the rate of population increase in the last century, and, although there is no global water scarcity as such, an increasing number of regions are chronically short of water.

Major Environmental Impacts of Water Resources Projects:

The impacts caused by construction of dams and reservoirs include changes in the microclimate, loss of vegetation cover, soil erosion, variation in water table and enhanced seismic activities due to pressure of water. Although the development of water resources through dams (small and large), inter basin transfers, aquifer storage and recovery, levees and dikes, and boreholes provides a buffer against climate variability, ill-conceived water storage structures constructed today will be a waste of scarce financial resources, and may aggravate unpleasant climate change impacts rather than mitigating . The realities of climate change are such that if the performance of agricultural water storage is to be enhanced in the future, much closer attention must be paid to planning and management.

The environmental impacts which a water resources project is likely to have can be classified as:

- Impacts within and around the area covered by dam and reservoir;
- Downstream effects caused by alteration in hydraulic regime.
- Regional effects in terms of overall aspects including resources use and socio-economic impacts

Though water resources development activities date back to thousands of years, only during the last 4-5 decades, both the size and number of projects have increased significantly. With the doubling of the global irrigated area over the last 50 years, withdrawals for agriculture have been rising, resulting in total global water withdrawals of only a share-about 9 percent of internal renewable water resources (FAO, 2011). This figure seems to represent small proportion; however, on-stream and off-stream environmental impacts due to the rapid expansion of irrigated lands and increasing withdrawals of freshwater are inevitable, as irrigation and water resource development can also cause social and environmental problems .

Water resources development projects have both beneficial and adverse environmental impacts. All river development schemes are built to produce obvious beneficial effects for society, the main ones being irrigation, land reclamation in river flood plains and tidal areas, domestic and industrial water supply, flood control and improved dry weather flow in rivers, hydroelectricity, navigation, recreational activities, and so on.

The benefits of irrigation have resulted in lower food prices, higher employment and more rapid agricultural and economic development. The spread of irrigation has been a key factor behind the near tripling of global grain production since 1950.

As a water management strategy, past water resource planning has focused mostly on large dams, the construction of which is often controversial although they have made an important and significant contribution to human development. They are often seen as essential for national economic development, and their macro-economic benefits tend to be highlighted while environmental considerations and especially local economic impacts and social impacts may be less adequately evaluated . However, dams and reservoirs, aqueducts, river diversions, major irrigation projects, industrial and domestic diversions, groundwater pumping etc have a major hydrological impact which could affect both present and future generations.

Environmental Impact Assessment (EIA): is a decision making process that systematically evaluates the possible significant (negative or positive) effects that a proposed project action may exert on the natural, social and human environment of a particular geographic area. It is, thus, possible that the EIA of a water resources development, like any other development projects, can end up with a „reject“ proposal and decision if the results of the analyses show that the project will have severe detrimental impacts.

Sustainable water resources development and the environment: The sustainable development of water resources is a multi-dimensional way of thinking about the connections or interdependencies among natural, social, and economic systems in the use of water. Hence, there is, as such, no credible sustainability where the environmental impact of the project has not been properly evaluated and mitigating measures have not been proposed in cases of adverse environmental impacts of the project.

Environmental Flows Assessment: Sustainable water resource systems are required to simultaneously contribute to the objectives of society, now and in the future, and maintaining their ecological, environmental, and hydrological integrity. As one of the legitimate users of water, the environment should be allotted sufficient amount of water for its sustainability, based on seasonal variability in water demand. Continuous supply of water, proportional to the natural flow regimes across different seasons is the basis for sustainability of the whole ecosystems. Hence, environmental flows assessment and allocation of water for ecological water demand should be mandatory before granting permission for construction of water resources development. Sustaining the environment by allotting sufficient amount of water is sustaining life on the planet, including human being.

Application of GIS-RS and simulation models in EIA of water resources development: The degree to which water resources and environmental planning task is successful, reliable and credible depends on the availability and quality of data to be used. Environmental planning of water resources development involves a wider range of geographic areas with a variety of topographic features. EIA of water resources development involves the collection, analysis, modelling and mapping of multitude of socio-economic, natural and manmade environmental data. However, it is often difficult to obtain the whole set of measured and surveyed environmental data. Hence, the analysis of remotely sensed data in GIS environment plays a role of paramount importance in acquiring and analyzing environmental data.

Some of the challenges in EIA and environmental planning of water resources development: Population pressure, climate change, ill-conceived planning and lack of appropriate policies and institutions are some of the challenges to sustainable environmental planning of water resources development. These parameters are subjects of national and international interest, and therefore, need full commitment of governments“ respective policies, laws, rules and regulations to address these parameters properly.

The importance of integration and public participation in EIA of water resources development: Water and other environmental resources related to it can no longer be viewed in isolation by one institution or any one group of professionals without explicit and simultaneous consideration of other related sectors and issues and vice versa. Hence, it is important to address issues related to water in integration with other environmental resources. The public at large has closer associations to the environment than formal organizations constituted by high level expertise. Besides, the public has its own ways of understanding and addressing environmental problems. Hence, public participation in decision making and management of environmental issues should be rendered adequate attention.

Appropriate policies and institutions: There should also be appropriate policy definitions and proper institutional setup in place in order to properly tap the available natural and social resource potentials. Besides formal (governmental or non-governmental) institutions, traditional ones have a great role to play in bridging external interventions and the public regarding environmental planning and management.

Pharmaceutical industry

The purpose of these guidelines is to identify the main factors to be considered when preparing an Environmental Impact Assessment (EIA) study for a pharmaceutical manufacturing plant. Each project should be carefully assessed to identify the key issues and an EIA should be prepared to assess them, using these guidelines for assistance.

OBJECTIVES OF THE ENVIRONMENTAL IMPACT ASSESSMENT:

The aim of Environmental Impact Assessment is to enable the administrative competent authority, the local and central government, and the developer to properly consider the potential environmental consequences of a proposal, and to make recommendations to mitigate these consequences if necessary. It is important to provide sufficient information for the competent administrative authority assess the proposal. If sufficient information is not available in the presented study, the study will not be approved, and the developer will waste time in gathering the lacking information. The EIA thus provides the basis for sound environmental administration and management.

Production facilities covered by the guidelines:

The pharmaceutical industry includes the manufacture, extraction, processing, purification, and packaging of chemical materials to be used as medications for humans and animals. Pharmaceutical manufacturing is divided into two stages: the production of the active ingredient or drug, primary processing, and secondary processing, the conversion of the active drugs into products suitable for administration.

THE EIA PROCESS The EIA :

should be prepared by a team of consultants with experience appropriate to the study of the different aspects of the development of a pharmaceutical industry. The team should be headed by a team leader with sufficient relevant experience, whose ultimate responsibility is to coordinate the inputs of the individual specialists and to provide an overview.

The EIA study could be done through a company or joint venture of consultants to ensure a full professional coverage.

The EIA process should proceed through a number of steps:

Description of the project: What type of projects, its size, components, and processes expected, all stages of implementation?

Screening: is a full EIA study required? 3.3 Scoping, or identification of potential environmental impacts: What has to be covered in the formal EIA and in what detail?

Baseline: What are the existing environmental conditions?

Prediction: What environmental impacts will the project have?

Evaluation: How will these impacts affect people and resources, and how significant are the resulting effects?

Mitigation: Can significant negative effects be avoided or made acceptable? Can benefits be enhanced?

For EIAs for pharmaceutical industries, members of, or advisers to, the team may include, but not necessarily be limited to, the following:

- An environmental management specialist with knowledge concerning noise, air emissions and waste water discharges
- A socio-economic specialist
- A landscape architect
- An industrial process engineer, specialised in pharmaceutical processes

Each member of the team, for their specialist subject(s), will follow the basic steps identified above. The number of experts required will depend on whether the proposal is for a development within an industrial estate, a development within an existing serviced industrial zone, or a development on a stand alone site.

thermal plant,

A thermal power station is a power plant in which the prime mover is steam driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankine cycle. The greatest variation in the design of thermal power stations is due to the different fossil fuel resources generally used to heat the water. Some prefer to use the term energy centre because such facilities convert forms of heat energy into electrical energy. Certain thermal power plants also are designed to produce heat energy for industrial purposes of district heating, or desalination of water, in addition to generating electrical power. Globally, fossil fuel thermal power plants produce a large part of man-made CO₂ emissions to the atmosphere, and efforts to reduce these are varied and widespread. The energy efficiency of a conventional thermal power station, considered salable energy produced as a percent of the heating value of the fuel consumed, is typically 33% to 48%.

An environmental impact assessment (EIA) is an assessment of the possible impacts that a proposed project may have on the environment, consisting of the environmental, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts.

Impact Management

The Socio-Environmental Management Plan laid out in this project was developed using observations and studies in the area of influence, site visits and public consultations.

The impact management plan has five objectives:

- Strengthen all the components that make up the social and environmental areas of influences throughout all phases of the project. Establish mitigation measures and a monitoring plan to prevent and reduce any significant
- negative impacts to acceptable levels and strengthen all positive impacts caused as a result of the project. Define the responsibilities of all the different actors to properly implement the mitigation
- measures during all phases of the project. Comply with the established environmental and social regulations in order to obtain
- environmental licence. Protect the health and safety of all the workers and citizens living in the project area.
- The plan includes sections to address mitigation measures, monitoring, a contingency plan, a waste management plan, a reforestation plan and an implementation plan.

Nuclear fuel complex,

Environment plays a vital role in overall development of a country. Recognizing the importance of environmental protection and sustainable development, the Ministry of Environment and Forest (MoEF), Government of India had formulated policies and procedures governing industrial and other developmental activities to prevent indiscriminate exploitation of the natural resources and to promote integration of environmental concerns at every stage in developmental projects. The purpose of Environmental Impact Assessment (EIA) is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed activity before action is taken. Early identification and characterization of critical environmental impacts allows the public and the government to form a view about the environmental acceptability of a proposed developmental project and what conditions should apply to mitigate or reduce risks and impacts.

Highway project

Environmental Impact Notification S.O.1533 (E), of 14th September 2006 as amended in 2009 has made it mandatory to obtain environmental clearance for scheduled development projects. The notification has classified these projects as Category A & B. Category A projects (including expansion and modernization of existing projects) require clearance from Ministry of Environment and Forests (MoEF), Govt. of India (GoI) and for category B, from State Environmental Impact Assessment Authority (SEIAA), constituted by the Govt. of India.

The existing Environmental Impact Assessment of MoEF is common for all the sectors requiring prior environmental clearance. Considering the diversity in all the sectors related to infrastructure and industrial development, MoEF launched a programme for development of sector specific EIA guidance manuals. The EIA guidance manual will help the project proponent and consultant in the preparation of EIA report. It also helps the regulatory authority while reviewing the report and the public as well to be aware of the related environmental issues. This EIA guidance manual accordingly addresses their related environmental concerns for the specific sector, that is, Asbestos-based industries.

Introduction: This contains the general information on highway projects, environmental clearance process, and identification of the project proponent.

Project Description : should cover the description of the project, such as, the type of project, need for the project, project location, highway alignment, utilities, implementation schedule and the estimated cost of the project.

Analysis of Alternatives (Technologies) should cover the details of various alternatives in respect of both location of site and technologies to be deployed, in case the initial scoping exercise consider such a need.

Description of Environment: should cover baseline data in the project area and study area.

Anticipated Environmental Impact and Mitigation Measures : should cover the anticipated impact on the environment and mitigation measures. The method of assessment of impact including studies carried out, modeling techniques adopted to assess the impact where pertinent shall be elaborated .It should give the details of the impact on the baseline parameters, both during the construction and operational phases and mitigation measures to be implemented by the proponent.

Environmental Monitoring Programme : should cover the planned Environmental Monitoring Program. It should include the technical aspects of monitoring the effectiveness of mitigation measures.

Additional Studies should cover the details of the additional studies, if any, required in addition to those specified in the TOR and which are necessary to cater to more specific issues applicable to the particular project. These studies may be suggested either by the proponent itself or the regulatory authority.

Project Benefits : should cover the benefits accruing to the locality, neighbourhood, region and nation as a whole. It should bring out details of benefits by way of improvement in the physical infrastructure, social infrastructure, employment potential and other tangible benefits.

Environmental Cost Benefit Analysis : should cover the Environmental Cost Benefit Analysis of the project, if recommended by the Expert Appraisal Committee at the scoping stage.

Environmental Management Plan :should comprehensively present the Environmental Management Plan (EMP), which includes the administrative and technical setup, summary matrix of EMP, the cost involved to implement the EMP, both during the construction and operational Phases.

Sewage treatment plant,

Sewage treatment plants are constructed to transform the raw sewage into an easier manageable waste and to retrieve and re-use the treated sewage water.

The end products of a treatment plant are sludge and treated sewage water. Both products may contain, in addition to organic biodegradable substances and micro-organisms, non-biodegradable and toxic substances due to the contamination of sewage with industrial waste waters.

From the environmental standpoint the most important aspect of a sewage treatment plant is the proposed disposal or use of the sludge and the treated sewage water.

The most common adverse environmental effects on coastal waters, connected with disposal or use of the sludge and the treated sewage water, are caused by: microbiological contamination, oxygen depletion due to high load of organic faecal matter, eutrophication caused by nutrients, and toxic and non-biodegradable substances originating mainly from contamination of sewage by industrial wastes.

Some treatment processes (e.g. oxygenation ponds, aerated lagoons) may lead, under the influence of wind, to the spread of pathogens through air transport over considerable distances.

Most sewage treatment and disposal processes are a serious source of offensive odour.

Improperly constructed or operated sewage treatment plants and improper disposal or use of sludge and treated sewage water may become a most serious public health problem. Therefore, whatever level of treatment and method of disposal and use is approved, it should strictly comply with national standards and internationally accepted environmental quality criteria, taking into account the recipient environment and the biological targets which may be affected, specifically man.

Elements specifically recommended for inclusion in the follow-up monitoring and re-evaluation programme are: regular compliance with methods approved for sewage treatment and disposal, including for use of treated sewage water; seepage of contaminants from the treatment plants or sludge disposal sites into freshwater aquifers or coastal waters; wind transport of pathogens originating from the treatment plant or sludge disposal site; elements recommended for monitoring of submarine sewerage outfalls (see section 4.5) if such an outfall is part of the project.

Description of the proposed project:

The proposed treatment plant should be described, accompanied by plans on a scale of 1 :2500 * , including the following:

- Types of sewage to be treated (industrial, domestic, agricultural).
- Number of inhabitants to be served by the plant.

- Types of clients to be served, e.g. industrial, residential, commercial, hospitals.
- Quantity of sewage (cubic metres per day, per year).
- Quality of sewage to be treated, including suspended solids (mgllitre), settleable solids (mgllitre), pH, turbidity, conductivity, BOD (mgllitre), COD (mgllitre), nitrogen, ammonia, phosphate, oil, surfactants, and heavy metals such as arsenic, cadmium, copper, lead, nickel and mercury
- Method to be used in treatment of sewage
- Layout of the plant (including treatment facilities and service area).
- Use of effluents (agriculture, recharging aquifer, disposal to sea or to nearest river).
- Sludge quantity and quality.
- Method of sludge treatment and disposal.
- Chemical, physical and bacteriological characteristics of effluents such as suspended solids, settleable solids, pH, turbidity, conductivity, BOD, COD, nitrogen, ammonia, phosphate, oil, surfactants, and heavy metals such as arsenic, cadmium, copper, lead, nickel and mercury, total coliforms, faecal coliforms and faecal streptococci.

Description of the environment

A description of the environment of the site without the proposed sewage treatment plant should concentrate on the immediate surroundings of the proposed project. The size of the area described will be determined by the predicted effects of the proposed plant.

(a) Physical site characteristics

- Site location on a map at a scale of 1:10,000 or 1:50,000 including residential areas, industrial area

(b) Climatological and meteorological conditions

- Basic meteorological data such as wind direction and wind velocity and access roads.
- Special climatic conditions such as storms, inversions, trapping and fumigation, proximity to seashore, average yearly rainfall and number of rainy days per year.

(c) Geological and hydrological conditions

- Geological structure of the proposed area, including hydrology and aquifers;
- Existing uses of water bodies around the proposed site and the quality of the water.

(d) Present land use of the site and its surroundings

(e) Characteristics of the lake area which will receive the discharged treated sewage

(f) Existence of endemic waterborne diseases.

Municipal Solid waste processing plant

The proposed integrated solid waste management project shall consist of the following components:

1. Primary collection of MSW: Door-to-Door collection of MSW is to be implemented.

2. Transportation of MSW: After collection MSW will be transported in the closed/covered vehicles to the processing and disposal site at Boragaon.

3. Processing and Disposal of MSW: MSW is to be processed for energy recovery before final disposal into landfill site. Only inerts or processing rejects to be land filled which is to be in range of 20-30% of total waste transported to the site. Processing and disposal site is to be developed.

i. RDF Plant to handle 500TPD MSW: Mixed MSW would be converted into Refuse Derived Fuel (RDF) in the RDF Plant.

ii. Compost Plant to handle 50 TPD of Organic waste: Organic components of MSW segregated during RDF Process will be treated in the compost plant to produce manure.

iii. Power Plant: Power Plant boiler will be fed with the 180 Tonne per day of RDF having CV in range of 2500-2800 Kcal/kg and 57 TPD of biomass, up to the limit laid as per MNRE Policy/ guidelines to use supplementary fuel for such plants as fuel and will generate 6 MW of electricity.

The baseline environmental status was assessed based on primary and secondary data collected through on-site field observations and obtained from agencies such as Indian Meteorological Department, Geological Survey of India, State Ground Water Department, State Pollution Control Board, Census of India and Local Forest Department. The following environmental components were focused at during this study: ☐

Air Environment (Meteorology, Ambient Air Quality, Noise Levels, Traffic Pattern, etc.) ☐

Water Environment (Quality and Quantity of Surface and Groundwater sources)

☐ Land Environment (Geology, Hydrogeology, Land use,

Solid Waste generation and characteristics) ☐ Ecological Environment (Terrestrial and Aquatic Flora & Fauna) ☐

Socio-Economic

Air ports.

Introduction .provides background information, details of the environmental clearance process, brief details and locations of the proposed project, geographical settings of the area. The terms of reference for preparation of EIA and structure of EIA report have also been described in this chapter.

Description of the Project . deals need for the project, project location, project layout, terminal buildings, utilities and services, power requirements, parking facilities, water requirement and sources, drainage and sewage disposal system, storm water drainage system, horticulture and landscaping, energy conservation measures, the project implementation schedule, estimated cost of development, etc.

Description of the Environment This presents existing environmental conditions of the 10km radius study area around the site including topography, geological, drainage pattern, water environment, climate & meteorology, ambient air quality, noise levels, flora & fauna, socio-economic conditions, etc.

Anticipated Environmental Impacts & Mitigation Measures. This describes the anticipated impact on the environment and mitigation measures for project. The method of assessment of impact including studies carried out, modeling techniques adopted to assess the impact where pertinent have been elaborated in this chapter. It gives the details of the impact on the baseline parameters, both during the construction and operational phases and suggests the mitigation measures to be implemented by the proponent. It also describes the overall both-direct and indirect, reversible and irreversible impacts of the proposed activities on different environmental parameters on different environmental parameters during construction and post construction phase and underscores the areas of concern, which need mitigation measures.

Analysis of Alternatives. This examines alternative means for proposed project involves description of each alternative, summary of adverse impacts of each alternative, mitigation measures proposed for each alternative and selection of best alternative.

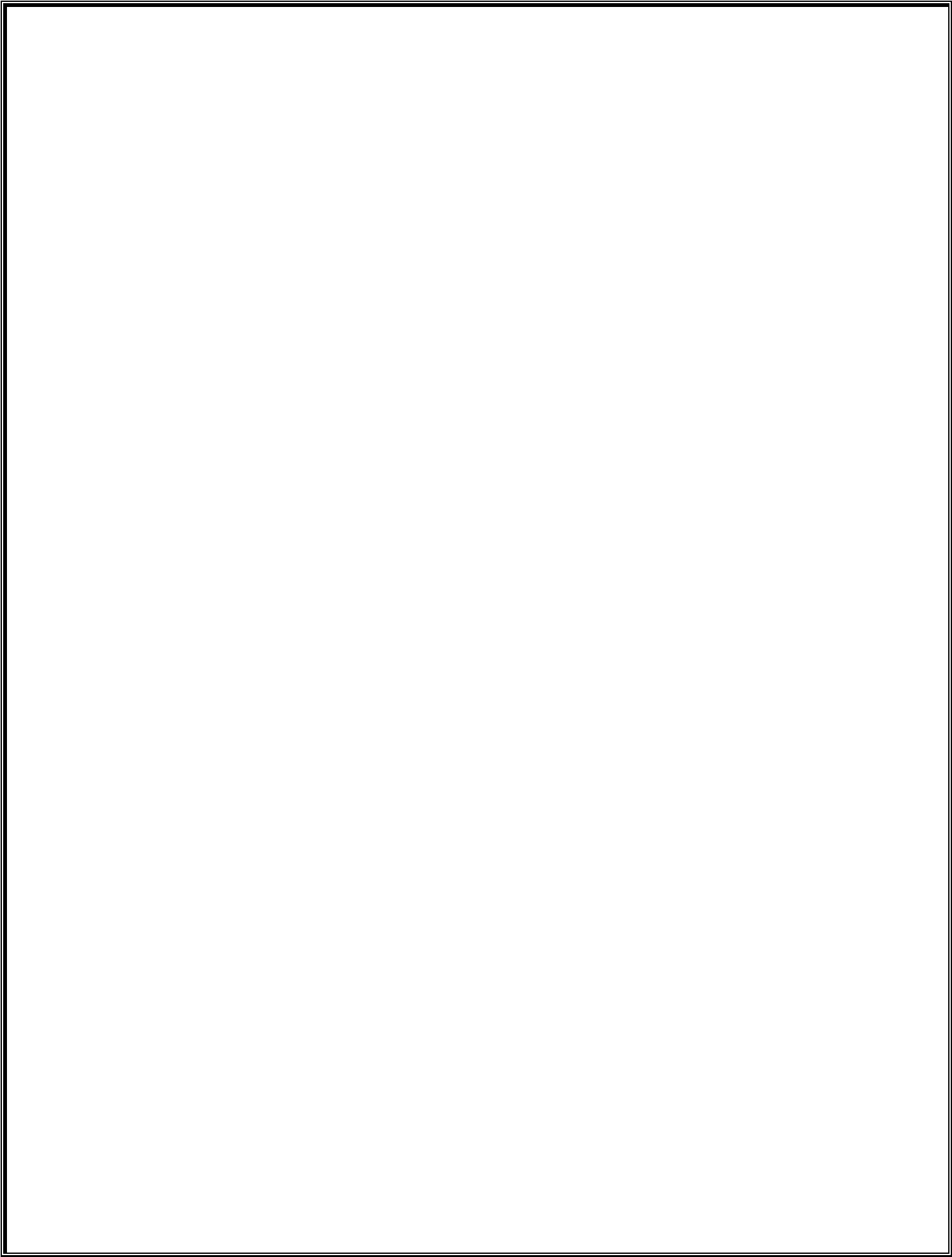
Environmental Monitoring Plan This describes environmental monitoring plan (EMP) for the project during construction and operation phases.

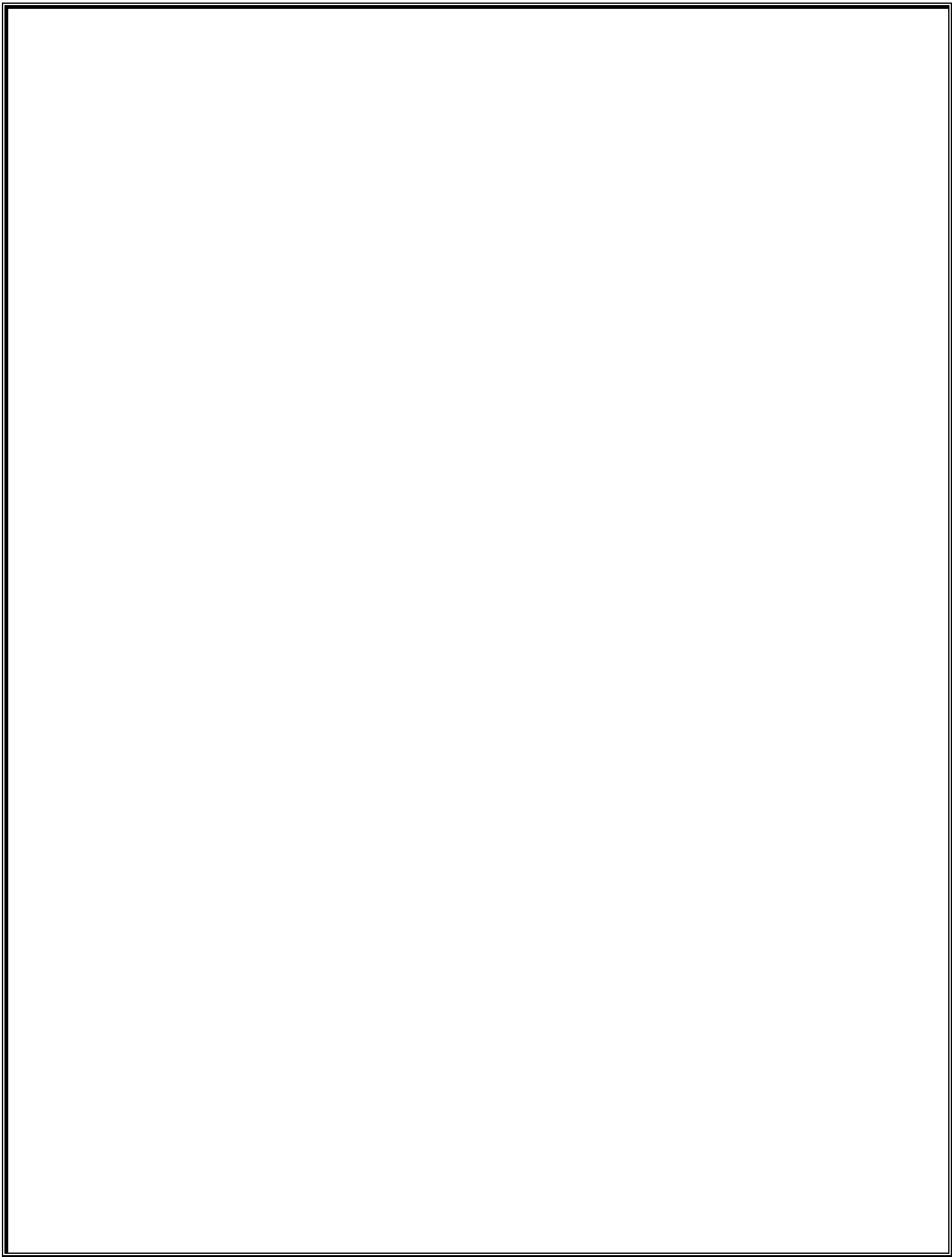
Additional Studies (Risk Analysis and Disaster Management Plan) This spelled out hazard identification, risk analysis and disaster management plan for an unlikely event of emergency at terminal building of the proposed Civil Enclave. Details of Public Hearing conducted by Uttar Pradesh Pollution Control Board.

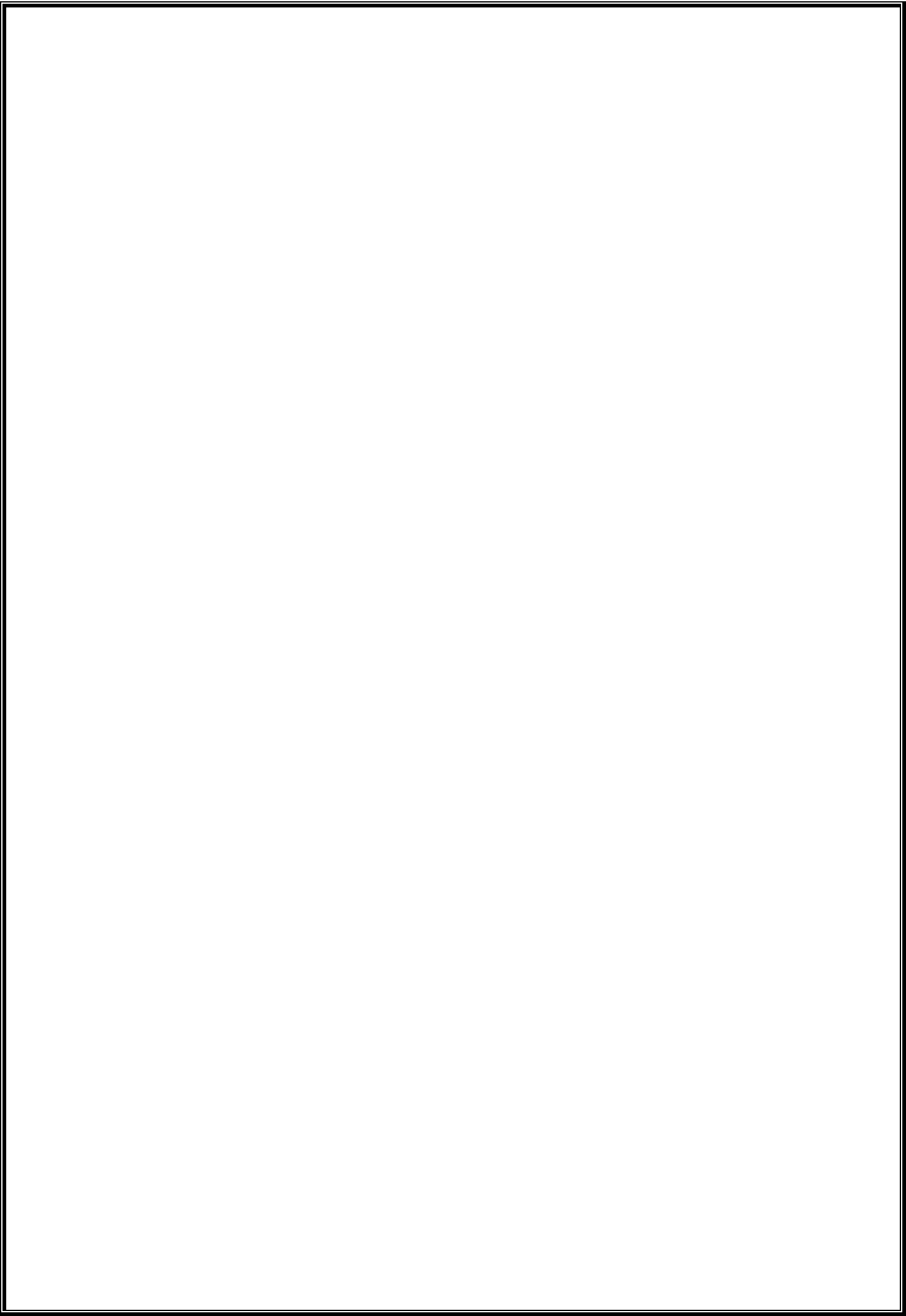
Project Benefits .This includes the benefits in terms of improvement in physical infrastructure, social infrastructure, employment potential, etc.

Environmental Cost Benefit Analysis This describes Environmental Cost Benefit Analysis.

Environmental Management Plan (EMP) This describes environmental management plan to mitigate adverse environmental impacts and to strengthen beneficial impacts.







LECTURE NOTES
ON
HUMAN COMPUTER INTERACTION

IV B.TECH-II SEM

PREPARED BY

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UNIT-I

INTRODUCTION

Human–computer interaction (HCI), alternatively man–machine interaction (MMI) or computer–human interaction (CHI) is the study of interaction between people (users) and computers.

- With today's technology and tools, and our motivation to create really effective and usable interfaces and screens, why do we continue to produce systems that are inefficient and confusing or, at worst, just plain unusable? Is it because:
 1. We don't care?
 2. We don't possess common sense?
 3. We don't have the time?
 4. We still don't know what really makes good design?

DEFINITION

- "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."

GOALS

- A basic goal of HCI is
 - to improve the interactions between users and computers
 - by making computers more usable and receptive to the user's needs.
- A long term goal of HCI is
 - to design systems that minimize the barrier between the human's cognitive model of what they want
 - to accomplish and the computer's understanding of the user's task

WHY IS HCI IMPORTANT

- User-centered design is getting a crucial role!
- It is getting more important today to increase competitiveness via HCI studies (Norman, 1990)
- High-cost e-transformation investments
- Users lose time with badly designed products and services
- Users even give up using bad interface
 - Ineffective allocation of resources

DEFINING THE USER INTERFACE

- User interface, design is a subset of a field of study called *human-computer interaction* (HCI).
- Human-computer interaction is the study, planning, and design of how people and computers work together so that a person's needs are satisfied in the most effective way.
- HCI designers must consider a variety of factors:
 - what people want and expect, physical limitations and abilities people possess,
 - how information processing systems work,
 - what people find enjoyable and attractive.
 - Technical characteristics and limitations of the computer hardware and software must also be considered.
- The *user interface* is to
 - the part of a computer and its software that people can see, hear, touch, talk to, or otherwise understand or direct.
- The user interface has essentially two components: input and output.
- *Input* is how a person communicates his / her needs to the computer.
 - Some common input components are the keyboard, mouse, trackball, one's finger, and one's voice.
- *Output* is how the computer conveys the results of its computations and requirements to the user.
 - Today, the most common computer output mechanism is the display screen, followed by mechanisms that take advantage of a person's auditory capabilities: voice and sound.
- The use of the human senses of smell and touch output in interface design still remain largely unexplored.
- Proper interface design will provide a mix of well-designed input and output mechanisms that satisfy the user's needs, capabilities, and limitations in the most effective way possible.
- The best interface is one that is not noticed, one that permits the user to focus on the information and task at hand, not the mechanisms used to present the information and perform the task.

THE IMPORTANCE OF GOOD DESIGN

With today's technology and tools, and our motivation to create really effective and usable interfaces and screens, why do we continue to produce systems that are inefficient and confusing or, at worst, just plain unusable? Is it because:

- We don't care?
- We don't possess common sense?
- We don't have the time?
- We still don't know what really makes good design?
- But we never seem to have time to find out what makes good design, nor to properly apply it. After all, many of us have other things to do in addition to designing interfaces and screens.
- So we take our best shot given the workload and time constraints imposed upon us. The result, too often, is woefully inadequate.
- Interface and screen design were really a matter of common sense, we developers would have been producing *almost identical* screens for representing the real world.
- Example bad designs
 - Closed door with complete wood
 - suggestion : glass door

THE IMPORTANCE OF THE USER INTERFACE

- A well-designed interface and screen is terribly important to our users. It is their window to view the capabilities of the system.
- It is also the vehicle through which many critical tasks are presented. These tasks often have a direct impact on an organization's relations with its customers, and its profitability.
- A screen's layout and appearance affect a person in a variety of ways. If they are confusing and inefficient, people will have greater difficulty in doing their jobs and will make more mistakes.
- Poor design may even chase some people away from a system permanently. It can also lead to aggravation, frustration, and increased stress.

The Benefits of Good Design

- Poor clarity forced screen users to spend one extra second per screen.
 - Almost one additional year would be required to process all screens.
 - Twenty extra seconds in screen usage time adds an additional 14 person years.

- The benefits of a well designed screen have also been under experimental scrutiny for many years.
 - One researcher, for example, attempted to improve screen clarity and readability by making screens less crowded.
 - Separate items, which had been combined on the same display line to conserve space, were placed on separate lines instead.
 - The result screen users were about 20 percent more productive with the less crowded version.
- Proper formatting of information on screens does have a significant positive effect on performance.
 - In recent years, the productivity benefits of well-designed Web pages have also been scrutinized.
- Training costs are lowered because training time is reduced.
- support line costs are lowered because fewer assist calls are necessary.
- Employee satisfaction is increased because aggravation and frustration are reduced.
- Ultimately, that an organization's customers benefit because of the improved service they receive.
- Identifying and resolving problems during the design and development process also has significant economic benefits
- How many screens are used each day in our technological world?
- How many screens are used each day in your organization? Thousands? Millions?
- Imagine the possible savings. Proper screen design might also, of course, lower the costs of replacing "broken" PCs.

A BRIEF HISTORY OF THE HUMAN-COMPUTER INTERFACE

- The need for people to communicate with each other has existed since we first walked upon this planet.
- The lowest and most common level of communication modes we share are movements and gestures.
- Movements and gestures are language independent, that is, they permit people who do not speak the same language to deal with one another.

- The next higher level, in terms of universality and complexity, is spoken language.
- Most people can speak one language, some two or more. A spoken language is a very efficient mode of communication if both parties to the communication understand it.
- At the third and highest level of complexity is written language. While most people speak, not all can write.
- But for those who can, writing is still nowhere near as efficient a means of communication as speaking.
- In modern times, we have the typewriter, another step upward in communication complexity.
- Significantly fewer people type than write. (While a practiced typist can find typing faster and more efficient than handwriting, the unskilled may not find this the case.)
- Spoken language, however, is still more efficient than typing, regardless of typing skill level.
- Through its first few decades, a computer's ability to deal with human communication was inversely related to what was easy for people to do.
 - The computer demanded rigid, typed input through a keyboard; people responded slowly using this device and with varying degrees of skill.
 - The human-computer dialog reflected the computer's preferences, consisting of one style or a combination of styles using keyboards, commonly referred to as Command Language, Question and Answer, Menu selection, Function Key Selection, and Form Fill-In.
- Throughout the computer's history, designers have been developing, with varying degrees of success, other human-computer interaction methods that utilize more general, widespread, and easier-to-learn capabilities: voice and handwriting.
 - Systems that recognize human speech and handwriting now exist, although they still lack the universality and richness of typed input.

INTRODUCTION OF THE GRAPHICAL USER INTERFACE

- The Xerox systems, Altus and STAR, introduced the mouse and pointing and selecting as the primary human-computer communication method.
- The user simply pointed at the screen, using the mouse as an intermediary.

- These systems also introduced the graphical user interface as we know it a new concept was born, revolutionizing the human-computer interface.

A BRIEF HISTORY OF SCREEN DESIGN

- While developers have been designing screens since a cathode ray tube display was first attached to a computer, more widespread interest in the application of good design principles to screens did not begin to emerge until the early 1970s, when IBM introduced its 3270 cathode ray tube text-based terminal.
- A 1970s screen often resembled the one pictured in Figure.

It usually consisted of many fields (more than are illustrated here) with very cryptic and often unintelligible captions.

TDX95210		THE CAR RENTAL COMPANY			10/11/16 10:25
NAME		TEL		RO	
<hr/>		<hr/>		<hr/>	
PUD	RD	C	RT	MPD	
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	
ENTRY ERROR XX465628996Q.997					
COMMAND →					

- It was visually cluttered, and often possessed a command field that challenged the user to remember what had to be keyed into it.
- Ambiguous messages often required referral to a manual to interpret.
- Effectively using this kind of screen required a great deal of practice and patience.
- Most early screens were monochromatic, typically presenting green text on black backgrounds.
- At the turn of the decade guidelines for text-based screen design were finally made widely available and many screens began to take on a much less cluttered look through concepts such as grouping and alignment of elements, as illustrated in Figure 1.2.

- User memory was supported by providing clear and meaningful field captions and by listing commands on the screen, and enabling them to be applied, through function keys. Messages also became clearer.
- These screens were not entirely clutter-free, however. Instructions and reminders to the user had to be inscribed on the screen in the form of prompts or completion aids such as the codes PR and Sc.
- Not all 1980s screens looked like this, however. In the 1980s, 1970s-type screens were still being designed, and many still reside in systems today.

THE CAR RENTAL COMPANY

RENTER»
 Name: _____
 Telephone: _____

LOCATION»
 Office: _____
 Pick-up Date: _____
 Return Date: _____

AUTOMOBIL»
 Class: _____(PR. ST. FU. MD. CO. SC)
 Rate: _____
 Miles per Day: _____

The maximum allowed miles per day is 150.
 Enter F1-Help F3-Exit F12=Cancel

- The advent of graphics yielded another milestone in the evolution of screen design, as illustrated in Figure above

While some basic "design principles did not change, groupings and alignment, for example,
 Borders were made available to visually enhance groupings and buttons and menus for implementing commands replaced function keys.

THE CAR RENTAL COMPANY

RENTER

Name:

Telephone:


LOCATION


Office:


Pick-up Date:

Return Date:

AUTOMOBILE

Class: 

Rate: 

Miles Per Day: 

- Multiple properties of elements were also provided, including many different font sizes and styles, line thicknesses, and colors.
- The entry field was supplemented by a multitude of other kinds of controls, including list boxes, drop-down combination boxes, spin boxes, and so forth.
- These new controls were much more effective in supporting a person's memory, now simply allowing for selection from a list instead of requiring a remembered key entry.
- Completion aids disappeared from screens, replaced by one of the new listing controls. Screens could also be simplified, the much more powerful computers being able to quickly present a new screen.
- In the 1990s, our knowledge concerning what makes effective screen design continued to expand. Coupled with ever-improving technology, the result was even greater improvements in the user-computer screen interface as the new century dawned.

THE POPULARITY OF GRAPHICS

- A graphical screen bore scant resemblance to its earlier text-based colleagues.
- Older text-based screen possessed a one dimensional
- Graphic screens assumed a three-dimensional look.
- Controls appeared to rise above the screen and move when activated.
- Information could appear, and disappear, as needed.
- Text could be replaced by graphical images called icons.
- These icons could represent objects or actions
- selection fields such as radio buttons, check boxes, list boxes, and palettes coexisted with the reliable old text entry field
- More sophisticated text entry fields with attached or dropdown menus of.
- Objects and actions were selected through use of pointing mechanisms.
- Increased computer power.
- User's actions to be reacted to quickly, dynamically, and meaningfully.
- WIMP interface: windows, icons, menus, and pointers.
- Graphic presentation is much more effective than other presentation methods.
- Properly used, it reduces the requirement for perceptual and mental information recoding and reorganization, and also reduces the memory loads.
- It permits faster information transfer between computers and people by permitting more visual comparisons of amounts, trends, or relationships; more compact representation of information;
- Graphics also can add appeal or charm to the interface and permit greater customization to create a unique corporate or organization style.

GRAPHICAL SYSTEMS ADVANTAGES AND DISADVANTAGES

- Reduce the memory requirements.
- More effective use of one's information.
- Dramatically reduce system learning requirements.
- Experience indicates that for many people they have done all these things.

ADVANTAGES

- Symbols recognized faster than text
- Faster learning
- Faster use and problem solving
- Easier remembering
- More natural
- Exploits visual/spatial cues
- Fosters more concrete thinking
- Provides context
- Fewer errors
- Increased feeling of control

- Immediate feedback
- Predictable system responses
- Easily reversible actions
- Less anxiety concerning use
- More attractive
- May consume less space
- Replaces natural languages
- Easily augmented with text displays
- Smooth transition from command language system

DISADVANTAGES

- Greater design complexity.
- Learning still necessary
- Replaces natural languages
- Easily augmented with text displays
- Smooth transition from command language system
- Lack of experimentally-derived design guidelines
- use a pointing device may also have to be learned
- Working domain is the present
- Human comprehension limitations
- Window manipulation requirements
- Production limitations
- Few tested icons exist
- Inefficient for touch typists
- Inefficient for expert users
- Not always the preferred style of interaction
- Not always fastest style of interaction
- Increased chances of clutter and confusion
- May consume more screen space
- Hardware limitations

THE CONCEPT OF DIRECT MANIPULATION

The system is portrayed as an extension of the real world: It is assumed that a person is already familiar with the objects and actions in his or her environment of interest.

The system simply replicates them and portrays them on a different medium, the screen.

A person has the power to access and modify these objects, among which are windows.

A person is allowed to work in a familiar environment and in a familiar way, focusing on the data, not the application and tools.

The physical organization of the system, which most often is unfamiliar, is hidden from view and is not a distraction.

Continuous visibility of objects and actions: Like one's desktop, objects are continuously visible. Reminders of actions to be performed are also obvious, labeled buttons replacing complex syntax and command names.

Cursor action and motion occurs in physically obvious and natural ways. One problem in direct manipulation, however, is that there is no direct analogy on the desk for all necessary windowing operations.

A piece of paper on one's desk maintains a constant size, never shrinking or growing. Windows can do both. Solving this problem required embedding a control panel, a familiar concept to most people, in a window's border.

This control panel is manipulated, not the window itself. Actions are rapid and incremental with visible display of results, the results of actions are immediately displayed visually on the screen in their new and current form.

Auditory feedback may also be provided. The impact of a previous action is quickly seen, and the evolution of tasks is continuous and effortless. Incremental actions are easily reversible.

EARLIER DIRECT MANIPULATION SYSTEMS

- The concept of direct manipulation actually preceded the first graphical system. The earliest full-screen text editors possessed similar characteristics.
- Screens of text resembling a piece of paper on one's desk could be created (extension of real world) and then reviewed in their entirety (continuous visibility).
- Editing or restructuring could be easily accomplished (through rapid incremental actions) and the results immediately seen.
- Actions could be reversed when necessary. It took the advent of graphical systems to crystallize the direct manipulation concept, however.

INDIRECT MANIPULATION

In practice, direct manipulation of all screen objects and actions may not be feasible because of the following:

- The operation may be difficult to conceptualize in the graphical system.
- The graphics capability of the system may be limited.
- The amount of space available for placing manipulation controls in the window border may be limited.
- It may be difficult for people to learn and remember all the necessary operations and actions.
- When this occurs, indirect manipulation is provided. Indirect manipulation substitutes words and text, such as pull-down or pop-up menus, for symbols, and substitutes typing for pointing.
- Most window systems are a combination of both direct and indirect manipulation. A menu may be accessed by pointing at a menu icon and then selecting it (direct manipulation).
- The menu itself, however, is a textual list of operations (indirect manipulation). When an operation is selected from the list, by pointing or typing, the system executes it as a command.
- Which style of interaction-direct manipulation, indirect manipulation, or a combination of both-is best, under what conditions and for whom, remains a question whose answer still eludes us.

CHARACTERISTICS OF THE GRAPHICAL USER INTERFACE

A graphical system possesses a set of defining concepts. Included are sophisticated visual Presentation, pick-and click interaction, a restricted set of interface options, visualization, object orientation, extensive use of a person's recognition memory, and concurrent performance of functions

Sophisticated Visual Presentation:

Visual presentation is the visual aspect of the interface. It is what people see on the screen.

- The sophistication of a graphical system permits displaying lines, including drawings and icons.
- It also permits the displaying of a variety of character fonts, including different sizes and styles.
- The display of 16 million or more colors is possible on some screens. Graphics also permit animation and the presentation of photograph and motion video.

The meaningful interface elements visually presented to the user in a graphical System include windows (primary, secondary, or dialog boxes), menus (menu bar, pull down, pop-up, cascading), icons to represent objects such as programs or files, assorted screen-based controls (text boxes, list boxes, combination boxes, settings, scroll bar and buttons), and a mouse pointer and cursor.

-- The objective is to reflect visually on screen the real world of the user as realistically, meaningfully, simply, and clearly possible.

A graphical system possesses a set of defining concepts. Included are sophisticated visual presentation, pick-and-click interaction, a restricted set of interface options, visualization, object orientation, extensive use of a person's recognition memory, and concurrent performance of functions.

Restricted Set of Interface Options: The array of alternatives available to the user is what is presented on the screen or may be retrieved through what is presented on the screen, nothing less, nothing more. This concept fostered the acronym WYSIWYG.

Pick-and-Click Interaction: Elements of a graphical screen upon which some action is to be performed must first identified.

- The motor activity required of a person to identify this element for a proposed action is commonly referred to as pick, the signal to perform an action as cue.
- The primary mechanism for performing this pick-and-click is most often the mouse and its buttons.
- The user moves the mouse pointer to the relevant element (pick) and the action is signaled (click).
- Pointing allows rapid selection and feedback. The hand and mind seem to work smoothly and efficiently together.
- The secondary mechanism for performing these selection actions is the keyboard most systems permit pick-and-click to be performed using the keyboard as well.

Visualization: Visualization is a cognitive process that allows people to understand .Information that is difficult to perceive, because it is either too voluminous or too abstract

Presenting specialized graphic portrayals facilitates visualization.

The best visualization method for an activity depends on what People are trying to learn from the data.

The goal is not necessarily to reproduce a really graphical image, but to produce one that conveys the most relevant information.

Effective visualizations can facilitate mental insights, increase productivity, and for faster and more accurate use of data.

Object Orientation: A graphical system consists of objects and actions. Objects are what people see on screen. They are manipulated as a single unit.

- Objects can be composed of sub objects. For example, an object may be a document. The document's sub objects may be a paragraph, sentence, word, and letter.
- A collection is the simplest relationship-the objects sharing a common aspect.
- A collection might be the result of a query or a multiple selection of objects. Operations can be applied to a collection of objects.
- A constraint is a stronger object relationship. Changing an object in a set affects some other object in the set.
- A document being organized into pages is an example of a constraint. A composite exists when the relationship between objects becomes so significant that the aggregation itself can be identified as an object.
- Examples include a range of cells organized into a spreadsheet, or a collection of words organized into a paragraph.
- A container is an object in which other objects exist. Examples include text in a document
- or documents in a folder.

A container often influences the behavior of its content. It may add or suppress certain properties or operations of objects placed within it, control access to its content, or control access to kinds of objects it will accept. These relationships help define an object's type. Similar traits and behaviors exist in objects of the same object type.

Another important object characteristic is persistence. Persistence is the maintenance of a state once it is established. An object's state (for example, window size, cursor location, scroll position, and so on) should always be automatically preserved when the user changes it.

Use of Recognition Memory: Continuous visibility of objects and actions encourages use of a person's more powerful recognition memory. The "out of sight, out of mind" problem is eliminated

CONCURRENT PERFORMANCE OF FUNCTIONS

Graphic systems may do two or more things at one time. Multiple programs may run simultaneously. When a system is not busy on a primary task, it may process background tasks (cooperative multitasking). When applications are running as truly separate tasks, the system may divide the processing power into time slices and allocate portions to each application.

Data may also be transferred between programs. It may be temporarily stored on a "clipboard" for later transfer or be automatically swapped between programs.

THE GRAPHICAL USER INTERFACE

- A user interface is a collection of techniques and mechanisms to interact with something.
- In a graphical interface the primary interaction mechanism is a pointing device of some kind.
- This device is the electronic equivalent to the human hand. What the user interacts with is a collection of elements referred to as objects.
- They can be seen, heard, touched, or otherwise perceived.
- Objects are always visible to the user and are used to perform tasks.
- They are interacted with as entities independent of all other objects.
- People perform operations, called actions, on objects. The operations include accessing and modifying objects by pointing, selecting, and manipulating. All objects have standard resulting behaviors.

THE WEB USER INTERFACE

The expansion of the World Wide Web since the early 1990s has been truly amazing. Once simply a communication medium for scientists and researchers, its many and pervasive tentacles have spread deeply into businesses, organizations, and homes around the world. Unlike earlier text-based and GUI systems that were developed and nurtured in an organization's Data Processing and Information Systems groups, the Web's roots were sown in a market-driven society thirsting for convenience and information.

Web interface design is essentially the design of navigation and the presentation of information. It is about content, not data.

Proper interface design is largely a matter of properly balancing the structure and relationships of menus, content, and other linked documents or graphics. The design goal is

to build a hierarchy of menus and pages that feels natural, is well structured, is easy to use, and is truthful.

The Web is a navigation environment where people move between pages of information, not an application environment. It is also a graphically rich environment.

Web interface design is difficult for a number of reasons. First, its underlying design language, HTML, was never intended for creating screens to be used by the general population.

Its scope of users was expected to be technical. HTML was limited in objects and interaction styles and did not provide a means for presenting information in the most effective way for people.

Next, browser navigation retreated to the pre-GUI era. This era was characterized by a "command" field whose contents had to be learned, and a navigational organization and structure that lay hidden beneath a mostly dark and blank screen.

GUIs eliminated the absolute necessity for a command field, providing menus related to the task and the current contextual situation.

Browser navigation is mostly confined to a "Back" and "Forward" concept, but "back-to-where" and "forward-to-where" is often unremembered or unknown.

Web interface design is also more difficult because the main issues concern information Architecture and task flow, neither of which is easy to standardize.

It is more difficult because of the availability of the various types of multimedia, and the desire of many designers to use something simply because it is available.

It is more difficult because users are ill defined, and the user's tools so variable in nature.

The ultimate goal of a Web that feels natural, is well structured, and is easy to use will reach fruition.

THE POPULARITY OF THE WEB

While the introduction of the graphical user interface revolutionized the user interface, the Web has revolutionized computing.

It allows millions of people scattered across the globe to communicate, access information, publish, and be heard.

- It allows people to control much of the display and the rendering of Web pages.

- Aspects such as typography and colors can be changed, graphics turned off, and decisions made whether or not to transmit certain data over non secure channels or whether to accept or refuse cookies.
- Web usage has reflected this popularity. The number of Internet hosts has risen dramatically:
 - In 1984, hosts online exceeded 1,000;
 - in 1987, 10,000;
 - in 1989, 100,000,
 - in 1990, 300,000;
 - in 1992 hosts exceeded one million.
- Commercialization of the Internet saw even greater expansion of the growth rate. In 1993, Internet traffic was expanding at a 341,634 percent annual growth rate. In 1996, there were nearly 10 million hosts online and 40 million connected people (PBS Timeline).
- User control has had some decided disadvantages for some Web site owners as well.
- Users have become much more discerning about good design.
- Slow download times, confusing navigation, confusing page organization, disturbing animation, or other undesirable site features often results in user abandonment of the site for others with a more agreeable interface.
- People are quick to vote with their mouse, and these warnings should not go unheeded.

GUI VERSUS WEB PAGE DESIGN

- GUI and Web interface design do have similarities. Both are software designs, they are used by people, they are interactive, they are heavily visual experiences presented through screens, and they are composed of many similar components.
- Significant differences do exist.

CONCEPT GUI WEB

- User hardware variations limited
- User hardware characteristics well defined.
- Screens appear exactly as specified.
- User hardware variations enormous.
- Screen appearance influenced by hardware being used.

GRAPHICAL USER INTERFACE

- User hardware variations limited
- User hardware characteristics well defined.
- Screens appear exactly as specified.

- Data and applications
- Typically created and used by known and trusted sources.
- Properties generally known.
- Typically placed into system by users or known people and organizations.
- Typically organized in a meaningful fashion.
- A notion of private and shared data exists:
- Install, configure, personalize, start, use, and upgrade programs.
- Open, use, and close data files.
- Fairly long times spent within an application. Familiarity with applications often achieved.
- Controlled and constrained by program.
- Windows, menus, controls, data, tool bars, messages, and so on.
- Many transient, dynamically appearing and disappearing.
- Presented as specified by designer. Generally standardized by toolkits and style guides
- Through menus, lists, trees, dialogs, and wizards. Not a strong and visible concept.
- Constrained by design.
- Generally standardized by toolkits and
- Style guides. User Focus • Data and applications • Information and navigation
- Enables maintenance of a better sense of context. Restricted navigation paths.
- Multiple viewable windows Interactions such as clicking menu choices, pressing buttons, selecting list choices, and cut/copy/paste occur within context of active program.
- Nearly instantaneous.
- Typically prescribed and constrained by toolkit.
- Visual creativity allowed but difficult.
- Little significant personalization.

- Unlimited capability proportional to sophistication of hardware and software. Targeted to a specific audience with specific tasks. Only limited by the amount of programming undertaken to support it
- Major objective exists within and across applications. Aided by platform toolkit and design guidelines. Universal consistency in GUI products generally created through toolkits and design guidelines.
- Integral part of most systems and applications. Accessed through standard mechanisms. Documentation, both online and offline,
- Usually provided.
- Personal support desk also usually provided
- Seamless integration of all applications into the platform environment a major objective.
- Toolkits and components are key elements in accomplishing this objective
- Tightly controlled in business systems, proportional to degree of willingness to invest resources and effort

WEB

- User hardware variations enormous.
- Screen appearance influenced by hardware being used.
- Information and navigation
- Full of unknown content.
- Source not always trusted.
- Often not placed onto the Web by users or known people and organizations.
- Highly variable organization.
- Privacy often suspect
- Link to a site, browse or read pages, fill out forms, register for services, participate in transactions, download and save things.
- Movement between pages and sites very rapid. Familiarity with many sites not established.
- Infinite and generally unorganized.
- Two components, browser and page.
- Within page, any combination of text, images, audio, video, and animation.
- May not be presented as specified by the designer dependent on browser, monitor, and user specifications.
- Little standardization
- Through links: bookmarks, and typed URLs. Significant and highly visible concept.
- Few constraints ,frequently causing a lost “sense of place”

- Few standards.
- Typically part of page design, fostering an lack of consistency
- Poorer maintenance of a sense of context. Single-page entities.
- Unlimited navigation paths.
- Contextual clues become limited or are difficult to find.
- Basic interaction is a single click. This can cause extreme changes in context, which may not be noticed.
- Quite variable, depending on transmission speeds, page content, and so on. Long times can upset the user
- Fosters a more artistic, individual, and unrestricted presentation style.
- Complicated by differing browser and display capabilities, and bandwidth limitations.
- Limited personalization available.
- Limited by constraints imposed by the hardware, browser, software, client support, and user willingness to allow features because of response time, security, and privacy concerns
- No similar help systems.
- The little available help is built into the page. Customer service support, if provided, oriented to product or service offered.
- Apparent for some basic functions within most Web sites (navigation, printing, and so on.)
- Sites tend to achieve individual distinction rather than integration.
- Susceptible to disruptions caused by user, telephone line and cable providers, Internet service providers, hosting servers, and remotely accessed sites.

PRINCIPLES OF USER INTERFACE DESIGN

- An interface must really be just an extension of a person. This means that the system and its software must reflect a person's capabilities and respond to his or her specific needs.
- It should be useful, accomplishing some business objectives faster and more efficiently than the previously used method or tool did.
- It must also be easy to learn, for people want to do, not learn to do.
- Finally, the system must be easy and fun to use, evoking a sense of pleasure and accomplishment not tedium and frustration.
- The interface itself should serve as both a connector and a separator
- a connector in that it ties the user to the power of the computer, and a separator in that it minimizes the possibility of the participants damaging one another.

- While the damage the user inflicts on the computer tends to be physical (a frustrated pounding of the keyboard), the damage caused by the computer is more psychological.
- Throughout the history of the human-computer interface, various researchers and writers have attempted to define a set of general principles of interface design.
- What follows is a compilation of these principles. They reflect not only what we know today, but also what we think we know today.
- Many are based on research, others on the collective thinking of behaviorists working with user interfaces.
- These principles will continue to evolve, expand, and be refined as our experience with Gills and the Web increases.

PRINCIPLES FOR THE XEROX STAR

- The design of the Xerox STAR was guided by a set of principles that evolved over its lengthy development process. These principles established the foundation for graphical interfaces.
- Displaying objects that are selectable and manipulable must be created.
- A design challenge is to invent a set of displayable objects that are represented meaningfully and appropriately for the intended application.
- It must be clear that these objects can be selected, and how to select them must be Self-evident.
- When they are selected should also be obvious, because it should be clear that the selected object will be the focus of the next action. Standalone icons easily fulfilled this requirement.
- The handles for windows were placed in the borders.
- Visual order and viewer focus: Attention must be drawn, at the proper time, to the important and relevant elements of the display. Effective visual contrast between various components of the screen is used to achieve this goal. Animation is also used to draw attention, as is sound.

Feedback must also be provided to the user. Since the pointer is usually the focus of viewer attention, it is a useful mechanism for providing this feedback (by changing shapes).

- Revealed structure: The distance between one's intention and the effect must be minimized.

Most often, the distance between intention and effect is lengthened as system power increases. The relationship between intention and effect must be, tightened and made as apparent as possible to the user. The underlying structure is often revealed during the selection process.

- Consistency: Consistency aids learning. Consistency is provided in such areas as element location, grammar, font shapes, styles, and sizes, selection indicators, and contrast and emphasis techniques.
- Appropriate effect or emotional impact: The interface must provide the appropriate emotional effect for the product and its market. Is it a corporate, professional, and secure business system? Should it reflect the fantasy, wizardry, and bad puns of computer games?
- A match with the medium: The interface must also reflect the capabilities of the device on which it will be displayed. Quality of screen images will be greatly affected by a device's resolution and color-generation capabilities.

GENERAL PRINCIPLES

- The design goals in creating a user interface are described below.
- They are fundamental to the design and implementation of all effective interfaces, including GUI and Web ones.
- These principles are general characteristics of the interface, and they apply to all aspects.
- The compilation is presented alphabetically, and the ordering is not intended to imply degree of importance.

Aesthetically Pleasing

Provide visual appeal by following these presentation and graphic design principles:

- Provide meaningful contrast between screen elements.
- Create groupings.
- Align screen elements and groups.
- Provide three-dimensional representation.

- Use color and graphics effectively and simply.

Clarity

The interface should be visually, conceptually, and linguistically clear, including

- Visual elements
- Functions
- Metaphors
- Words and Text

Compatibility

Provide compatibility with the following:

- The user
- The task and job
- The Product

Adopt the User's Perspective

Configurability

Permit easy personalization, configuration, and reconfiguration of settings.

- Enhances a sense of control
- Encourages an active role in understanding

Comprehensibility

A system should be easily learned and understood: A user should know the following:

- What to look at
- What to do
- When to do it
- Where to do it
- Why to do it
- How to do it

The flow of actions, responses, visual presentations, and information should be in a sensible order that is easy to recollect and place in context.

Consistency

A system should look, act, and operate the same throughout. Similar components should:

- Have a similar look.
- Have similar uses.
- Operate similarly.

- The same action should always yield the same result
- The function of elements should not change.
- The position of standard elements should not change.

Control

The user must control the interaction.

- Actions should result from explicit user requests.
- Actions should be performed quickly.
- Actions should be capable of interruption or termination.
- The user should never be interrupted for errors
- The context maintained must be from the perspective of the user.
- The means to achieve goals should be flexible and compatible with the user's skills, experiences, habits, and preferences.
- Avoid modes since they constrain the actions available to the user.
- Permit the user to customize aspects of the interface, while always providing a Proper set of defaults

Directness

Provide direct ways to accomplish tasks.

- Available alternatives should be visible.
- The effect of actions on objects should be visible.

Flexibility

A system must be sensitive to the differing needs of its users, enabling a level and type of performance based upon:

- Each user's knowledge and skills.
- Each user's experience.
- Each user's personal preference.
- Each user's habits.
- The conditions at that moment.

Efficiency

Minimize eye and hand movements, and other control actions.

- Transitions between various system controls should flow easily and freely.
- Navigation paths should be as short as possible.
- Eye movement through a screen should be obvious and sequential.

Anticipate the user's wants and needs whenever possible.

Familiarity

- Employ familiar concepts and use a language that is familiar to the user.
- Keep the interface natural, mimicking the user's behavior patterns.
- Use real-world metaphors.

Forgiveness

- Tolerate and forgive common and unavoidable human errors.
- Prevent errors from occurring whenever possible.
- Protect against possible catastrophic errors.
- When an error does occur, provide constructive messages.
-

Predictability

- The user should be able to anticipate the natural progression of each task.
 - Provide distinct and recognizable screen elements.
 - Provide cues to the result of an action to be performed.
- All expectations should be fulfilled uniformly and completely.

Recovery

A system should permit:

- Commands or actions to be abolished or reversed.
- Immediate return to a certain point if difficulties arise.

Ensure that users never lose their work as a result of:

- An error on their part.
- Hardware, software, or communication problems

Responsiveness

The system must rapidly respond to the user's requests. Provide immediate acknowledgment for all user actions:

- Visual.
- Textual
- Auditory.

Transparency

Permit the user to focus on the task or job, without concern for the mechanics of the interface.

- Workings and reminders of workings inside the computer should be invisible to the user.

Simplicity

Provide as simple an interface as possible.

Five ways to provide simplicity:

- Use progressive disclosure, hiding things until they are needed
- Present common and necessary functions first
- Prominently feature important functions
- Hide more sophisticated and less frequently used functions.
- Provide defaults.
- Minimize screen alignment points.
- Make common actions simple at the expense of uncommon actions being made harder.
- Provide uniformity and consistency.

UNIT-II

OBSTACLES AND PITFALLS IN DEVELOPMENT PATH

- No body ever gets it right for the first time
- Development is chock full of surprises.
- Good design requires living in a sea of changes.
- Designers need good tools.
- Performance design goals
- People may make mistakes while using a good system also

COMMON PITFALLS

- No early analysis and understanding the users needs and expectations.
- A focus on using design features or components .
- No usability testing.
- No common design team vision.
- Poor communication

COMMON USABILITY PROBLEMS

- Ambiguous menus and icons.
- Languages that permit only single direction movement through a system.
- Input and direct manipulation limits.
- Complex linkage.
- Inadequate feedback.
- Lack of system anticipation.
- Inadequate error messages.

IRRITATING CHARACTERS

- Visual clutter
- Impaired information readability
- Incomprehensible components
- Annoying distractions.
- Confusing navigation.
- Inefficient operations
- Inefficient page scrolling.
- Information overload

DESIGN TEAM

- Development
- Human factors
- Visual Design
- Usability assesment
- Documentation
- Training

HUMAN INTERACTION WITH COMPUTERS

Understanding How People Interact with Computers Characteristics of computer systems, past and present, that have caused, and are causing, people problems. We will then look at the effect these problems have –

- Why people have trouble with computers
- Responses to poor design
- People and their tasks

Why People Have Trouble with Computers

- Extensive technical knowledge but little behavioral training.
- With its extensive graphical capabilities.
- Poorly designed interfaces.
- What makes a system difficult to use in the eyes of its user?
- Use of jargon
- Non-obvious design
- Fine distinctions
- Disparity in problem-solving strategies
- an "error-preventing" strategy
- Design inconsistency

PSYCHOLOGICAL

Typical psychological responses to poor design are:

- Confusion: Detail overwhelms the perceived structure. Meaningful patterns are difficult to ascertain, and the conceptual model or underlying framework cannot be understood or established.
- Annoyance: Roadblocks that prevent a task being completed, or a need from being satisfied, promptly and efficiently lead to annoyance. Inconsistencies in design, slow computer reaction times, difficulties in quickly finding information, outdated

information, and visual screen distractions are a few of the many things that may annoy users.

- Frustration: An overabundance of annoyances, an inability to easily convey one's intentions to the computer, or an inability to finish a task or satisfy a need can cause frustration. Frustration is heightened if an unexpected computer response cannot be undone or if what really took place cannot be determined: Inflexible and unforgiving systems are a major source of frustration.
- Panic or stress: Unexpectedly long delays during times of severe or unusual pressure may introduce panic or stress. Some typical causes are unavailable systems or long response times when the user is operating under a deadline or dealing with an irate customer.
- Boredom: Boredom results from improper computer pacing (slow response times or long download times) or overly simplistic jobs.
- These psychological responses diminish user effectiveness because they are severe blocks to concentration.

--Thoughts irrelevant to the task at hand are forced to the user's attention, and necessary concentration is impossible.

--The result, in addition to higher error rates, is poor performance, anxiety, and dissatisfaction Physical.

- Psychological responses frequently lead to, or are accompanied by, the following physical reactions.
- Abandonment of the system: The system is rejected and other information sources are relied upon. These sources must, of course, be available and the user must have the discretion to perform the rejection.

In business systems this is a common reaction of managerial and professional personnel. With the Web, almost all users can exercise this option.

- Partial use of the system: Only a portion of the system's capabilities are used, usually those operations that are easiest to perform or that provide the most benefits. Historically, this has been the most common user reaction to most computer systems. Many aspects of many systems often go unused.
- Indirect use of the system: An intermediary is placed between the would-be user and the computer. Again, since this requires high status and discretion, it is another typical response of managers or others with authority.

- Modification of the task: The task is changed to match the capabilities of the system. This is a prevalent reaction when the tools are rigid and the problem is unstructured, as in scientific problem solving.
- Compensatory activity: Additional actions are performed to compensate for system inadequacies. A common example is the manual reformatting of information to match the structure required by the computer. This is a reaction common to workers whose discretion is limited, such as clerical personnel.
- Misuse of the system: The rules are bent to shortcut operational difficulties. This requires significant knowledge of the system and may affect system integrity.
- Direct programming: The system is reprogrammed by its user to meet specific needs. This is a typical response of the sophisticated worker.
- These physical responses also greatly diminish user efficiency and effectiveness. They force the user to rely upon other information sources, to fail to use a system's complete capabilities, or to perform time-consuming "work-around" actions

IMPORTANT HUMAN CHARACTERISTICS IN DESIGN

- Importance in design are perception, memory, visual acuity, foveal and peripheral vision, sensory storage, information processing, learning, skill, and individual differences.
 - Perception
 - Proximity
 - Similarity
 - Matching patterns
 - Succinctness
 - Closure
 - Unity
 - Continuity
 - Balance
 - Expectancies
 - Context
 - Signals versus noise
- Memory: Memory is not the most stable of human attributes, as anyone who has forgotten why they walked into a room, or forgotten a very important birthday, can attest.
 - -*Short-term*, or working, memory.
 - *Long-term* memory
 - *Mighty* memory
 - Sensory Storage

- Mental Models: As a result of our experiences and culture, we develop mental models of things and people we interact with.
- A mental model is simply an internal representation of a person's current understanding of something. Usually a person cannot describe this mental model and most often is unaware it even exists.
- Mental models are gradually developed in order to understand something, explain things, make decisions, do something, or interact with another person.
- Mental models also enable a person to predict the actions necessary to do things if the action has been forgotten or has not yet been encountered.
- Movement Control : Once data has been perceived and an appropriate action decided upon, a response must be made.
- In many cases the response is a movement. In computer systems, movements include such activities as pressing keyboard keys, moving the screen pointer by pushing a mouse or rotating a trackball, or clicking a mouse button

THE IMPLICATIONS IN SCREEN DESIGN

- Learning: Learning, as has been said, is the process of encoding information in long-term memory information that is contained in short-term memory.
- It is a complex process requiring some effort on our part. Our ability to learn is important-it clearly differentiates people from machines.
- Given enough time people can improve the performance in almost any task. Too often, however, designers use our learning ability as an excuse to justify complex design.
- A design developed to minimize human learning time can greatly accelerate human performance.
- People prefer to stick with what they know, and they prefer to jump in and get started. Unproductive time spent learning is something frequently avoided.
- Skill: The goal of human performance is to perform skillfully. To do so requires linking inputs and responses into a sequence of action.

- The essence of skill is performance of actions or movements in the correct time sequence with adequate precision. It is characterized by consistency and economy of effort.
- Economy of effort is achieved by establishing a work pace that represents optimum efficiency.
- It is accomplished by increasing mastery of the system through such things as progressive learning of shortcuts, increased speed, and easier access to information or data.
- Skills are hierarchical in nature, and many basic skills may be integrated to form increasingly complex ones. Lower-order skills tend to become routine and may drop out of consciousness.
- System and screen design must permit development of increasingly skillful performance.
- Individual Differences: In reality, there is no average user. A complicating but very advantageous human characteristic is that we all differ-in looks, feelings, motor abilities, intellectual abilities, learning abilities and speed, and so on.
- In a keyboard data entry task, for example, the best typists will probably be twice as fast as the poorest and make 10 times fewer errors.
- Individual differences complicate design because the design must permit people with widely varying characteristics to satisfactorily and comfortably learn the task or job, or use the Web site.
- In the past this has usually resulted in bringing designs down to the level of lowest abilities or selecting people with the minimum skills necessary to perform a job.
- But technology now offers the possibility of tailoring jobs to the specific needs of people with varying and changing learning or skill levels. Multiple versions of a system can easily be created.
- Design must provide for the needs of all potential users

HUMAN CONSIDERATIONS IN DESIGN

- The User's Knowledge and Experience
The knowledge possessed by a person, and the experiences undergone, shape the design of the interface in many ways. The following kinds of knowledge and experiences should be identified.
- Computer Literacy - Highly technical or experienced, moderate computer experience, or none
- System Experience - High, moderate, or low knowledge of a particular system and its methods of interaction
- Application Experience - High, moderate, or low knowledge of similar systems

HUMAN CONSIDERATIONS IN DESIGN

- Task Experience - Other Level of knowledge of job and job tasks
- Systems Use - Frequent or infrequent use of other systems in doing job
- Education - High school, college, or advanced degree
- Reading Level - Less than 5th grade, 5th-12th, more than 12th grade
- Typing Skill - Expert (135 WPM), skilled (90 WPM), good (55 WPM), average (40 WPM), or "hunt and peck" (10 WPM).
- Native Language or Culture- English, another, or several.

JOB/TASK/NEED

- Type of System Use - Mandatory or discretionary use of the system.
- Frequency of Use - Continual, frequent, occasional, or once-in-a-lifetime use of system
- Task or Need importance - High, moderate, or low importance of the task being performed
- Task Structure - Repetitiveness or predictability of tasks being automated, high, moderate, or low
- Social Interactions - Verbal communication with another person required or not required
- Primary Training - Extensive or formal training, self training through manuals, or no training
- Turnover Rate - High, moderate, or low turnover rate for jobholders
- Job Category - Executive, manager, professional, secretary, clerk
- Lifestyle - For Web e-commerce systems, includes hobbies, recreational pursuits, and economic status

PSYCHOLOGICAL CHARACTERISTICS

- Attitude - Positive, neutral, or negative feeling toward job or system
- Motivation - Low, moderate, or high due to interest or fear
- Patience - Patience or impatience expected in accomplishing goal
- Expectations - Kinds and reasonableness
- Stress Level - High, some, or no stress generally resulting from task performance
- Cognitive Style - Verbal or spatial, analytic or intuitive, concrete or abstract.

PHYSICAL CHARACTERISTICS

- Age Young middle aged or elderly
- Gender Male or Female
- Handness Left, right or ambidextrous
- Disabilities Blind, defective vision, deafness, motor handicap

HUMAN INTERACTION SPEEDS

- The speed at which people can perform using various communication methods has been studied by a number of researchers.
- Reading: The average adult, reading English prose in the United States, has a reading speed in the order of 250-300 words per minute. Proof reading text on paper has been found to occur at about 200 words per minute, on a computer monitor, about 180 words per minute.
- One technique that has dramatically increased reading speeds is called Rapid Serial Visual Presentation, or RSVP. In this technique single words are presented one at a time in the center of a screen. New words continually replace old words at a rate set by the reader. For a sample of people whose paper document reading speed was 342 words per minute. (With a speed range of 143 to 540 words per minute.) Single words were presented on a screen in sets at a speed sequentially varying ranging from 600 to 1,600 words per minute. After each set a comprehension test was administered.

READING

- Prose text - 250-300 words per minute.
- Proof reading text on paper - 200 words per minute.
- Proofreading text on a monitor - 180 words per minute.

LISTENING

- Speaking to a computer: 150-160 words per minute.
- After recognition corrections: 105 words per minute.

KEYING

- Typewriter
 - Fast typist: 150 words per minute and higher
 - Average typist: 60-70 words per minute
- Computer
 - Transcription: 33 words per minute
 - Composition: 19 words per minute
- Two finger typists
 - Memorized text: 37 words per minute
 - Copying text: 27 words per minute
- Hand printing
 - Memorized text: 31 words per minute.
 - Copying text: 22 words per minute.

UNDERSTAND THE BUSINESS FUNCTION

- Business definition and requirements analysis
 - Direct methods
 - Indirect methods
 - Requirements collection guidelines
- Determining basic business functions
 - Developing conceptual modes
 - Understanding mental models
 - Users new mental model
- Design standards or style guides
 - Value of standards and guidelines
 - Document design
 - Design support and implementation
- System training and documentation
 - Training
 - Documentation

DIRECT METHODS

- Individual Face-to-Face Interview
- Telephone Interview or Survey
- Traditional Focus Group
- Facilitated Team Workshop
- Observational Field Study
- User-Interface Prototyping
- Usability Laboratory Testing
- Card Sorting for Web Sites
- A technique to establish groupings of information for Web sites

INDIRECT METHODS

- MIS Intermediary
- Paper Surveyor Questionnaire
- Electronic Surveyor Questionnaire
- Electronic Focus Group
- Marketing and Sales
- Support Line
- E-Mail or Bulletin Board
- User Group
- Competitor Analyses
- Trade Show
- Other Media Analysis
- System Testing

DETERMINING BASIC BUSINESS FUNCTIONS

- Major system functions are listed and described, including critical system inputs and outputs.

A flowchart of major functions is developed. The process the developer will use is summarized as follows:

Gain a complete understanding of the user's mental model based upon:

- The user's needs and the user's profile.
- A user task analysis.
- Develop a conceptual model of the system based upon the user's mental model.
This includes:
 - Defining objects.
 - Developing metaphors.

UNDERSTANDING THE USER'S MENTAL MODEL

- The next phase in interface design is to thoroughly describe the expected system user or users and their current tasks.
- The former will be derived from the kinds of information collected in Step 1 "Understand the User or Client," and the requirements analysis techniques described above.
- A goal of task analysis, and a goal of understanding the user, is to gain a picture of the user's mental model.
- A mental model is an internal representation of a person's current conceptualization and understanding of something.
- Mental models are gradually developed in order to understand, explain, and do something.
- Mental models enable a person to predict the actions necessary to do things if the actions have been forgotten or have not yet been encountered.

PERFORMING A TASK ANALYSIS

- User activities are precisely.
- Task analysis involves breaking down the user's activities to the individual task level.
- Knowing why establishes the major work goals;
- Complete description of all user tasks and interactions.
- Work activities are studied using the techniques just reviewed;
- Direct observation, interviews, questionnaires, or obtaining measurements of actual current system usage.
- Listing of the user's current tasks.
- Another result is a list of objects the users see as important to what they do

DEVELOPING CONCEPTUAL MODELS

- The output of the task analysis is the creation, by the designer, of a conceptual model for the user interface.
- A conceptual model is the general conceptual framework through which the system's functions are presented.
- Such a model describes how the interface will present objects, the relationships between objects, the properties of objects, and the actions that will be performed.

- A conceptual model is based on the user's mental model. Since the term mental model refers to a person's current level of knowledge about something, people will always have them

DEVELOPING CONCEPTUAL MODELS

- Since mental models are influenced by a person's experiences, and people have different experiences, no two user mental models are likely to be exactly the same.
- Each person looks at the interface from a slightly different perspective. The goal of the designer is to facilitate for the user the development of useful *mental model of the system*.
- This is accomplished by presenting to the user a *meaningful conceptual model of the system*.
- When the user then encounters the system, his or her *existing mental model* will, hopefully, mesh well with the system's conceptual model.
- As a person works with a system, he or she then develops a *mental model of the system*.
- The system mental model the user derives is based upon system's behavior, including factors such as the system inputs, actions, outputs (including screens and messages), and its feedback and guidance characteristics, all of which are components of the conceptual model.
- Documentation and training also play a formative role. Mental models will be developed regardless of the particular design of a system, and then they will be Modified with experience.
- What must be avoided in design is creating for the user a conceptual model that leads to the creation of a false mental model of the system, or that inhibits the user from creating a meaningful or efficient mental model.

Guidelines for Designing Conceptual Models

- Reflect the user's mental model, not the designer's.
- Draw physical analogies or present metaphors.
- Comply with expectancies, habits, routines, and stereotypes.
- Provide action-response compatibility.
- Make invisible parts and process of a system visible.
- Provide proper and correct feedback.
- Avoid anything unnecessary or irrelevant.

- Provide design consistency.
- Provide documentation and a help system that will reinforce the conceptual model.
- Promote the development of both novice and expert mental models.

Defining Objects

- Determine all objects that have to be manipulated to get work done.

Describe:

- The objects used in tasks.
 - Object behavior and characteristics that differentiate each kind of object.
 - The relationship of objects to each other and the people using them.
 - The actions performed.
 - The objects to which actions apply.
 - State information or attributes that each object in the task must preserve, display, or allow to be edited.
- Identify the objects and actions that appear most often in the workflow.
 - Make the several most important objects very obvious and easy to manipulate

Developing Metaphors

- Choose the analogy that works best for each object and its actions.
- Use real-world metaphors.
- Use simple metaphors.
- Use common metaphors.
- Multiple metaphors may coexist.
- Use major metaphors, even if you can't exactly replicate them visually.
- Test the selected metaphors.

SCREEN DESIGNING

How to distract the screen user

- Unclear captions
- Improper type and graphic emphasis
- Misleading headings
- Irrelevant and unnecessary headings
- Inefficient results
- Clustered and cramped layout
- Poor quality of presentation
- Legibility
- Appearance
- arrangement
- Visual inconsistency

- Lack of design features
- Over use of 3D presentations
- Overuse of too many bright colors
- Bad typography

Variety of distractions

- Numerous audio and visual interruptions
- Extensive visual clutter
- Poor information readability
- In comprehensible screen components
- Confusing and inefficient navigation
- Inefficient operations
- Excessive or inefficient page scrolling
- Information overload
- Design in consistency
- Outdated information

What screen users want

- an orderly clean clutter free appearance
- An obvious indication of what is being shown and what should be done with it.
- Expected information located where it should be.
- A clear indication of what relates to what.
- Plain and simple english
- A clear indication of when an action can make a permanent change in data

What screen users do

- Identifies a task to be performed or need to be fulfilled.
- Decides how the task will be completed or need fulfilled.
- Manipulates the computers controls.
- Gathers necessary data.
- Forms judgments resulting in decisions relevant to task.

Design goals

- Reduce visual work
- Reduce intellectual work
- Reduce memory work
- Reduce mentor work
- Eliminate burdens or instructions.

SCREEN MEANING AND PURPOSE

Each screen element

- Every control
- All text
- Screen organization

- All emphasis
- Each color
- Every graphic
- All screen animation
- All forms of feedback

Must

- Have meaning to screen users
- Serve a purpose in performing task organizing screen elements

Consistency

- Provide real world consistency
- Provide internal consistency
- Operational and navigational procedures
- Visual identity or theme
- Component
- Organization
- Presentation
- Usage
- Locations
- Follow the same conventions
- Deviate only when there is clear benefit to user

ORDERING OF SCREEN DATA & CONTENT

- Divide information into units that are logical, meaningful and sensible.
- Organize by interrelationships between data or information.
- Provide an ordering of screen units of elements depending on priority.
- Possible ordering schemes include
 - Conventional
 - Sequence of use
 - Frequency of use
 - Function
 - Importance
 - General to specific.
- Form groups that cover all possibilities.
- Ensure that information is visible.
- Ensure that only information relative to task is presented on screen.
- Organizational scheme is to minimize number of information variables.
- Upper left starting point
- Provide an obvious starting point in the screen's upper left Corner.

SCREEN NAVIGATION AND FLOW

- Provide an ordering of screen information and elements that:

- is rhythmic guiding a person's eye through display
- encourages natural movement sequences.
- minimizes pointer and eye movement distances.
- Locate the most important and most frequently used elements or controls at top left.
- Maintain top to bottom , left to right flow.
- Assist in navigation through a screen by
 - Aligning elements
 - Grouping elements
 - Use of line borders
 -
- Through focus and emphasis, sequentially, direct attention to items that are
 - Critical
 - Important
 - Secondary
 - Peripheral
 -
- Tab through window in logical order of displayed information.
- locate command button at the end of the tabbing order sequence,
- When groups of related information must be broken and displayed on separate screens, provide breaks at logical or natural points in the information flow.
- In establishing eye movement through a screen, also consider that the eye tends to move sequentially , for example –
 - From dark areas to light areas
 - From big objects to little objects
 - From unusual shapes to common shapes.
 - From highly saturated colors to unsaturated colors.
- These techniques can be initially used o focus a person's attention.
- Maintain top to bottom, left to right through the screen. This top to bottom orientation is Recommended for information entry for the following reasons –
 - Eye movements between items will be shorter.
 - Control movements between items will be shorter.
 - Groupings are more obvious perceptually.
 - When one's eyes moves away from the screen and then back, it returns to about same place it left, even if it is seeking next item in sequence.
 -
- Most product style guides recommend a left to right orientation.
- Our earliest display screens reflected this left to right entry orientation.

- Top to bottom orientation is also recommended for presenting displays of read only information that must be scanned.

VISUALLY PLEASING COMPOSITION

- Provide visually pleasing composition with the following qualities –
 - balance
 - Symmetry
 - Regularity
 - Predictability
 - Sequentiality
 - Economy
 - Unity
 - Proportion
 - Simplicity
 - Groupings.

Balance

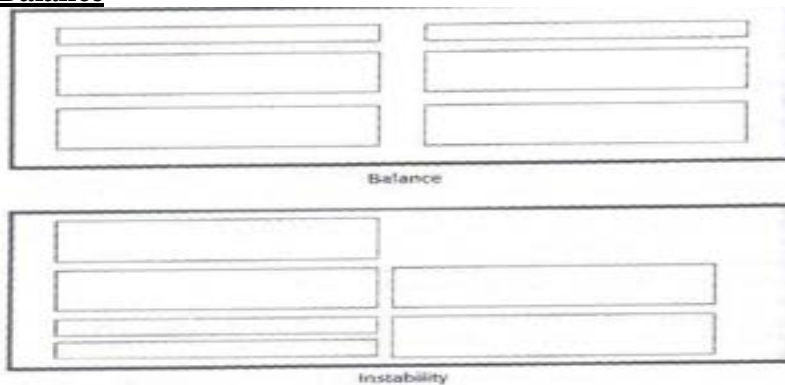


Figure 3.1 Balance (versus instability).

Symmetry

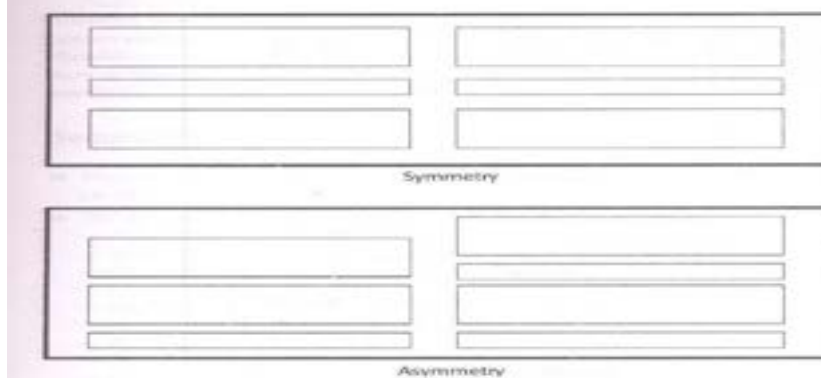


Figure 3.2 Symmetry (versus asymmetry).

Regularity

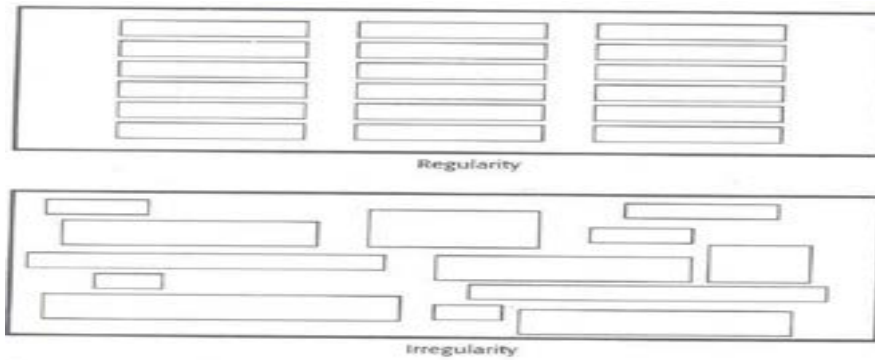


Figure 3.3 Regularity (versus irregularity).

Predictability

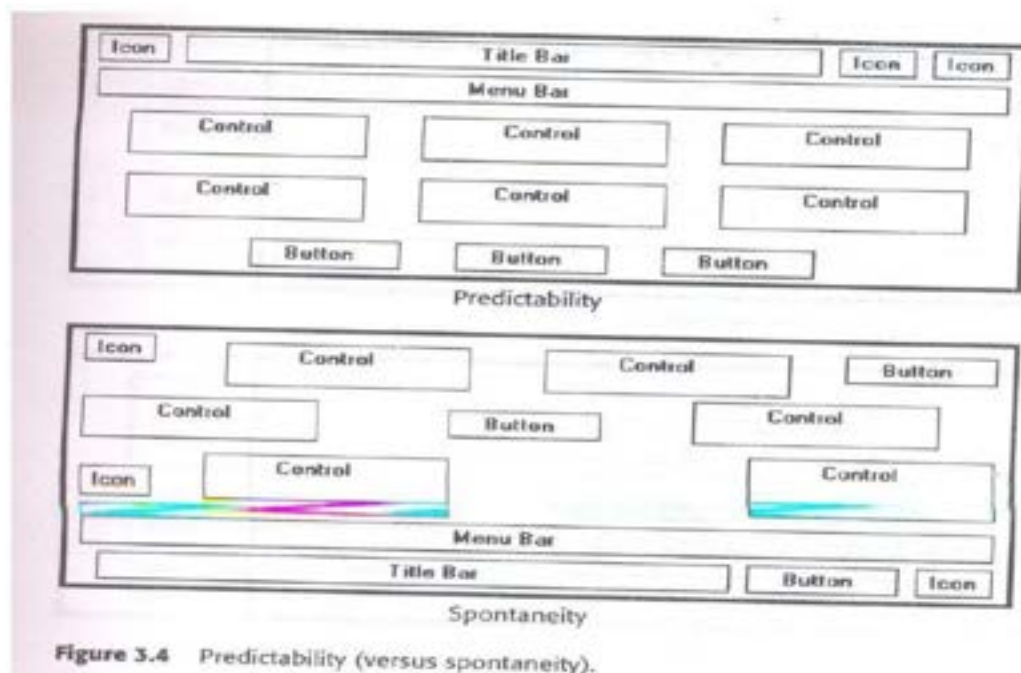


Figure 3.4 Predictability (versus spontaneity).

Sequentially

- The eye tends to be attracted to :
- A brighter element before one less bright
- Isolated elements before elements in a group
- Graphics before text
- Color before black and white
- Highly saturated colors before those less saturated.
- Dark areas before light areas
- A big element before a small one

- An unusual shape before a usual one
- Big objects before little objects

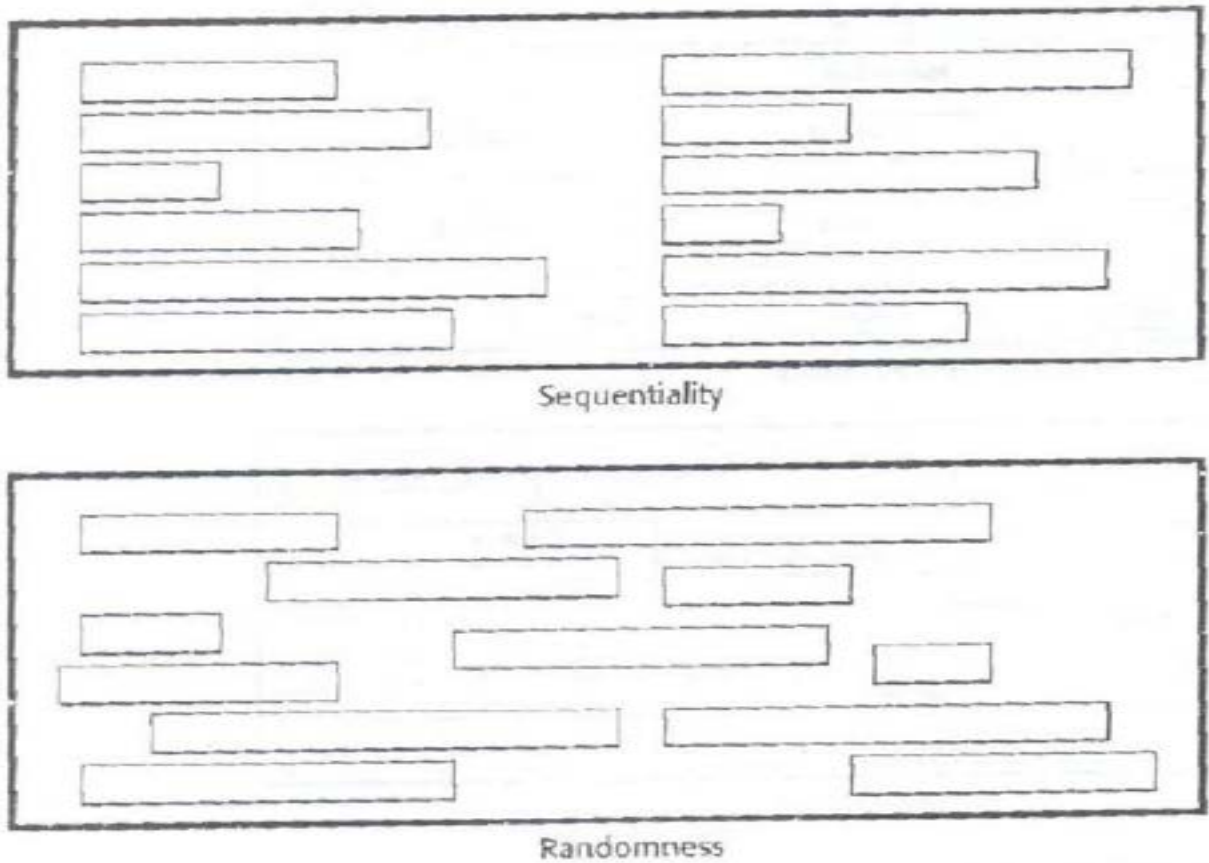


Figure 3.5 Sequentiality (versus randomness).

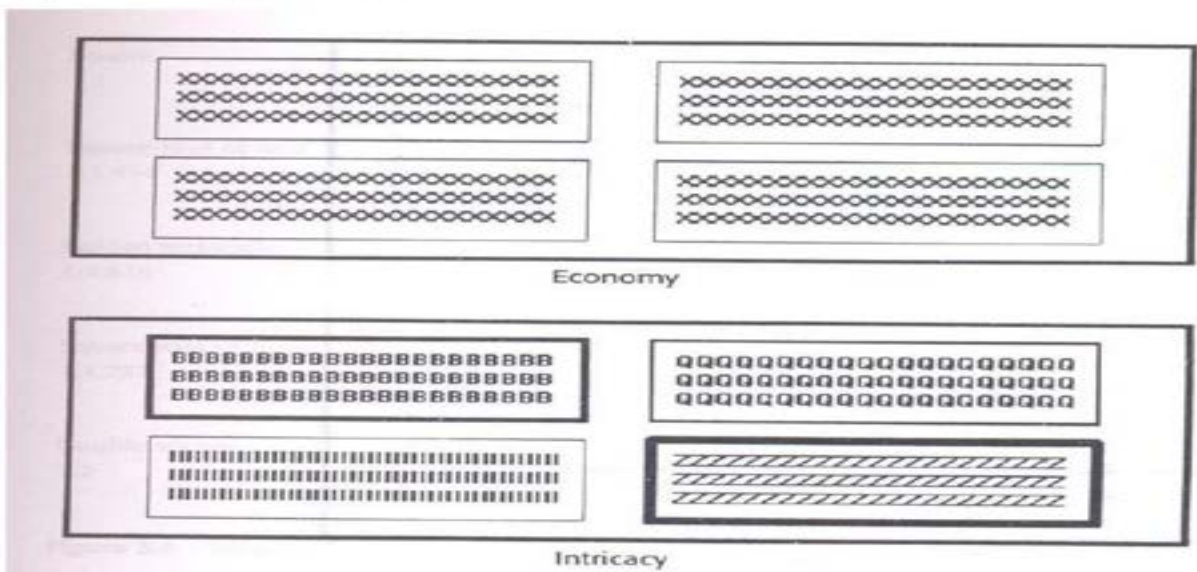


Figure 3.6 Economy (versus intricacy).

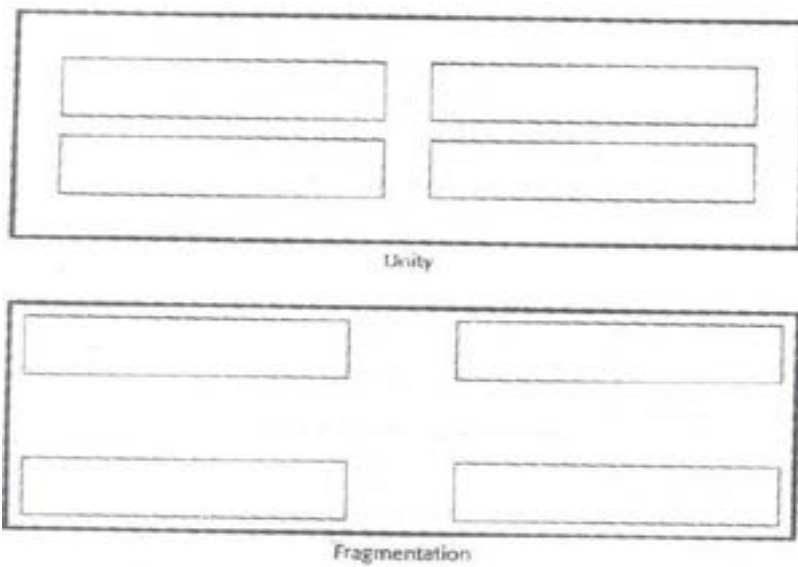
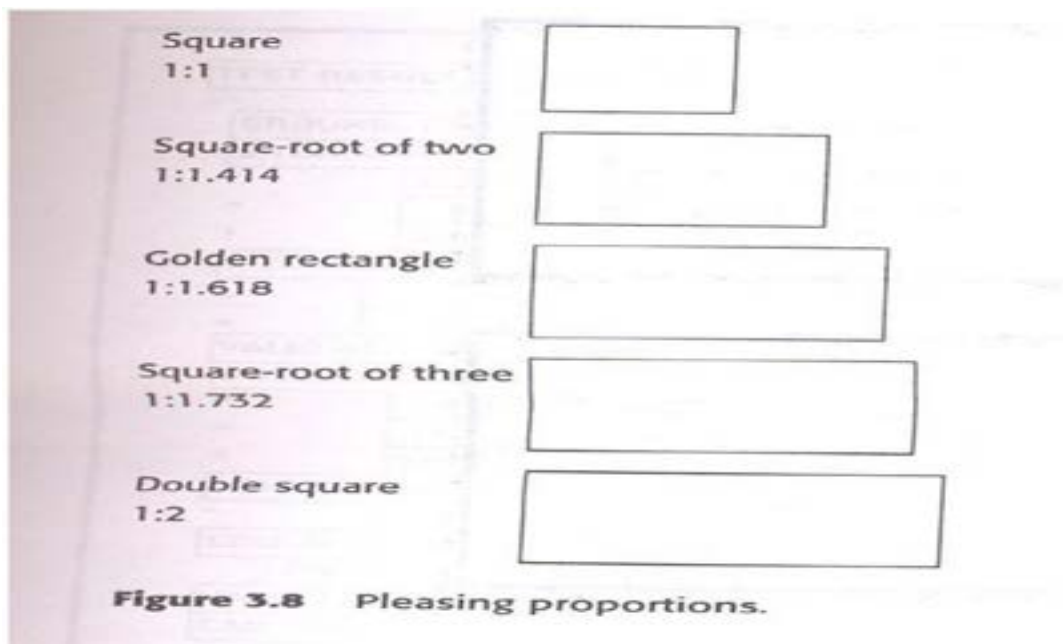


Figure 3.7 Unity (versus fragmentation).



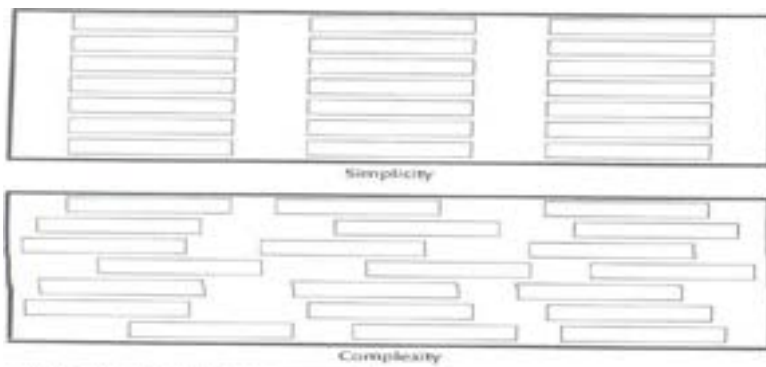


Figure 3.9 Simplicity (versus complexity).

TEST RESULTS	SUMMARY:	GROUND
GROUND, FAULT T-G		
3 TERMINAL DC RESISTANCE		
+	3500.00 K OHMS T-R	
+	14.21 K OHMS T-R	
+	3500.00 K OHMS R-G	
3 TERMINAL DC VOLTAGE		
+	0.00 VOLTS T-G	
+	0.00 VOLTS R-G	
VALID AC SIGNATURE		
3 TERMINAL AC RESISTANCE		
+	8.02 K OHMS T-R	
+	14.17 K OHMS T-R	
+	820.52 K OHMS R-G	
LONGITUDINAL BALANCE PSOR		
+	30 DB	
COULD NOT COUNT RINGERS DUE TO		
LOW RESISTANCE		
VALID LINE C.R.T CONFIGURATION		
CAN SWAN AND BREAK DIAL TONE		

Figure 3.10 Original screen, from Tullis (1981), with title, captions, and data inscribed by rectangles.

- Figure 3.11 (redesigned):
 18 fields with 7 horizontal (column) alignment points = 43 bits.
 18 fields with 8 vertical (row) alignment points = 53 bits.
 Overall complexity = 96 bits.

TIP GROUND 14 K

DC RESISTANCE

3500 K T-R
14 K T-G
2500 K R-G

DC VOLTAGE

0 V T-G
0 V R-G

AC SIGNATURE

9 K T-R
14 K T-G
629 K R-G

BALANCE

39 DB

CENTRAL OFFICE

VALID LINE CKT
DIAL TONE OK

Figure 3.11 Redesigned screen, from Tullis (1981), with title, captions, and data inscribed by rectangles.

TEST RESULTS SUMMARY: GROUND

GROUND, FAULT T-G

3 TERMINAL DC RESISTANCE

> 3500.00 K OHMS T-R
= 14.21 K OHMS T-R
> 3500.00 K OHMS R-G

3 TERMINAL DC VOLTAGE

= 0.00 VOLTS T-G
= 0.00 VOLTS R-G

VALID AC SIGNATURE

3 TERMINAL AC RESISTANCE

= 8.82 K OHMS T-R
= 14.17 K OHMS T-R
= 628.52 K OHMS R-G

LONGITUDINAL BALANCE POOR

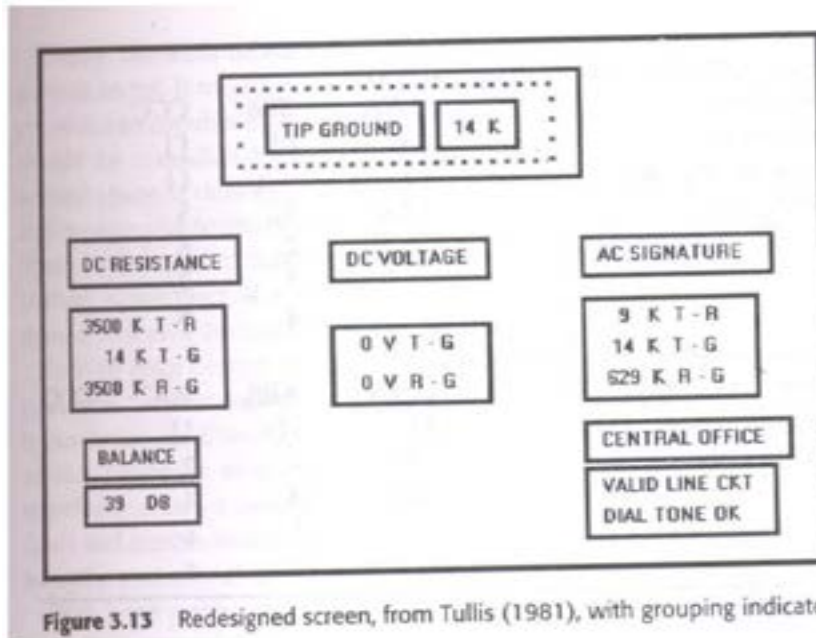
= 39 DB

COULD NOT COUNT RINGERS DUE TO LOW RESISTANCE

VALID LINE CKT CONFIGURATION

CAN DRAW AND BREAK DIAL TONE

Figure 3.12 Original screen, from Tullis (1981), with grouping indicated by bold boxes.



GROUPING USING BORDERS

- Provide functional groupings
- Create spatial groupings
- Provide meaningful titles for each grouping
- Incorporate line borders
- Do not exceed three line thickness
- Create lines consistent in height and length
- For adjacent groupings with borders where ever possible
- Use rules and borders sparingly

FOCUS AND EMPHASIS

- Visually emphasize the
- Most prominent element
- Most important elements
- Central idea or focal point
- De emphasize less important elements
- To ensure that
- Too many screen elements are emphasized.
- Screen clutter
- Using too many emphasize techniques
- To provide emphasis use techniques such as :
- Higher brightness
- Reverse polarity
- Larger and distinctive font

- Underlining
- Blinking
- Line rulings
- Contrasting colors
- Larger size
- Positioning
- Isolation
- Distinctiveness
- White space

INFORMATION RETRIEVAL ON WEB

- The most sought after web commodity is content.
- Behavior is often goal driven.
- Reading is no longer a linear activity.
- Impatience.
- Frequent switching of purpose.
- Web users access site for different reasons: a focused search for a piece of information or an answer less focused for browsing or surf.
- High tech capabilities, fancy graphics do not compensate for inefficient or poor content.
- Initial focus on attention
- Page perusal
- Scanning guidelines
- Browsing
- Browsing guidelines
- Searching
- Problems with search facilities
- Search facility guidelines
- Express the search
- Progressive search refinement
- Launch the search
- Present meaningful results

SCANNING GUIDELINES

- Organization
 - Minimize eye movement
 - Provide groupings of information
 - Organize content in a logical and obvious way.
- Writing
 - Provide meaningful headings and subheadings.
 - Provide meaningful titles
 - Concisely write the text.

- Use bullets/ numbers
- Array information in tables
- Presentation
 - Key information in words or phrases
 - Important concepts

BROWSING GUIDELINES

- Facilitate scanning
- Provide multiple layers of structure
- Make navigation easy
- Respect users desire to leave
- Upon returning help users reorient themselves.
- Users can browse deeply or simply move on.
- Provide guidance to help reorientation
- Understand terms to minimize to need for users to switch context.

PROBLEMS WITH SEARCHING

- Not understanding the user.
- Difficulties in formulating the search.
- Difficulties in presenting meaningful results.
- Identify the level of expertise of user.

KNOW THE SEARCH USER

- Plan for user's switchig purposes during search process.
- Plan for flexibility in the search process.
- Anticipate
- Nature of every possible query
- Kind of information desired
- How much information will result the search.

STATISTICAL GRAPHICS

- A statistical graphic is data presented in a graphical format.
- A well designed statistical graphic also refered to as chart or graph.
- Use of statistical graphics
 - reserve for material that is rich, complex or difficult.
- Data Presentation
 - emphasize the data
 - Minimize non data elements
 - Minimize redundant data
 - Fill the graph's available area with data.
 - Show data variation
- Provide proper context for data interpretation.

- Scales and shading
 - place ticks to marks scales on the outside edge of each axis.
 - employ a linear scale.
 - mark scales at standard or customary intervals
 - Start a numeric scale at zero.
 - display only a single scale on axis.
 - provide aids for scale interpretation.
 - clearly label each axis.
 - Provide scaling consistency
 - consider duplicate axis for large scale data.
 - Proportion
 - Lines
 - Labeling
 - Title
 - Interpretation of numbers

TYPES OF STATISTICAL GRAPHS

- ✓ curve and line graphs
- ✓ Single graph
- ✓ Four or five maximum
- ✓ Label identification
- ✓ Legend
- ✓ Tightly packed curves
- ✓ Important or critical data
- ✓ Comparing actual and projected data
- ✓ Data differences
- ✓ Surface charts
- ✓ Ordering
- ✓ Coding schemes
- ✓ Labels
- ✓ Scatter plots
- ✓ two dimensions
- ✓ Consistent intervals
- ✓ multiple data sets
- ✓ Significant points
- ✓ Bar graphs
- ✓ consistent orientation
- ✓ Meaningful organization
- ✓ Bar spacing
- ✓ Differentiation
- ✓ Important or critical data
- ✓ Related bar ordering
- ✓ Reference index
- ✓ labeling
- ✓ Segmented or stacked bars.

- ✓ Data category ordering
- ✓ Large segments
- ✓ Coding schemes
- ✓ labeling
- ✓ Flow charts
- ✓ Order of stps
- ✓ Orientation
- ✓ Coding conventions
- ✓ Arrows
- ✓ Highlighting
- ✓ One decission at each step
- ✓ Consistently order and word all choices
- ✓ Pie chart

TECHNOLOGICAL CONSIDERATION -INTERFACE DESIGN

Graphical systems

- Screen design must be compatible with the capabilities of the system –
 - system power
 - Screen size
 - Screen resolution
 - Display colors
 - Other display features
- Screen design must be compatible with the capabilities of the
 - Platform compatibility
 - development and implementation
 - Platform style guide
- Browser
 - compatibility
 - monitor size and resolution
 - fonts
 - Color
 - Bandwidth
 - Version
- Other considerations
 - Downloading
 - Currency
 - Page printing
 - Maintainability

UNIT-III

STRUCTURES OF MENUS

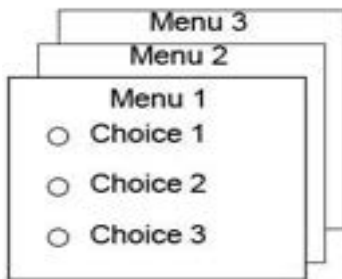
- **Single Menus**

– No other menus will follow necessitating additional user choices



- ☐ Novice
- ☐ Intermediate
- ☐ Expert

- **Sequential Linear Menus**

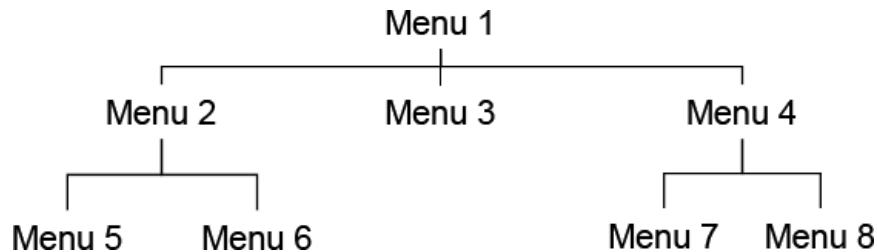


- **Simultaneous Menus**

<p>ALTERNATIVE 1</p> <ul style="list-style-type: none"> <input type="radio"/> Choice 1 <input type="radio"/> Choice 2 <input type="radio"/> Choice 3 <p>ALTERNATIVE 2</p> <ul style="list-style-type: none"> <input type="radio"/> Choice 1 <input type="radio"/> Choice 2 <input type="radio"/> Choice 3 	<p>ALTERNATIVE 3</p> <ul style="list-style-type: none"> <input type="radio"/> Choice 1 <input type="radio"/> Choice 2 <input type="radio"/> Choice 3 <p>ALTERNATIVE 4</p> <ul style="list-style-type: none"> <input type="radio"/> Choice 1 <input type="radio"/> Choice 2 <input type="radio"/> Choice 3
---	---

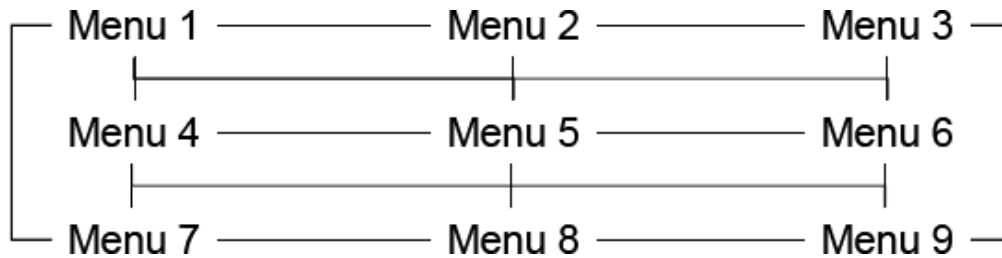
- **Hierarchical Menus**

- When many relationships exist between menu alternatives, and some menu options are only appropriate depending upon a previous menu selection, a hierarchical structure is the best solution.



- **Connected Menus**

- This menu gives you a full control over the navigation flow



- **Event-Trapping Menus**

- Provide ever-present background of control over the system's state and parameters while the user is working on a foreground task
 - Serve three functions
 - Immediately change some parameter in the current environment (bold text)
 - Take user out of current environment to perform function (spell check)
 - Exit and allow user to go to new environment (exit)

FUNCTIONS OF MENUS

- Navigation to a New Menu
- Execute an Action or Procedure
- Displaying Information
- Data or Parameter Input

CONTENT OF MENUS

- Menu Context
 - Provides information to keep the user oriented
- Menu Title
 - Provides the context for the current set of choices
- Choice Descriptions:
 - Descriptions can range from a mnemonic, numeric or alphabetized listing
- Completion Instructions
 - Tell users how to indicate their choices

FORMATTING OF MENUS

- Consistency
 - Provide consistency in menu
- Organization, presentation, and choice ordering
- Display
 - Frequent references
- Permanently display the menu in an area of the screen that will not obscure other screen data
 - Occasional references
- Presentation
 - Should be obvious with a unique and consistent structure
- Organization
 - Provide a main menu
 - Display
- All relevant alternatives (gray-out inactive choices)
 - Minimize number of menu levels
 - Number of menu choices presented on a screen
- 4-8 choices without logical grouping of elements

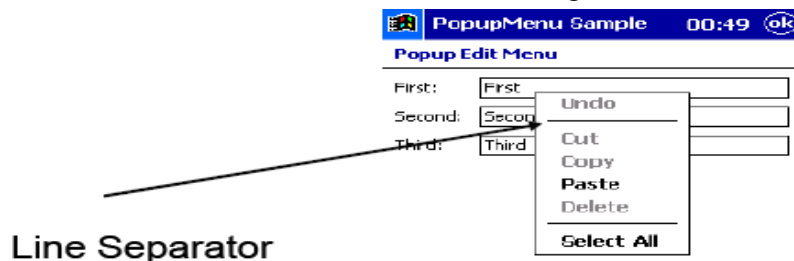
- 18-24 choices with logical groupings of elements with no more than 10 items within a group
 - Never require menus to be scrolled
- Complexity
 - Provide both simple and complex menus
- Item Arrangement
 - Orient for top-to-bottom reading
 - Left justify descriptions
 - Organize for left to right reading
- Ordering
 - Numeric order
 - Sequence/Frequency of occurrence
 - Importance
 - Semantic similarity

GROUPINGS

- Create grouping of items that are logical, unique, meaningful and mutually exclusive
- Present no more than six or seven groupings on screen
- Separate grouping created through either
 - Wider spacing, or a thin ruled line
- Provide immediate access to critical or frequently chosen items

LINE SEPARATOR

- Separate vertically arrayed grouping with subtle solid lines
- Separate vertically arrayed subgroupings with subtle dotted or dashed lines
- For independent groupings
 - Extend the line to the left and right menu borders



PHRASING THE MENU

- Menu Titles: Should be Short, Simple, Distinctive title
- Menu Choice Description:
 - Can be single, compound or multiple words
 - Use task-oriented not data-oriented wording
 - Must never use the same wording as its menu title
 - Identical choices on different menus should be worded identically
- Keyboard Accelerators
 - Ctrl +B or (Ctrl +B)
- Keyboard Equivalents
 - Normal, Bold, Italic
- Intent Indicators
 - To a cascade indicator: place a triangle or right pointing solid arrow following the choice
 - To a window indicator: place ellipsis (...) immediately follow the choice



SELECTING MENU CHOICES

- Initial Cursor Positioning
- Choice Selection
 - Pointers
 - Keyboards
 - Selection/Execution

- Combining techniques
- Defaults
 - Provide a default whenever possible (as Bold Text)
- Unavailable Choices
 - Should be dimmed or “grayed out”

MARK TOGGLES OR SETTING

- Purpose
 - Use to designate that an item or feature is active over a relatively long period of time
 - Use to provide a reminder that an item or feature is active or inactive
 - Position the indicator to the left of the option
 - For situations where several nonexclusive choices may be selected, consider including one alternative that deselects all items and reverts the state to the normal condition

Bold old Ctrl+B

Italic Ctrl+I

TOGGLED MENU ITEMS

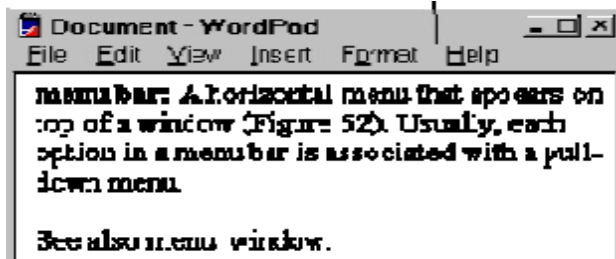
- Purpose
 - Use to designate two opposite commands that are accessed frequently
 - Use when the menu item displayed will clearly indicate that the opposite condition currently exists
 - Provide a meaningful, fully spelled-out description of action
 - Begin with a clear verb
 - Use mixed-case letter

view	view
Hide Grid	Show grid

KINDS OF GRAPHICAL MENUS

- Menu Bar
- Pull-Down Bar
- Cascading Menu Bar
- Pop-Up Menu
- Iconic Menu

Menu Bar



- Advantage
 - Always visible
 - Easy to browse
 - Do not obscure the screen working area
 - Allow for use of keyboard equivalents
- Disadvantage
 - Consume a full row of screen space
 - Require looking away from the main working area to find
 - Require moving pointer from the main working area to select
 - Horizontal orientation is less efficient for scanning
- All primary windows must have a menu bar
- All menu bars must have an associated pull-down menu containing at least two choices
- Do not allow the user to turn off the display of the menu bar
- Locate at the top of the screen, just below the screen title
- Use single-word choices whenever possible
- Order choice left-to-right with
 - Most frequent choices to left/ related information grouped together
- Help, when included should be located at the right side
- Layout: x File xxx Edit xxx Options Help x
- Separate the bar from the remainder of the screen by
 - A different background or Solid lines above and below
- Use reverse color selection cursor to surround the choice

Pull-Down Menu

- Proper Usage
 - A small number of items
 - Items best represented textually
 - Items whose content rarely changes

- Advantages
 - No window space is consumed when they r not used
 - Allow for display of both keyboard equivalents and accelerators
 - Vertical orientation permits more choices to be displayed
- Disadvantage
 - Require searching and selecting
 - Require moving the pointer out of working area to select
 - May obscure the screen working area
- Gray-out or dim items that can not be chosen
- Position the pull-down directly below the selected menu bar choice
- Restrict to no more than 5-10 choices
- Place frequent or critical items at the top
- Multicolumn menus are not desirable
- Alight the first character of the pull-down descriptions under the second character of the applicable menu bar choice
- If a menu item establishes or changes the attributes of data or properties of the interface, mark the pull down choice or choices whose state is current or active “On”
- Grouping:
 - Mark Toggles or Setting
 - Cascade and Leading to other windows indicator
 - Keyboard Equivalents and Accelerators

Cascading Menus



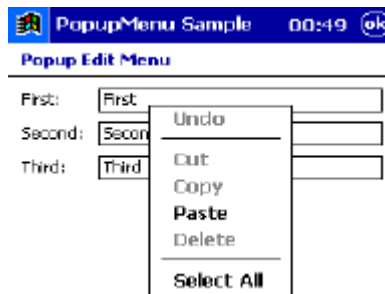
- **Advantage:**

- Top-level menus are simplified because some choices are hidden
- More first-letter mnemonics are available because menus possess fewer alternatives
- High-level command browsing is easier because subtopics are hidden

- **Disadvantage**

- Access to submenu items requires more steps
- Access to submenu items require a change in pointer movement
- Place an arrow or right-pointing triangle to the right of each menu
- Leave the choice leading to the cascading menu highlighted
- Do not exceed three menu levels (two cascades)

Pop Up Menu



- Choices may be also presents alternatives or choices within the context of the task
- Pop-up menus may be requested when the mouse pointer is positioned over a designated or hot area of screen (a window border) or over a designed icon

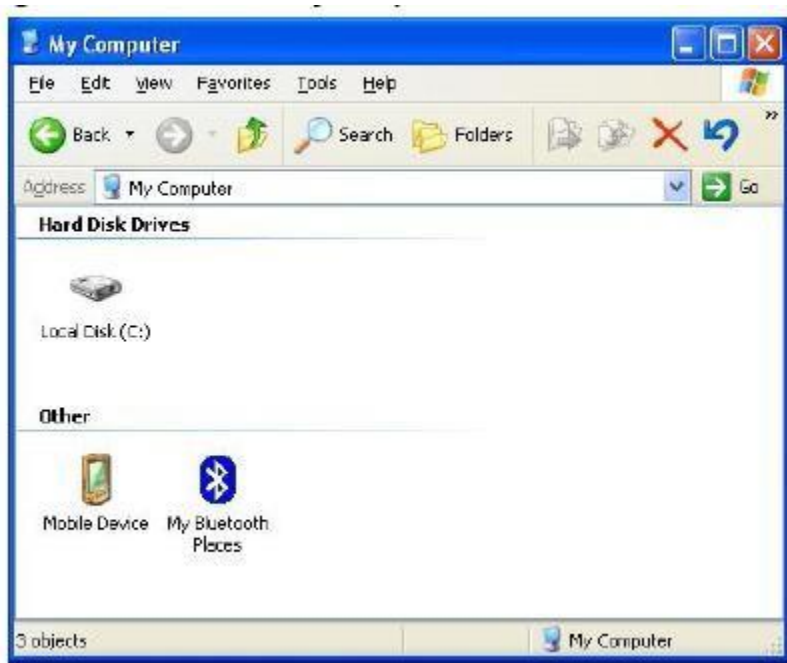
- **Advantage**

- They do not use window space when not displayed
- They appear in the working area

- **Disadvantage**

- They existence must be learned and remembered
- May obscure the screen working area
- Require a special action to see the menu (Mouse click)

Iconic Menu



- Use to remind user of the functions, commands, application choices
- Create icons that
 - Help enhance recognition and hasten option selection
 - Meaningful and clearly represent choices

SELECT THE PROPER KINDS OF WINDOWS

A window is an area of the screen that contains a particular view of some area of the computer or some portion of a person's dialog with the computer.

Content

- A window's characteristics
- A window's components
- A window's presentation styles
- The types of windows available
- Organizing window system functions
- A window's operations
- Web system frames and pop-up windows

Window Characteristics

- A name or title, allowing it to be identified
- A size in height and width (which can vary)
- Only active windows can have their contents altered
- A window may be partially or fully hidden behind another window
- Information within a window may extend beyond window's display area
- Presentation is arranged in relation to other windows (tiled, overlapping, or cascading)
- Methods for manipulation of the window on the screen
- Its highlight, that is, the part that is selected

Windows are useful in the following

- Presentation of Different Levels of Information
- Presentation of Multiple Kinds of Information
- Sequential Presentation of Levels or Kinds of Information
- Access to Different Sources of Information
- Combining Multiple Sources of Information
- Perform More Than One Task
- Reminding
- Monitoring
- Multiple Representations of the Same Task

Components of a Window

- Frame (Border)
- Title Bar
- Title Bar Icon
- Window Sizing Buttons
- What's This Button
- Menu Bar
- Status Bar
- Scroll Bars
- Split Box(Split Bar)
- Toolbar
- Command Area
- Size Grip
- Work Area

Window Presentation Styles

- Tiled Windows
 - They are easier, according to studies, for novice or inexperienced people to learn

- Yield better user performance for tasks where the data requires little window manipulation to complete the task
- Only a limited number can be displayed in the screen area available
- As windows are opened or closed, existing windows change in size. This can be annoying
- As the number of displayed windows increases, each window can get very tiny
- Overlapped Windows
 - Visually, their look is 3-D, resembling the desktop that is familiar to the user
 - Windows can maintain larger sizes
 - Windows can maintain consistent sizes, position
 - They are operationally much more complex than tiled windows.

More control functions require greater user attention and manipulation

- Windows themselves can be lost behind other windows and be resumed not to exist
- Cascading Windows (Special type of overlapping window)
 - No window is ever completely hidden
 - Bringing any window to the front is easier
 - It provides simplicity in visual presentation and cleanness

Picking a Presentation Style

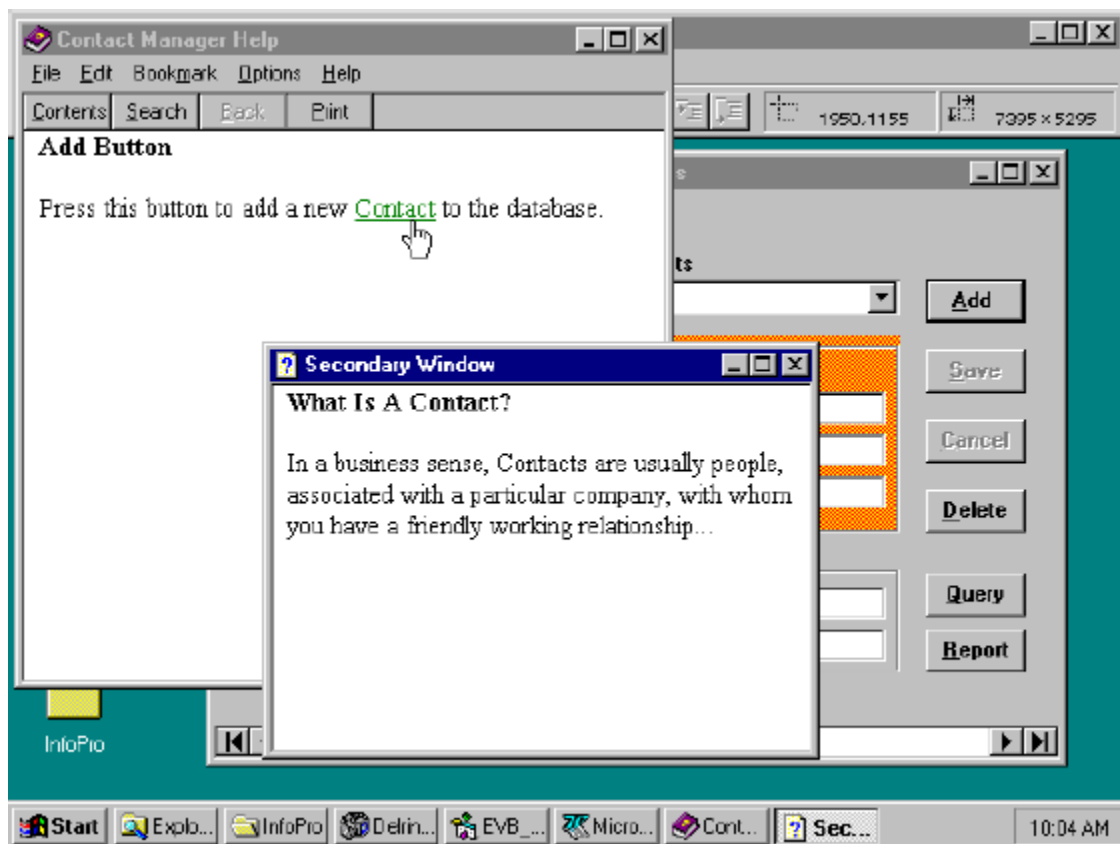
- Use tiled window for:
 - Single task activities
 - Data that needs to be seen simultaneously
 - Tasks requiring little window manipulation
 - Novice or inexperienced users
- Use overlapping windows for:
 - Switching between tasks
 - Tasks necessitating a greater amount of window manipulation
 - Expert or experienced users
 - Unpredictable display contents

Type of Windows

- Primary Window
 - Should represent an independent function or application
 - Use to present constantly used window components and controls
 - Use for presenting information that is continually updated (Date and time)
 - Often called main window or application window
 - Do not divide independent function into two or more primary windows.

- Secondary Windows
 - A dependent secondary
- It can only be displayed from a command on the interface of its primary window
 - A independent secondary
- Can be opened independently of a primary window (property sheet)
- Microsoft Windows possesses several types of secondary type of secondary windows called
 - Dialog boxes
 - Property sheet
 - Property inspectors
 - Message boxes
 - Palette windows
 - Pop-up windows

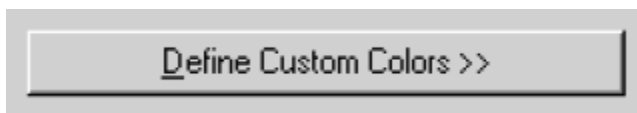
• Secondary Windows



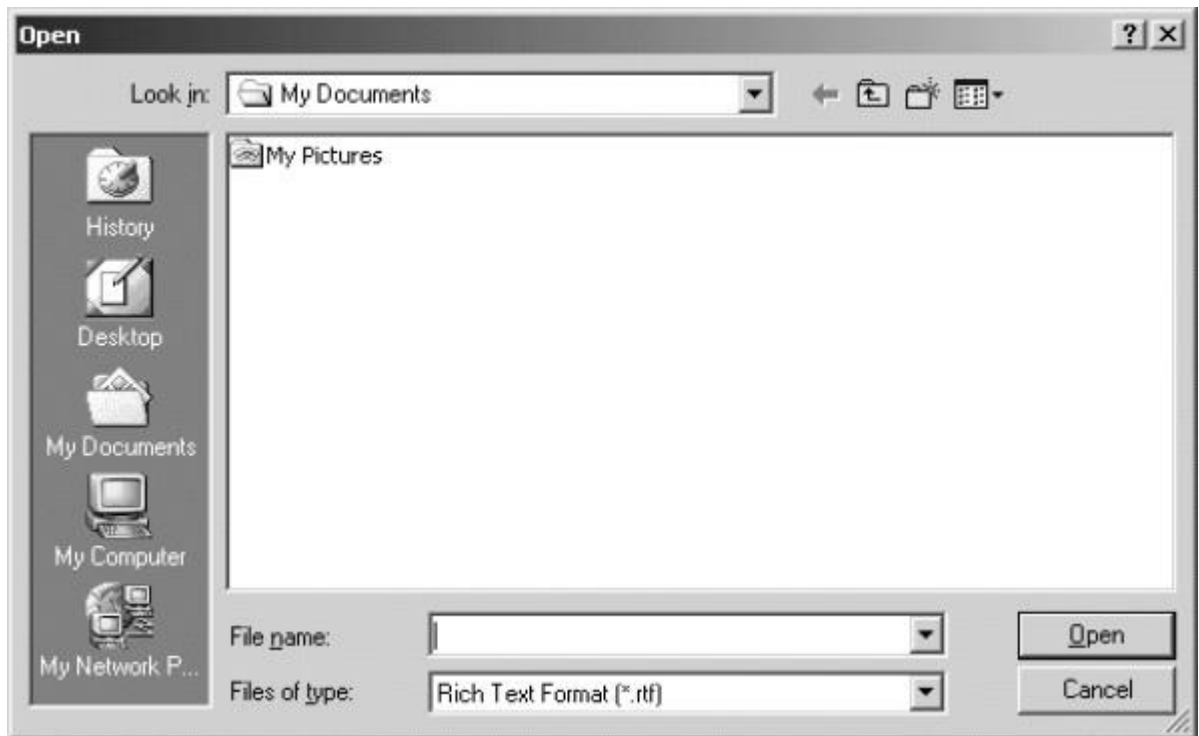
Modal and Modeless

- Modal window
 - Will not permit interaction with another window until the current dialog is completed

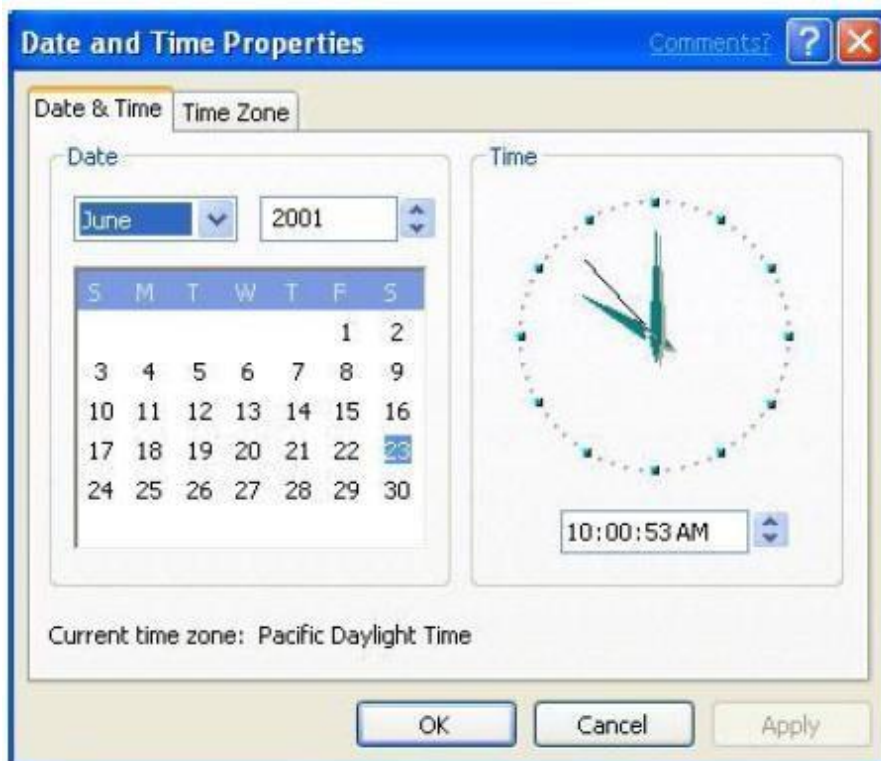
- Remain displayed until the appropriate action is taken after which it is removed
 - Modal dialog boxes typically request critical information or actions
- Modeless window
 - Switching between the box and its associated is permitted
- Cascading
 - To provide advanced options at a lower level in a complex dialog
 - Provide a command button leading to the next dialog box with ...
 - Provide no more than two cascades in a given path
 - Don not cover previous critical information
- Relevant information
- Title Bar
- Unfolding
 - To provide advanced options at the same level in a complex dialog
 - Provide a command button with an expanding dialog symbol >>
 - Expand to right or downward



- Dialog Boxes
 - Use for presenting brief messages
 - Use for requesting specific, temporary actions
 - Use for performing actions that
 - Take a short time to complete
 - Are not frequently changed
 - Usually be those that do not occur frequently
 - Command button to include
 - OK
 - Cancel
 - Others as necessary



Property Sheets and Property Inspectors



- Property sheets
 - Use for presenting the complete set of properties for an object
 - Categorize and group within property pages, as necessary
 - Command buttons to include
- Ok
- Cancel
- Apply
- Reset
- Others as necessary
 - For single property sheets, place the command on the sheet
 - For tabbed property pages, place the commands outside the tabbed pages

Property Inspectors

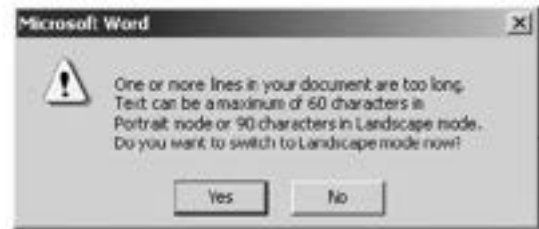


- **Property Inspectors**
 - Use for displaying only the most common or frequently accessed object properties
 - Properties of an object are displayed by using a dynamic viewer or browser that reflects the properties of the current selection
 - Property value in the selected object should be changed as soon as the user makes the change in the related property control
- Message Boxes
- If a message requires no choices to be made but only acknowledgement, include an ok button and optionally a help menu
- If the message requires the user to make a choice, include a command button for each option
- Include OK and Cancel buttons only when the user has the option of continuing or stopping the action
- Use Yes and No buttons when the user must decide how to continue
- If the choices are too ambiguous, label the command buttons with the names of specific actions, for example,

Save and Delete



Progress message box



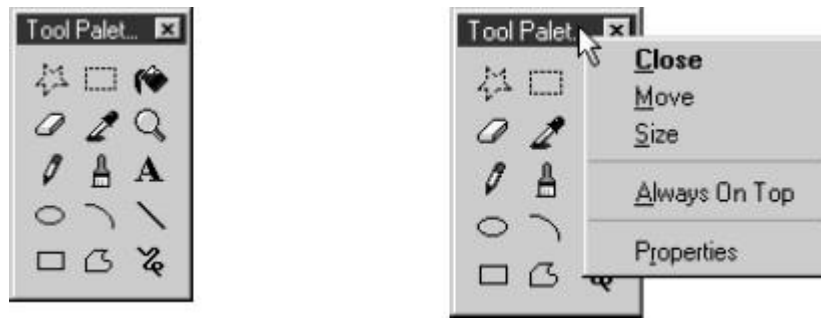
Yes No message box



Message box choices

Palette and Pop-Up Windows

- Palette windows are modeless secondary windows that present a set of controls.
- Palette windows are distinguished by their visual appearance, a collection of images, colors or patterns
- The title bar for a palette window is shorter and includes only a close button
- Use pop-up windows to display
 - Additional information when an abbreviated form of the information is the main presentation
 - Textual labels for graphical controls
 - Context-sensitive Help information
 - Pop-up windows do not contain standard secondary window components such as a title bar and close button



Select the Proper Device-Based Controls

Device-based controls, often called input devices, are the mechanisms through which people communicate their desires to the system.

Identify the characteristics and capabilities of device-based control

- Trackball
- Joystick
- Graphic tablet
- Light pen
- Touch screen
- Voice
- Mouse
- Keyboard

Trackball

- Description
 - A ball that rotates freely in all directions in its socket
- **Advantages**
 - Direct relationship between hand and pointer movement in terms of direction and speed
 - Does not obscure vision of screen
 - Does not require additional desk space (if mounted on keyboard)
- **Disadvantage**
 - Movement indirect, in plane different from screen
 - Requires hand to be removed from keyboard keys
 - Requires different hand movements
 - May be difficult to control
 - May be fatiguing to use over extended time

Joystick

- **Advantages**

- Direct relationship between hand and pointer movement in terms of direction and speed
- Does not obscure vision of screen
- Does not require additional desk space (if mounted on keyboard)

- **Disadvantage**

- Movement indirect, in plane different from screen
- Requires hand to be removed from keyboard keys
- Requires different hand movements
- May be difficult to control
- May be fatiguing to use over extended time
- May be slow and inaccurate.

Graphic (*Touch*) Tablet

- **Description**

- Pressure-, heat-, light-, or light-blockage-sensitive horizontal surfaces that lie on the desktop or keyboard
- May be operated with fingers, light pen, or objects like pencil

- **Advantages**

- Direct relationship between hand and pointer movement in terms of direction and speed
- Does not obscure vision of screen
- More comfortable horizontal operating plane

- **Disadvantage**

- Movement is indirect, in a plane different from screen
- Requires hand to be removed from keyboard
- Requires different hand movements to use
- Finger may be too large for accuracy with small objects

Touch Screen

- **Advantages**

- Direct relationship between hand and pointer movement in terms of direction and speed
- Movement is direct, in the same plane as screen
- Requires no additional desk space

- **Disadvantage**

- Finger may obscure part of screen
- Finger may be too large for accuracy with small objects
- Requires moving the hand far from the keyboard to use
- Very fatiguing to use for extended period of time
- May Damage the screen

Light Pen

- **Description**

– A special surface on a screen sensitive to the touch of a special stylus or pen

- **Advantage**

- Direct relationship between hand and pointer movement in terms of direction, distance, and speed
- Movement is direct, in the same plane as screen
- Requires minimal additional desk space
- Stands up well in high-use environments
- More accurate than finger touching

- **Disadvantage**

- Hand may obscure part of screen
- Requires picking it to use
- Requires moving the hand far from the keyboard to use
- Very fatiguing to use for extended period of time

Voice

- **Description**

- Automatic speech recognition by the computer

- **Advantage**

- Simple and direct
- Useful for people who cannot use a keyboard
- Useful when the user's hands are occupied

- **Disadvantage**

- High error rates due to difficulties in

- Recognizing boundaries between spoken words

- Blurred word boundaries due to normal speech patterns

- Slower throughput than with typing
- Difficult to use in noisy environment
- Impractical to use in quiet environment

Mouse

- **Advantage**

- Direct relationship between hand and pointer movement in terms of direction, distance, and speed.
- Permit a comfortable hand resting position
- Selection mechanisms are included on mouse
- Does not obscure vision of the screen

- **Disadvantage**

- Movement is indirect, in a plane different from screen
- Requires hand to be removed from keyboard
- Requires additional desk space
- May require long movement distances
- Requires a degree of eye-hand coordination

Mouse Usage Guidelines

- Provide a “hot zone” around small or thin objects that might require extremely fine mouse positioning
- Never use double-clicks or double-drags as the only means of carrying out essential operations
- Do not use mouse plus keystroke combinations
- Do not require a person to point at a moving target

Keyboard

- **Advantage**
 - Familiar
 - Accurate
 - Does not take up additional desk space
 - Very useful for
- Entering text and alphanumeric data
- Inserting in text and alphanumeric data
- Keyed shortcuts accelerators
- Keyboard mnemonics equivalents
- **Disadvantage**
 - Slow for non-touch-typists
 - Slower than other devices in pointing
 - Requires discrete actions to operate
 - No direct relationship between finger or hand movement.

Keyboard Guidelines

- Provide keyboard accelerators
 - Assign single keys for frequently performed, small-scale tasks
 - Use standard platform accelerators
 - Assign Shift-key combinations for actions that extend or are complementary to the actions of key or key combination used without the Shift-key
 - Assign Ctrl-key combinations for
- Infrequent actions
- Tasks that represent larger-scale versions of the task assigned to the unmodified key
- Provide keyboard equivalents
 - Use standard platform equivalents
 - Use the first letter of the item description
 - Provide window navigation through use of keyboard keys

Selecting the Proper Device-Based Control

- Provide keyboard accelerators
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 - Use standard platform accelerators
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 - Provide window navigation through use of keyboard keys

Selecting the Proper Device-Based Controls

- Provide keyboards for tasks involving
 - Heavy text entry and manipulation
 - Movement through structured arrays consisting of few discrete objects
- Provide an alternative pointing device for graphical or drawing tasks
 - Mouse: pointing, selecting, drawing, and dragging
 - Joystick: selecting and tracking
 - Trackball: pointing, selecting and tracking
 - Touch screen pointing and selecting
 - Graphic tablet pointing selecting, drawing, and dragging
- Provide touch screens under the following conditions
 - The opportunity for training is minimal
 - Targets are large, discrete and spread out
 - Frequency of use is low
 - Desk space is at a premium
 - Little or no text input requirement exists
- Consider user characteristics and preferences
 - Provide keyboards for touch typists
- Minimize eye and hand movements between devices

Pointer Guidelines

- The pointer
 - Should be visible at all times
 - Should contrast well its background
 - Should maintain its size across all screen locations and during movement
- Shape of pointer
 - Should clearly indicate its purpose and meaning
 - Should be constructed of already defined shapes
 - Should not be used for any other purpose other than its already defined meaning
- Use only as many shapes as necessary to inform the user about current location and status
- Animation should not distract

Choose the Proper Screen Based Controls

Screen Based controls, often simply called controls and sometimes called widgets. By definitions, they are graphic objects that represent the properties or operations of other objects.

Operable Controls

- Operable controls are those that permit the entry, selection, changing, or editing of a particular value, or cause a command to be performed.
 - Buttons
 - Text entry/read-only, selection, combination entry/selection
 - Specialized controls

Buttons

- Description
 - A square or rectangular-shaped control with a label inside that indicates action to be accomplished
 - The label may consist of text, graphics, or both
- Command Buttons
- Toolbars

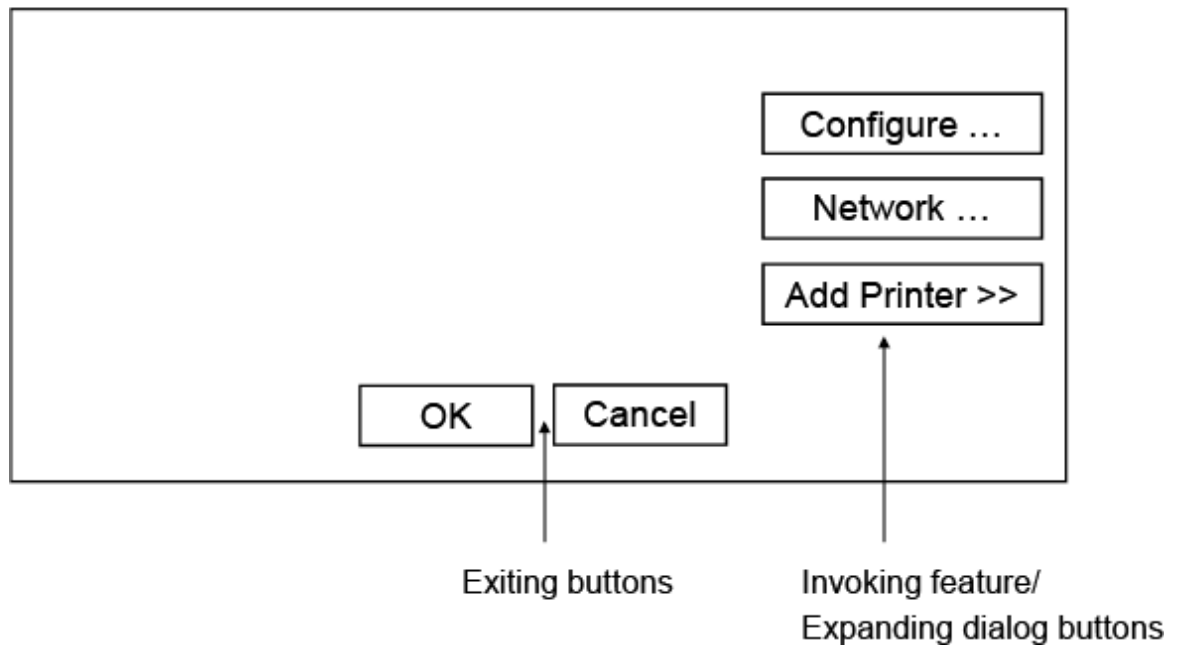


Command Buttons (Usage and Label)

- Use to provide fast access to frequently used or critical commands (for windows with a menu bar)
- Use to provide access to all necessary commands (for windows without a menu bar)
- Use single-word labels whenever possible (Use two –three words for clarity, if necessary)
- Use mixed-case letters with the first letter of each significant label word capitalized.
- Do not number labels
- Center the label within the button borders
- Provide consistency in button labeling across all screens
- Restrict the number of buttons on a window to six or fewer
- Provide as large as button as feasible and maintain consistent button heights and widths

Command Buttons (Location and Layout)

- Buttons exiting a dialog, and usually closing the window, should be positioned horizontally and centered across the lower part of the window
- For a button invokes a dialog or expands the dialog, position it centered and aligned vertically along the right side of the window
- Do not provide alignment with other screen controls. Maintain alignment and spacing only within the buttons themselves
- Position the buttons within windows before locate the other window controls



Command Buttons (Location and Layout)

- If a button has a *contingent* relationship to another control, position it adjacent to the related control
- Buttons found on more than one window should be consistently positioned

Consistent positioning

Groceries : 0 selected

Select All →

- ☐ Bread
- ☐ Cereal
- ☐ Dairy Foods
- ☐ Desserts
- ☐ Drinks

Command Buttons (Organization)

- Most frequent actions to the left or top
- Keep related buttons grouped together
- Exception: Buttons containing excessively long labels may be wider
- Windows Recommends
 - An affirmative action the left or above
 - The default first
 - OK and Cancel next to each other
 - Help last

Command Buttons (Intent Indicators)

- No intent indicator is necessary, when a button causes an action to be immediately performed

Apply

- When a button leads to a cascading dialog, include an ellipsis (...)

Open ...

- When a button leads to a menu, include a triangle pointing in the direction the menu will appear after the label

Menu >

- When a button leads to an expanding dialog, include a double arrow (>>)

Options >>

- When a button has a contingent relationship to another control, include a single arrow pointing at the control

← Clear

Command Buttons (Expansion and Defaults)

- Gray buttons after Expansion or when not applicable
- When a window is first displayed, provide a default action, if practical
- A default should be the most likely action:
 - A confirmation
 - An application of the activity being performed
 - A positive action such as OK
 - If a destructive action is performed (such as a deletion) the default should be Cancel
- Indicate the default action by displaying the buttons with a bold or double border

Command Buttons (Keyboard Equivalents, Accelerators)

- The mnemonic should be the first character of the button's label
- If duplication exists in first characters, use another character in the label
- Designate the mnemonic character by underlining it

- Assign a keyboard accelerator to each button to facilitate keyboard selection

Command Buttons (Scrolling and Button Activation)

- Use buttons to move between multi-page forms, not scroll bars Label buttons Next and Previous
- Highlight the button in some visually distinctive manner when the point is resting on it and the button is available for selection

Toolbars (Usage, Structure and size)



- Provide easy and fast access to most frequently used commands or options across multiple screens
- Provide buttons of equal size
- Create a meaningful and unique icon
- Center the image within the button
- Create a meaningful label
- Provide the smaller size as the default size with a user option to change it

Toolbars (Organization and Location)

- Place the most frequently used actions to the left or the top
- Keep related buttons grouped together
- Separate potentially destructive buttons from frequently chosen selections
- Permit user to reconfigure the button organization
- Position main features and functions bar horizontally across top of window just below menu bar
- Position subtask and sub features bars along sides of window
- Permit the location of the bar to be changed by the user

Toolbars (Active items, Button Activation and Customization)

- Make only currently available toolbar items available
- Temporarily not available items by displaying grayed out

- Highlight the button in some visually distinctive manner when the pointer is resting on it
- Call attention to the button in another visually distinctive manner when it has been activated or pressed
- Permit toolbars to be turned off by user
- Allow the customizing of toolbars

Text Entry/Read-Only Controls (Captions)

For entry boxes

- Place a colon (:) immediately following the caption
- For single fields, caption can be located in front of upper left corner of the box
- For multiple fields, position the caption upper left of the box

For read-only boxes

- If the data field is long or about the same length, center the caption above the displayed text box
- If the data is alphanumeric, short, or quite variable in length, left-justify the caption above the displayed
- If the data field is numeric and variable in length, right justify the caption above the displayed

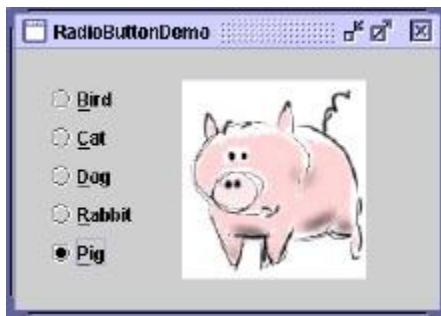
Text Entry/Read-Only Controls (Fields)

- To visually indicate that it is an enterable field, present the box in a recessed manner
- Present read-only text boxes on the window background
- Break up long text boxes through incorporation of slashes(/), dashes (-), spaces, or common delimiters
- Call attention to text box data through a highlighting technique
- Gray-out temporarily unavailable text boxes

Selection Controls

- Radio Buttons
- Check Boxes
- Palettes
- List Boxes
- List View Controls
- Drop-down/Pop-up List Boxes

Radio Buttons



- A two part control consisting of the following
 - Small circles, diamonds, or rectangles
 - Choice descriptions
- When a choice is selected
 - The option is highlighted
 - Any existing choice is automatically un highlighted and deselected
- Purpose
 - To set one item from a small set of option (2 to 8)
- For mutually exclusive choices (that is, only can be selected)
- Most useful for data and choices that are
 - Discrete
 - Small and fixed in number
 - Not easily remembered
 - Most easily understood when the alternatives can be seen together and compared to one another
 - Never change in content

- Do not use
 - For commands

Radio Buttons (Defaults and Structure)

- If there is a default selection, designate it as the default and display its button filled in. Else, display all the buttons without setting a dot
- When a multiple selection includes choices, display the buttons in another unique manner, such as gray shadow
- Left-align the buttons and choice descriptions
- A columnar orientation is the preferred unless vertical space on the screen is limited
- Enclose the buttons in a border to visually strengthen the relationship

Radio Buttons (Organization, Related Control)

- Arrange selection in expected order or follow other patterns (frequency of occurrence, sequence of use, or importance)
- Position any control related to a radio button immediately to the right of the choice description. End the label with an arrow

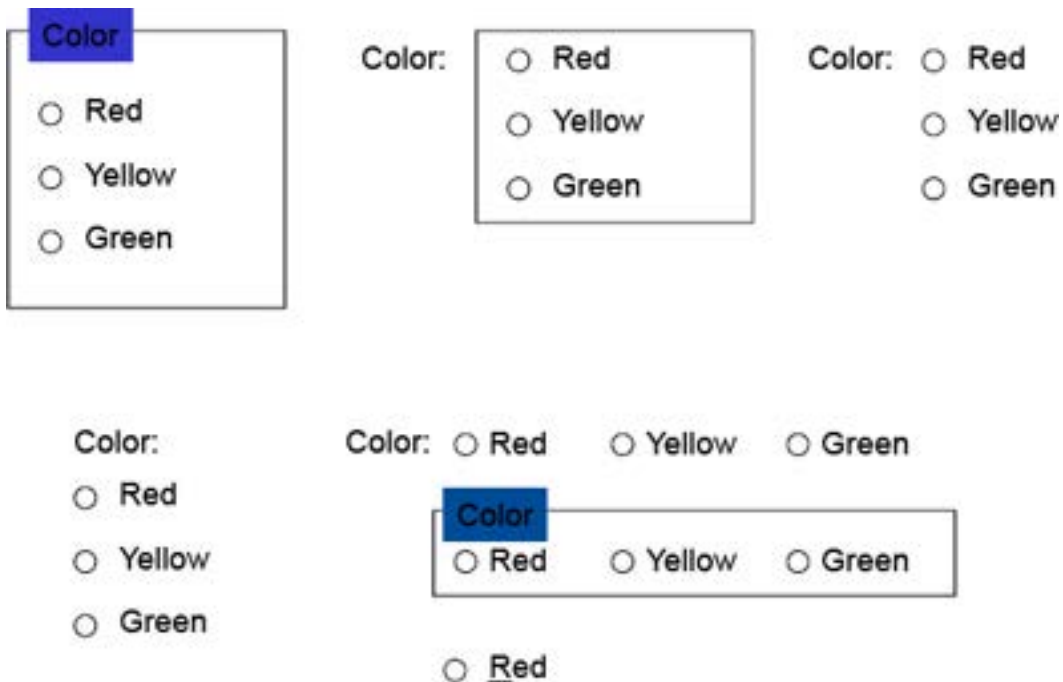
Radio Buttons (Captions)

- Display full spelled out in mixed-case letters, capitalizing the first letter of all significant words
- Columnar orientation
 - With a control border, position the caption:
- Upper-left-justified within the border
- Alternatively, to the left of the topmost choice description with (:)
 - Without a control border position the caption:
- Left-justified above the choice description with (:)
 - Alternatively, the caption may be located to the left of the topmost choice description with (:)
 - Position the caption to the left of the choice
 - Alternatively, with a control border, left-justified within the border
- Horizontal orientation

Radio Buttons (Keyboard Equivalents and Selection and Indication)

- Assign a keyboard mnemonic to each choice description by underlining the applicable letter in the choice description
- Highlight the selection choice in some visually distinctive way when the cursor's resting on it
- When a choice is selected, distinguish it visually from the unselected choices
- If there is a default choice, display the selected choice as set in the control

Radio Buttons



Check Boxes



- Each option acts as a switch and can be either “on” or “off”
 - When an option is selected, a mark (X) appears within the square box, or the box is highlighted in some other manner
 - Otherwise the square is unselected or empty (off)
- Each box can be
 - Switched on or off independently
 - Used alone or grouped in sets

!!Other properties are similar to the radio button’s properties!!

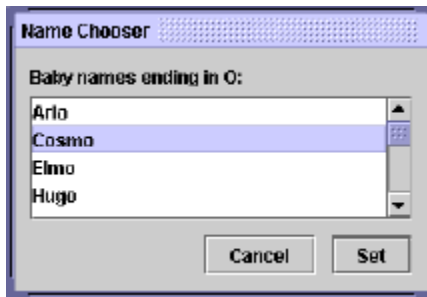
Palettes



- A control consisting of a series of graphical alternatives. The choices themselves are descriptive, being composed of colors, patterns, or images
- To set one of a series of mutually exclusive options presented graphically or pictorially
- Usually consume less screen space than textual equivalents
- Do not use
 - Where the alternatives cannot be meaningfully and clearly represented pictorially
 - Where words are clearer than images
 - Where the choices are going to change
- Create boxes of equal size
- Position the boxes adjacent to, or butted up against another
- A columnar orientation is the preferred manner
- Top to bottom, Left to right ordering by expected order, frequency of occurrence, sequence of use or alphabetically
- Display it less brightly than the other choices, if a choice is not available

- Highlight the choice in some visually distinctive way when the pointer is resting
- When a choice is selected, distinguish it visually from the unselected choices

List Boxes



- A permanently displayed box-shaped control containing a list of attributes or objects from which
 - A single selection is made (mutually exclusive), or
 - Multiple selections are made (non-mutually exclusive)
- Unlimited number of choices
- If the list content change, items will be hard to find
- Good for data that are
 - Best represented textually
 - Not frequently selected
 - Large in number
 - Fixed in list length
- Clearly and meaningfully describe the choices available
- Present in mixed case
- Left-align into columns
- Require no more than 40 page-downs to search a list
 - If more are required, provide a method for using criteria
- Must be long enough to display 6-8 choices
 - If it is the major control within a window, the box may be larger
- When box can't made wide enough to display longest entry
 - Break the long entries with an ellipsis (...)
 - Provide horizontally scrolling

- Order in a logical and meaningful way to permit easy browsing (allow user to change the sort order will be great)
- If a particular choices is not available in the current context, omit , gray or dim it
- Enclose the choices in a box with a solid border
- Use mixed-case
- Preferred position of the control caption is above upper-left
- When a list box is disabled, display its caption as gray out
- Highlight the selection choice when the pointer is resting on

Single-Selection List Boxes



- If presented with an associated text box control
 - Position the list box below and as close as possible to the text box
 - The list box caption should be worded similarly to the text box caption
 - If the related text box and the list box are very close, the caption may be omitted from the list box
- When the list box is first displayed
 - Present the currently active choice highlighted or marked with a circle or diamond to the left of the entry
 - If a choice has not been previously selected, provide a default choice and display it in the same manner that is used in selecting it

Multiple-Selection List Boxes



- Mark the selected choice with an X or check mark to the left of the entry

- Consider providing a summary list box
 - Position it to the right of the list box
 - Use the same color for the summary list box
- Consider providing a display-only text control indicating how many choices have been selected
 - Position it justified upper-right above the list box
- Provide command buttons for *Select All* and *Deselect All*
- When the list box is first displayed
 - Display the currently active choices
 - Mark with an X or check mark to the left of the entry

Drop-Down/Pop-up List Boxes



- Unlimited number of choices
- When displayed, all choices may not always be visible, requiring scrolling
- Use drop-down/pop-up when
 - Screen space or layout consideration makes radio buttons or single-selection list boxes impractical
 - Do not use a drop-down list if it is important that all options be seen together.
- Provide a visual cue that a box is hidden by including a downward pointing arrow, or other meaningful image
- !Other properties are the same as List boxes!

Combination Entry/Selection Controls and Other Operable Controls

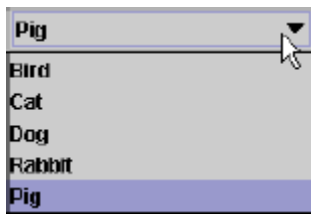
- Spin Boxes
- Combo Boxes
- Drop-down/Pop-up Combo Boxes
- Slider

Spin Boxes



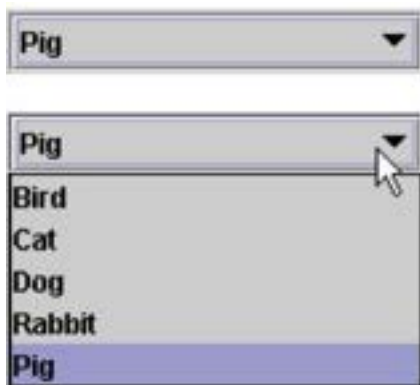
- A single line field followed by two small, vertically arranged buttons (pointing up and pointing down arrow)
- Selection/entry is made by
 - Using the mouse to point at one of directional buttons
 - Keying a value directly into field itself
- Consumes little screen spaces
- Useful only for certain kinds of data
- Proper usage for
 - For mutually exclusive choices
 - Where screen space is limited
 - Small in number
 - Infrequently changed, selected
- To reduce the size of potentially long lists, break the listing into subcomponents (break a date into dd mm yy)
- When first displayed, present a default choice in the box
- The spin box should be wide enough to display the longest entry or choice
- Caption is mixed-case letters
- Position the caption to the left of the box
 - Alternatively, left-justified above the box
- For numeric values
 - Show a larger value using the up arrow

Combo Boxes



- A single rectangular text box entry field, beneath which is a larger rectangular list box (resembling a drop-down list box)
- The text box permits a choice to be keyed within it
- As text is typed into the text box, the list scrolls to the nearest match
- Also, when an item in the list box is selected, that item is placed within the text box

Drop-down/Pop-up combo Boxes



- A single rectangular text box with a small button to the side and an associated hidden list of options
- Selection are made by using the mouse or keyboard
- The information keyed doesn't not have to match
- Unlimited number of entries and choices
- Flexible, permitting selection or typed entry
- Requiring scrolling

- Proper usage
 - Where screen is limited
 - For data and choices that are
- Best represented textually
- Frequently changed
- Large in number

Drop-down/Pop-up combo Boxes

- Provide a visual cue that a list box is hidden by including a downward-pointing
- *Other properties are the same as Drop-down/Pop-up List Box!!*

Slider

- A scale exhibiting degrees of a quality on a continuum
- To make a setting when a continuous qualitative adjustment is acceptable
- Spatial representation of relative setting
- Not as precise as an alphanumeric indication
- Proper usage:
 - When an object has a limited range of possible settings
 - When the range of values is continuous
 - When graduations are relatively fine



Custom Controls

- Presentation controls
 - Provide details about other screen elements or controls or assist in giving the **screen structure**
- Static Text Fields
- Group boxes
- Column Headings
- ToolTips

- Balloon Tips
- Progress indicators

Task Best Control If screen Space Constraints Exist

- Mutually Exclusive Radio Buttons Drop-down/Pop-up List Box
- Not Mutually Exclusive Check Boxes Multiple-Selection List Box
- Select or Type a Value
- Text Entry Field
- Radio Buttons with “Other”
- Drop-down Combo Box
- Setting a Value within a Range
- Spin Button Text Box

Suggested Uses for Graphical Controls

IF: USE:

- Mutually exclusive alternative
- Best represented verbally
- Very limited in number (2 to 8)

AND:

- Typed entry is never necessary
- Content can never change
- Adequate screen space is available

Radio Buttons

OR:

- Typed entry is never necessary
- Content can never change
- Adequate screen space is not available

Drop-down/Pop-up List Box

OR:

- Typed entry may be necessary
- Content can change
- Adequate screen space is available

Combo box

Suggested Uses for Graphical Controls

IF: USE:

OR:

- Type entry may be necessary
- Content can change
- Adequate screen space is not available

Drop-down/Pop-up Combo Box

Suggested Uses for Graphical Controls

IF: USE:

- Mutually exclusive alternative
- Best represented verbally
- Potentially large in number (9 or more)

AND:

- Typed entry is never necessary
- Content can never change
- Adequate screen space is available

Single-Selection List Box

OR:

- Typed entry is never necessary
- Content can never change
- Adequate screen space is not available

Drop-down/Pop-up List Box

OR:

- Typed entry may be necessary
- Content can change
- Adequate screen space is available

Combo box

Suggested Uses for Graphical Controls

IF: USE:

OR:

- Typed entry may be necessary
- Content can change
- Adequate screen space is not available

Drop-down/Pop-up Combo Box

Suggested Uses for Graphical Controls

IF: USE:

- Mutually exclusive alternative
- Best represented graphically
- Content rarely changes

- Small or large number of items

Palette

IF: USE:

- Mutually exclusive alternatives
- Not frequently selected
- Content does not change
- Predictable, consecutive data
- Typed entry sometimes desirable

And:

- Adequate screen space is not available Spin Box

OR:

- Adequate screen space is not available Combo Box
- Suggested Uses for Graphical Controls

IF: USE:

- Mutually exclusive alternative
- Continuous data with a limited range of setting
- Value increases/decreases in a well-known, predictable way
- Spatial representation enhances comprehension

Slider

IF: USE:

- Nonexclusive alternatives
- Best represented verbally
- Typed entry is never necessary
- Content can never change
- Adequate screen space is available

And:

- Very limited in number (2 to 8) Check Boxes

OR:

- Potentially large in number (9 or more) Multiple-Selection List Box
- Revision

Write Clear Text and Message

Words

Do not use technical words, made-up words or terms filespec,abend, or spool, Ungroup or dearchive

- Do not use abbreviations or acronyms
 - Always use the fully spelled-out form the first time it is encountered in the interface
- Consider the usage of contradictions or short forms (won't vs will not, un- -ness), Complete words is preferred

- Positive terms (avoid the prefix “ir-” “in-” “dis-” and “un-”)
- Simple action words (“Project status listing” → “List”)
- Consistency
- Multiple-word phrases are more readable if the entire phrase is on one line
- Abbreviation, mnemonics, and acronyms should not include punctuation

Sentences and Messages

- Brief and simple
- Directly and immediately usable (Should not search through reference)
- Affirmative statement is easier to understand than negative statements
- Active voice is usually easier to understand than passive voice
- Main topic at the beginning
- Use the same grammatical structure for elements of sentences
- Imply that the system is awaiting the user’s direction, not that the system is directing the user
- Negative tones or actions, or threats are not very friendly (“*Numbers are illegal*” vs “*Months must be entered by name*”)
- Encouraging message would be better than insulting message
- Should remain factual and informative, and should not attempt humor or punishment

Messages

- Screen messages is classified into two categories
 - System messages:
 - Generated by the system to keep the user informed of the system’s state and activities
 - Instructional messages (prompting message) :
 - tell the user how to work with, or complete the screen displayed

System Messages

- Status messages
 - Providing information concerning the progress of a lengthy operation
 - Usually contains a progress indicator and a short message
- Informational messages (notification messages)
 - This kind of message is usually identified by an “I” icon to the left of the message
- Warning messages
 - They are usually identified by an “!”
 - The user must determine whether the situation is in fact a problem and may be asked to advise the system whether or not to proceed (A deletion request by a user is any action that commonly generates a warning messages)

System Messages

- Critical messages (Action messages)
 - Call attention to conditions that require a user action before the system can proceed
 - Some products use a “Do Not” symbol while others use a “Stop” sign. An X in a circle used by Microsoft Windows
- Question messages
 - A question message asks a question and offers a choice of options for selection
 - It is designated by a “?” icon proceeding the message text

Writing Message Box Text

- Title bar: Clearly identify the source of the message
 - The name of the object to which it refers
 - The name of the application to which it refers
 - Do not include an indication of message type
 - Use mixed case in the headline style
- Message box: Provide a clear and concise description of the condition of the condition causing the message box to be displayed
 - Use complete sentences with ending punctuation
 - Show only message box about the cause of condition in single message

- Make the solution an option offered in the message
- Use the word “Please” conservatively
- Do not exceed two or three lines
- Center the message text in window
- Include the relevant icon identifying the type of message

Message Box Controls

- Command Buttons:
 - If a message requires no choices to be made, include an *OK* button
 - If a message requires a choice to be made
 - *OK* and *Cancel* buttons only when the user has the option to continue or cancel
 - *Yes* and *No* buttons when the user must decide how to continue
 - If these choices are too ambiguous, label with the name of specific actions
 - If a message describes an interrupted process, provide *Stop* button
 - If a message offer a chance to cancel a process, provide a *Cancel* button
 - If more details about a message must be presented, provide a *Help* button
 - Display only one message box for a specific condition
- Close Box:
 - Enable the title bar Close only if the message includes a *Cancel* button

Instructional Messages

- Provide instructional information at the depth of detail needed by the user
 - Accessing instruction through a *Help* function is the best solution
- Location it at strategic position on the screen
- Display it in a manner that visually differentiates it from other screen elements
- In writing, follow all relevant writing guideline for words, sentences, and messages

ERROR!

PLEASE HIT YOUR BACK BUTTON AND ENTER A SEARCH

THE SEARCH FIELD DID NOT CONTAIN AN ENTRY

PLEASE CLICK THE BACK BUTTON AND TYPE A SEARCH VALUE

Text for Web Pages

- Words
 - Avoid using words that are specific to the Web (A few Web-specific terms are “This Web site”, “Click here” and “Follow this link”)
 - A good test of this guideline is to print out a page, read it, and see if it makes as much sense on paper as it does on screen
- Error Messages
 - Provide helpful error messages for:
 - Incomplete or incorrectly keyed, entered, or selected data
 - Requests for documents that do not exist or cannot be found
 - Present them in a visually distinctive and noticeable manner
- Instructions
 - Make sure instruction are detailed enough to be understood without being specific to one browser version or brand
 - Don’t use “Return To”
 - Describe where an “Up” button leads where the user will go

Text for Web Pages

- Presentation
 - Provide text that contrasts highly with the background
- Writing
 - Write objectively
 - Use the inverted pyramid organization
 - Be concise, using only about half the number of words of conventional text
 - Each paragraph should be short and Contain only one main idea
 - Make text more scannable by using bulleted listings, tables, headings and bold types
 - Too many links within text can disrupt reading continuity and content understanding
 - Place them at the beginning or end of paragraphs or section of text
 - Test for readability by printing out text to carefully proofread it

Links

- Create wording that make link that user can predict where the link leads
 - Descriptive
 - Differentiable
 - Predictive
- Create links that are brief and to the point, avoiding wordiness
- Write text containing embedded links as if there were no links in it
 - Choose the most relevant words or phrase as the active link
 - Link must not be continued over two lines
- Standalone links should not exceed one sentence in length
 - Paragraph with embedded links are sometimes useful for a variety of reasons
 - Paragraph with embedded links are sometimes useful for a variety of reasons
 - Embedded Links
Paragraph with embedded links are sometimes useful for a variety of reasons

Link Titles

- A short explanation of a link before the user selects the link
- Provide link titles that describes
 - The name of site the link will lead to
 - The name of subsection the link will lead to
 - The kind of information to be found at the destination
 - Warning about possible problems to be encountered at the other end
- Restrict them to no more than 60 characters

Page Title

- Should contain many keywords at possible
- Provide a page title
 - That possess meaningful keywords

- Whose first word is its most important descriptor
- That makes sense when viewed completely out of context
- That is different from other page titles
- Is written in mixed case using the headline
- Do not highlight keywords

Heading and Headlines

- Used to scan to find screen content of interest.
- Their wording must provide a strong clue as to the content they relate to
- Heading should be descriptive and straightforward
- No clever, cute or funny headline
- Skip leading articles (the and a)

Create Meaningful Graphics, Icons and Images

Creating Images

- ✓ Create familiar and concrete shapes
- ✓ Create visually and conceptually distinct shapes
- ✓ Incorporate unique features of an object
- ✓ Do not display within a border
- ✓ Clearly reflect object represented
- ✓ Simple reflect object represented, avoiding excessive detail
- ✓ Create as a set, communicating relationships to one another through common shapes
- ✓ Provide consistency in icon type
- ✓ Create shapes of the proper emotional tone

Creating Images

- Create familiar and concrete shapes
- Create visually and conceptually distinct shapes
- Incorporate unique features of an object
- Do not display within a border
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- Create as a set, communicating relationships to one another through common shapes

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Icons

- Icons are most often used to represent objects and actions with which users can interact
- Icons may stand alone on a desktop or in a window, or be grouped together in a toolbar
- A secondary use of a icon is to reinforce important information, a warning icon in a dialog message box

Characteristics of Icons

- **Syntactics** refers to a icon's physical structure
 - Shape, Color, Size
 - Similar shapes and colors can be used to classify a group of related icons
- **Semantics** is the icon's meaning
 - What does it refer – a file, a waste basket, or some other objects?
- **Pragmatics** is how the icons are physically produced and depicted
 - Is the screen resolution sufficient to illustrate ?
- Syntactics, semantics and pragmatics determine an icon's effectiveness and usability

Influences on Icon Usability

- Provide icons that are
 - Familiar
 - Clarity
 - Simple
 - Consistent
 - Directness of the meaning
 - Efficient
 - Discriminable from others

- Also consider the
 - Context in which the icon is used
 - Expectancies of users
 - Complexity of task

Choosing Icons

- A Successful Icon
 - Looks different from all other icons
 - Is obvious what it does or represents
 - Is recognizable when no larger than 16 pixels square
 - Look as good in black and white as in color
- Size
 - 16x16, 24x24, 26x26, 32x32 pixels 16-and-256 color version
 - Use colors from the system palette
- Provide as large a hot zone as possible
 - With stylus or pen: 15 pixels square
 - With mouse: 20 pixels square
 - With finger: 40 pixels square

Choosing Images

- Use existing icons when available
- Use images for nouns, not verbs
- Use traditional images
- Consider user cultural and social norms

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Drawing Images

- Providing consistency in shape over varying sizes
- Do not use triangular arrows in design to avoid confusion with other system symbols
- When icons are used to reflect varying attributes, express these attributes as meaning meaningfully as possible
- Provide proper scale and orientation
- Use perspective and dimension whenever possible
- Accompany icon with a label to assure intended meaning

Icon Animation and Audition

- Animation

- Use
 - To provide feedback
 - For visual interest
- Make it interruptible or independent of user's primary interaction
- Do not use it for decoration
- Permit it to be turned off by the user
- For fluid animation, present images at 16++ frames /second
- Auditions
 - Consider auditory icons

The design Process

- Define the icon's purpose and use
- Collect, evaluate, and sketch ideas
- Draw in black and white
- Draw using an icon-editing utility or drawing package
- Test for users
 - Expectations
 - Recognition
 - Learning
- Test for clarity
- Register new icons in the system's registry

Graphics in Web

- Use Graphics to
 - Supplements the textual content, not as a substitute for it
 - Convey information that can't be effectively accomplished using text
 - Enhance navigation through
 - Presenting a site overview
 - Identifying site pages
 - Identifying content areas

- Limit the use of graphics that take long time to load
- Coordinate the graphics with all other page elements

Images

- Use standard images, image internationalization
- Provide descriptive text or labels with all images
- Distinguish navigational images from decorative images
- Minimize
 - The number of presented images
 - The size of presented images
 - Image animation
 - Number of colors
- GIF, JPEG is prefer

Photographs/Pictures

- Use when every aspect of the images is relevant
- Use JPEG format
- On the initial page
 - Display a small version
 - A thumbnail
 - Zoom-in on most relevant detail
 - Link to larger photos showing as much detail as needed

Video

- To show the proper way to perform a task
- To provide a personal message
- To grab attention
- Never automatically download a video into a page
- Provide controls (playing, pausing, and stopping)

- Considering using
 - Existing video
 - Audio only
 - A slide show with audio

Diagrams

- To show the structure of objects
- To show the relationship of objects
- To show the flow of a process or task
- To reveal a temporal or spatial order

Animation

- To explain ideas involving a change in
 - Time
 - Position
- To illustrate the location or state of a process
- To show continuity in transitions
- To enrich graphical representations
- To aid visualization of 3-D structures
- Provide a freeze frame and stop mode
- Avoid distracting animation

Audition

- Uses as a supplement to text and graphics
- To establish atmosphere
- To create a sense of place
- To teach
- To sample

- The content should be simple
- Provide audio controls

Combining Mediums

- Use sensory combination that work best together
 - Auditory text with visual graphics
 - Screen text with visual graphics
- Both the visual and auditory information should be totally relevant to the task being performed
- Visual and auditory textual narrative should be presented simultaneously
- Considering downloading times when choosing a media
- Testing
 - Legibility
 - Comprehensibility
 - Acceptance

Choose the Proper Colors

Color Uses

- Use color to assist in formatting
 - Relating elements into grouping
 - Breaking apart separate groupings of information
 - Highlighting or calling attention to important information
- Use color as visual code to identify
 - Screen captions and data
 - Information from different sources
 - Status of information
- Use color to
 - Realistically portray natural objects

- Increase screen appeal

Possible Problems with Color

- High Attention-Getting Capacity
 - Viewer might associate, tie together, screen elements of same color
 - Result in confusing, slower reading
- Interference with Use of Other Screens
- Varying Sensitivity of the Eye to Different Colors
 - Viewing red and blue → Eye fatigue
- Color-Viewing Deficiencies
- Cross-Disciplinary and Cross-Cultural Differences
 - For financial managers - Corporate qualities or reliability
 - For health care professionals – Death
 - For nuclear reactor monitors – Coolness or water
 - For American movie audiences – Tenderness or Pornography

Choosing Colors for Categories of Information

- Color chosen to organize information or data on a screen must aid the transfer of information from the display to the user, Some examples of using color code
 - If decisions are made based on the status of information on the screen, color-code the types of status the information
 - Screen searching is performed to locate information of particular kind, color-code for contrast
 - If the sequence of information use is constrained or ordered, use color to identify the sequence
 - If the information on a screen is crowded, use color to provide visual grouping
- Never rely on color as the only way of identifying a screen element
- Always consider how spatial formatting, highlighting, and messages may also be useful

Color in Context

- Color are subject to contextual effects
- Small adjacent colored images may appear to the eye to merge or mix

- A color on a dark background will look lighter and brighter than the same color on a light background
- Colors also change as light levels change

Usage

- Design for monochrome first or in shades of black, white and gray
- Doing this will permit the screen to be effectively used:
 - By people with a color-viewing deficiency
 - On monochrome displays
 - In conditions where ambient lighting distorts the perceived color
 - If the color ever fails
- Use colors conservatively
 - Do not use color where other identification techniques, such as location, are available

Discrimination and Harmony

- Select 4-5 colors for best absolute discrimination
 - Red, yellow, green, blue, and brown
- Select 6-7 colors for best comparative discrimination
 - Orange, yellow-green, cyan, violet, and magenta
- Choose harmonious colors
 - One color plus two colors on either side of its complement
 - Three colors at equidistant point around the color circle
- For extended viewing or older viewers, use brighter colors

Emphasis

- To draw attention or to emphasize elements, use bright or highlighted colors or use less bright colors for deemphasize
 - The perceived brightness of colors from most to least is white, yellow, green, blue, red

- To emphasize separation, use contrasting colors
 - Red and green, blue and yellow
- To convey similarity, use similar colors
 - Orange and yellow, blue and violet

Common Meanings

- To indicate that actions are necessary, use warm colors
 - Red, orange, yellow
- To provide status or background, use cool colors
 - Green, blue, violet, purple
- Conform to human expectation
 - Red: Stop, fire, hot, danger
 - Yellow: Caution, slow, test
 - Green: Go, OK, clear, vegetation, safety
 - Blue: Cold, water, calm, sky, neutrality
 - Gray, White: Neutrality
 - Warm colors: Action, response required, spatial closeness
 - Cool colors: Status, background information, spatial remoteness
- Typical implications of color with dramatic portrayal are
 - High illumination: Hot, active, comic situations
 - Low illumination: Emotional, tense, tragic, romantic situations
 - High saturation: Emotional, tense, hot, comic situations
 - Warm colors: Active, leisure, recreation, comic situations
 - Cool colors: Efficiency, work, tragic and romantic situations
- Proper use of color also requires consideration of the experiences and expectation of the screen viewers

Location and Ordering

- In the center of the visual field, use red and green

- For peripheral viewing, use blue, yellow, black, and white
- Use adjacent colors that differ by hue and value or lightness for a sharp edge and maximum differentiation
- Order colors by their spectral position
 - Red, orange, yellow, green, blue, indigo, violet

Foregrounds and Backgrounds

- Foregrounds
 - Use colors that highly contrast with the background color
 - For text or data
 - Black on light-color background of low intensity (no bright white)
 - Desaturated spectrum colors such as white, yellow, or green on dark background
 - Warmer more active colors
 - To emphasize an element, highlight it in a light value of the foreground color, pure white, or yellow
 - To deemphasize an element, lowlight it in a dark value of the foreground color

Foregrounds and Backgrounds

- Backgrounds
 - Use colors that do not compete with the foreground
 - Use
 - Light-colored backgrounds of low intensity: Off-white or light gray
 - Desaturated colors
 - Cool, dark colors such as blue or black
 - Colors on the spectral extreme end
 - Blue, black, gray, brown, red, green, and purple

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- Backgrounds
 - Use colors that do not compete with the foreground

- Use
 - Light-colored backgrounds of low intensity: Off-white or light gray
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Gray Scale

- For fine discrimination use a black-gray-white scale
 - Recommend values
 - White: Screen background, text located in any black area
 - Light gray: Background of a Pushbutton area
 - Medium gray: Icon background area, Menu drop shadow, Window drop shadow, Inside area of system icons, Filename bar
 - Dark gray: Window boarder
 - Black: Text, Window title bar, Icon border, Icon elements, Ruled lines

Text in Color

- Text in color is not as visible as it is in black
- When switching text from black to color
 - Double the width of lines
 - Use bold or larger type:
 - If originally 8 to 12 points, increase by 1 to 2 points
 - If originally 14 to 24 points, increase by 2 to 4 points

Text in Color

- Text in color is not as visible as it is in black
- When switching text from black to color
 - Double the width of lines
 - Use bold or larger type:
 - If originally 8 to 12 points, increase by 1 to 2 points

- If originally 14 to 24 points, increase by 2 to 4 points
- Check legibility by squinting at text
 - Too-light type will recede or even disappear

Choosing color for web pages

- Always minimize the number of presented colors for faster downloading
- Always consider color in context, never in isolation
- Use similar or same color schemes throughout a Web site → help the user maintain a sense of place
- Foreground colors should be as different as possible from background colors
- The most recommended foreground text color is black presented on a light-colored background of low intensity (off white or light gray)
- Use dark backgrounds when establishing contrast between an area of the screen and the main screen body
- Choosing color for web pages
- High intensity colors as background such as red, magenta and bright green) must be avoided
- When choosing foreground and background colors, ensure that contrasting combinations are selected
- Use a uniform color in large screen areas
- Large areas of the same color download faster
- For smaller element, the more contrast is required
- Use flat Web-safe colors
- Select color that can be easily reproduced in black and white

Use of Color to Avoid

- Relying exclusively on color (Spatial Formatting and component locations)
- Too many colors at one time
- Highly saturated, spectrally extreme colors together
- Red/blue and yellow/purple
- Yellow/blue, green/blue and red/green
- Low-brightness color for extended viewing or older viewer
- Colors of equal brightness
- Colors lacking contrast
- Fully saturated colors for frequently read screen components
- Use of Color to Avoid
- Pure blue for text, thin lines, and small shapes
- Colors in small areas
- Colors for fine details
- Black, gray, and white will provide better resolution
- Other colors for large area or attracting attention
- Non-opponent colors
- Red/yellow or green/blue
- Recommend: Red/green or yellow/blue
- Red and green in the periphery of large-scale displays

- Yellow and blue are much better

Use of Color to Avoid

- Adjacent colors only differing in the amount of blue they possess
- Single color distinctions for color-deficient user
- Using colors in unexpected ways
- Using color to improve readability of densely packed text
 - Recommend to use space lines

UNIT-4

Specification Methods

- Design requires a good notation to record and discuss alternate possibilities:
 - The default language for specifications in any field is natural language, e.g., English
 - Communication medium, e.g., sketchpad, or blackboard
- Natural-language specifications tend to be:
 - lengthy
 - vague
 - ambiguous
- Therefore often are difficult to prove:
 - correct
 - consistent
 - complete
- Backus-Naur Form (a.k.a. Backus Normal Form or BNF)
 - high-level components are described as nonterminals
 - specific strings are described as terminals
- Grammars Example

```
<Telephone book entry> ::= <Name><Telephone number>
<Name> ::= <Last name>, <First name>
<Last name> ::= <string>
<First name> ::= <string>
<string> ::= <character>|<character><string>
<character> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z
<Telephone number> ::= (<area code>) <exchange>-<local number>
<area code> ::= <digit><digit><digit>
<exchange> ::= <digit><digit><digit>
<local number> ::= <digit><digit><digit><digit><digit> ::= 0|1|2|3|4|5|6|7|8|9
```
- Examples of acceptable entries
 - WASHINGTON, GEORGE (301) 555-1234
 - BEEF, STU (726) 768-7878

- A, Z (999) 111-1111

- Multiparty grammars
 - <Session> ::= <U: Opening> <C: Responding>
 - <U: Opening> ::= LOGIN <U: Name>
 - <U: Name> ::= <U: string>
 - <C: Responding> ::= HELLO [<U: Name.~>

U: User C: Computer

- Multiparty grammars are effective for text oriented command sequences
- **Transition Diagram**
 - a set of *nodes* that represents system states and a set of *links* between the nodes that represents possible transitions
- State Charts

Interface-Building Tools: **Features of Interface-Building Tools.**

- User Interface Independence
 - Separate interface design from internals
 - Enable multiple user interface strategies
 - Enable multiple platform support
 - Establish user interface architect role
 - Enforce standards
- Methodology & Notation
 - Develop design procedures
 - Find ways to talk about design
 - Create project management
- Rapid Prototyping
 - Try out ideas very early
 - Test, revise, test, revise,...
 - Engage end users, managers, and others

- Software Support
 - Increase productivity
 - Offer some constraint & consistency checks
 - Facilitate team approaches
 - Ease maintenance

User interface mockup tools

- Examples
 - Paper and pencil
 - Word processors
 - Slide-show software
 - Macromedia Director, Flash mx, or Dreamweaver
- Visual Editing
 - Microsoft Visual Studio
 - Borland JBuilder

Finding the right tool is a tradeoff between six main criteria:

- Part of the application built using the tool.
- Learning time
- Building time
- Methodology imposed or advised
- Communication with other subsystems
- Extensibility and modularity

The windowing system layer

- Sometimes working at a low-level is required.
- E.g., new platform
- The while(true) main loop

The GUI toolkit layer

- Widgets, such as windows, scroll bars, pull-down or pop-up menu, etc.
- Difficult to use without an interface

The application framework and specialized language layer

- Application frameworks are based on object-oriented programming
 - Can quickly build sophisticated interfaces
 - Require intensive learning
- Specialized language layers lighten the programming burden
 - Tcl (and its toolkit Tk)
 - Perl/Tk
 - Python/Tk
 - Visual Basic
 - Java Script

Evaluation and Critiquing Tools

Tullis' Display Analysis Program, Version 4.0:

- Takes alphanumeric screen designs and produces display-complexity metrics plus some advice:
 - Upper-case letters: 77% The percentage of upper-case letters is high.
 - Consider using more lower-case letters, since text printed in normal upper- and lower-case letters is read about 13% faster than text in all upper case. Reserve all upper-case for items that need to attract attention.
 - Maximum local density = 89.9% at row 9, column 8.
Average local density = 67.0%
 - The area with the highest local density is identified...you can reduce local density by distributing the characters as evenly as feasible over the entire screen.
 - Total layout complexity = 8.02 bits
Layout complexity is high.
 - This means that the display items (labels and data) are not well aligned with each other...Horizontal complexity can be reduced by starting items in fewer different columns on the screen (that is, by aligning them vertically).
- **Doctor HTML - Web Page Analyzer:**
- Did not find the required open and close HEAD tag. You should open and close the HEAD tag in order to get consistent performance on all browsers.
- Found extra close STRONG tags in the document. Please remove them.

UNIT -5

Keyboard Layouts

QWERTY layout

- 1870 Christopher Latham Sholes
- good mechanical design and a clever placement of the letters that slowed down the users enough that key jamming was infrequent
- put frequently used letter pairs far apart, thereby increasing finger travel distances

Dvorak layout

- 1920
- reduces finger travel distances by at least one order of magnitude
- Acceptance has been slow despite the dedicated efforts of some devotees
- it takes about 1 week of regular typing to make the switch, but most users have been unwilling to invest the effort

ABCDE style

- 26 letters of the alphabet laid out in alphabetical order nontypists will find it easier to locate the keys

Additional keyboard issues

- IBM PC keyboard was widely criticized because of the placement of a few keys
 - backslash key where most typists expect SHIFT key
 - placement of several special characters near the ENTER key
- Number pad layout
- wrist and hand placement

Keys

- 1/2 inch square keys
- 1/4 inch spacing between keys
- slight concave surface
- matte finish to reduce glare finger slippage
- 40- to 125-gram force to activate
- 3 to 5 millimeters displacement
- tactile and audible feedback important

- certain keys should be larger (e.g. ENTER, SHIFT, CTRL)
- some keys require state indicator, such as lowered position or light indicator (e.g. CAPS LOCK)
- key labels should be large, meaningful, permanent
- some "home" keys may have additional features, such as deeper cavity or small raised dot, to help user locate their fingers properly (caution - no standard for this)

Function keys

- users must either remember each key's function, identify them from the screen's display, or use a template over the keys in order to identify them properly
- can reduce number of keystrokes and errors
- meaning of each key can change with each application placement on keyboard can affect efficient use
- special-purpose displays often embed function keys in monitor bezel
- lights next to keys used to indicate availability of the function, or on/off status
- typically simply labeled F1, F2, etc, though some may also have meaningful labels, such as CUT, COPY, etc.
- frequent movement between keyboard home position and mouse or function keys can be disruptive to use
- alternative is to use closer keys (e.g. ALT or CTRL) and one letter to indicate special function

Cursor movement keys

- up, down, left, right
- some keyboards also provide diagonals
- best layout is natural positions
- inverted-T positioning allows users to place their middle three fingers in a way that reduces hand and finger movement
- cross arrangement better for novices than linear or box
- typically include typamatic (auto-repeat) feature
- important for form-fillin and direct manipulation
- other movements may be performed with other keys, such as TAB, ENTER, HOME, etc.

Keyboard and keypads for small devices

- Wireless or foldable keyboards
- Virtual keyboards
- Cloth keyboards
- Soft keys
- Pens and touchscreens

Pointing Devices

Pointing devices are applicable in six types of interaction tasks:

1. Select:

- user chooses from a set of items.
- used for traditional menu selection, identification of a file in a directory, or marking of a part in an automobile design.

2. Position:

- user chooses a point in a one-, two-, three-, or higher-dimensional space
- used to create a drawing, to place a new window, or to drag a block of text in a figure.

3. Orient:

- user chooses a direction in a two-, three-, or higher-dimensional space.
- direction may simply rotate a symbol on the screen, indicate a direction of motion for a space ship, or control the operation of a robot arm.

4. Path:

- user rapidly performs a series of position and orient operations.
- may be realized as a curving line in a drawing program, the instructions for a cloth cutting machine, or the route on a map.

5. Quantify:

- user specifies a numeric value.
- usually a one-dimensional selection of integer or real values to set parameters, such as the page number in a document, the velocity of a ship, or the amplitude of a sound.

6. Text:

- user enters, moves, and edits text in a two-dimensional space. The
- pointing device indicates the location of an insertion, deletion, or change.
- more elaborate tasks, such as centering; margin setting; font sizes; highlighting, such as boldface or underscore; and page layout.

Direct-control pointing devices

lightpen

- enabled users to point to a spot on a screen and to perform a select, position, or other task

- it allows direct control by pointing to a spot on the display
- incorporates a button for the user to press when the cursor is resting on the desired spot on the screen
- lightpen has three disadvantages: users' hands obscured part of the screen, users had to remove their hands from the keyboard, and users had to pick up the lightpen

Touchscreen

- allows direct control touches on the screen using a finger
- early designs were rightly criticized for causing fatigue, hand-obscuring-the-screen, hand-off-keyboard, imprecise pointing, and the eventual smudging of the display
- lift-off strategy enables users to point at a single pixel
- the users touch the surface
- then see a cursor that they can drag around on the display
- when the users are satisfied with the position, they lift their fingers off the display to activate
- can produce varied displays to suit the task
- are fabricated integrally with display surfaces

Tablet PCs and Mobile Devices:

- Natural to point on the LCD surface
- Stylus
- Keep context in view
- Pick up & put down stylus
- Gestures and handwriting recognition

Indirect pointing devices

- mouse
 - the hand rests in a comfortable position, buttons on the mouse are easily pressed, even long motions can be rapid, and positioning can be precise
- trackball
 - usually implemented as a rotating ball 1 to 6 inches in diameter that moves a cursor

- joystick
 - are appealing for tracking purposes
- graphics tablet
 - a touch-sensitive surface separate from the screen
- touchpad
 - built-in near the keyboard offers the convenience and precision of a touchscreen while keeping the user's hand off the display surface
- Human-factors variables
 - speed of motion for short and long distances
 - accuracy of positioning
 - error rates
 - learning time
 - user satisfaction
- Other variables
 - cost
 - durability
 - space requirements
 - weight
 - left- versus right-hand use
 - likelihood to cause repetitive-strain injury
 - compatibility with other systems

Comparison of pointing devices

- Some results
 - direct pointing devices faster, but less accurate
 - graphics tablets are appealing when user can remain with device for long periods without switching to keyboard
 - mouse is faster than isometric joystick
 - for tasks that mix typing and pointing, cursor keys are faster and are preferred by users to a mouse
 - muscular strain is low for cursor keys
- Fitts' Law

- Index of difficulty = $\log_2 (2D / W)$
- Time to point = $C1 + C2 (\text{index of difficulty})$
- $C1$ and $C2$ are constants that depend on the device
- Index of difficulty is $\log_2 (2 \cdot 8 / 1) = \log_2(16) = 4$ bits
- A three-component equation was thus more suited for the high-precision pointing task:
- Time for precision pointing = $C1 + C2 (\text{index of difficulty}) + C3 \log_2 (C4 / W)$

Novel devices

- Foot controls
- Eye-tracking
- Multiple-degrees-of-freedom devices
- DataGlove
- Haptic feedback
- Bimanual input
- Ubiquitous computing and tangible user interfaces
- Handheld devices

Speech and auditory interfaces

- Speech recognition still does not match the fantasy of science fiction:
 - demands of user's working memory
 - background noise problematic
 - variations in user speech performance impacts effectiveness
 - most useful in specific applications, such as to benefit handicapped users
- Discrete word recognition
 - recognize individual words spoken by a specific person; can work with 90- to 98-percent reliability for 20 to 200 word vocabularies
 - Speaker-dependent training, in which the user repeats the full vocabulary once or twice
 - Speaker-independent systems are beginning to be reliable enough for certain commercial applications
 - been successful in enabling bedridden, paralyzed, or otherwise disabled people
 - also useful in applications with at least one of the following conditions:
 - speaker's hands are occupied

- mobility is required
 - speaker's eyes are occupied
 - harsh or cramped conditions preclude use of keyboard
- voice-controlled editor versus keyboard editor
 - lower task-completion rate
 - lower error rate
- use can disrupt problem solving
 - Continuous-speech recognition
 - Not generally available:
 - difficulty in recognizing boundaries between spoken words
 - normal speech patterns blur boundaries
 - many potentially useful applications if perfected
 - Speech store and forward
 - Voice mail users can
 - receive messages
 - replay messages
 - reply to caller
 - forward messages to other users, delete messages
 - archive messages
 - Systems are low cost and reliable.
 - Voice information systems
 - Stored speech commonly used to provide information about tourist sites, government services, after-hours messages for organizations
 - Low cost
 - Voice prompts
 - Deep and complex menus frustrating
 - Slow pace of voice output, ephemeral nature of speech, scanning and searching problems
 - Voice mail
 - Handheld voice recorders
 - Audio books
 - Instructional systems

- Speech generation
 - Michaelis and Wiggins (1982) suggest that speech generation is "frequently preferable" under these circumstances:
 - The message is simple.
 - The message is short.
 - The message will not be referred to later.
 - The message deals with events in time.
 - The message requires an immediate response.
 - The visual channels of communication are overloaded.
 - The environment is too brightly lit, too poorly lit, subject to severe vibration, or otherwise unsuitable for transmission of visual information.
 - The user must be free to move around.
 - The user is subjected to high G forces or anoxia

Audio tones, audiolization, and music

- Sound feedback can be important:
 - to confirm actions
 - offer warning
 - for visually-impaired users
 - music used to provide mood context, e.g. in games
 - can provide unique opportunities for user, e.g. with simulating various musical instruments

Displays – Small and Large

- The display has become the primary source of feedback to the user from the computer
- The display has many important features, including:
 - Physical dimensions (usually the diagonal dimension and depth)
 - Resolution (the number of pixels available)
 - Number of available colors, color correctness
 - Luminance, contrast, and glare

- Power consumption
- Refresh rates (sufficient to allow animation and video)
- Cost
- Reliability

Usage characteristics distinguish displays:

- Portability
- Privacy
- Saliency
- Ubiquity
- Simultaneity

Display technology

- Monochrome displays
 - are adequate, and are attractive because of their lower cost
- RGB shadow-mask displays
 - small dots of red, green, and blue phosphors packed closely
- Raster-scan cathode-ray tube (CRT)
 - electron beam sweeping out lines of dots to form letters
 - refresh rates 30 to 70 per second
- Liquid-crystal displays (LCDs)
 - voltage changes influence the polarization of tiny capsules of liquid crystals
 - flicker-free
 - size of the capsules limits the resolution
- Plasma panel
 - rows of horizontal wires are slightly separated from vertical wires by small glass-enclosed capsules of neon-based gases
- Light-emitting diodes (LEDs)
 - certain diodes emit light when a voltage is applied
 - arrays of these small diodes can be assembled to display characters
- Electronic ink
 - Paper like resolution

- Tiny capsules with negatively and positively charged particles
- Braille displays
- Pins provide output for the blind
- Large displays
- Informational wall displays
- Interactive wall displays
- Multiple desktop displays
- Heads-up and helmet mounted displays
- A heads-up display can, for instance, project information on a partially silvered widescreen of an airplane or car
- A helmet/head mounted display (HMD) moves the image with the user
- 3D images

Mobile device displays

- Currently mobile devices used for brief tasks, except for game playing
- Optimize for repetitive tasks
- Custom designs to take advantage of every pixel
- DataLens allows compact overviews
- Web browsing difficult
- Okay for linear reading, but making comparisons can be difficult

Animation, image, and video

- Accelerated graphics hardware
- More information shared and downloaded on the web
- Scanning of images and OCR
- Digital video
- CDROMS and DVDs
- Compression and decompression through MPEG
- Computer-based video conferencing

Printers

- Important criteria for printers:
 - Speed
 - Print quality
 - Cost
 - Compactness
 - Quiet operation
 - Use of ordinary paper (fanfolded or single sheet)
 - Character set
 - Variety of typefaces, fonts, and sizes
 - Highlighting techniques (boldface, underscore, and so on)
 - Support for special forms (printed forms, different lengths, and so on)
 - Reliability
- dot-matrix printers
 - print more than 200 characters per second, have multiple fonts, can print boldface, use variable width and size, and have graphics capabilities
- inkjet printers
 - offer quiet operation and high-quality output
- thermal printers or fax machines
 - offer quiet, compact, and inexpensive output on specially coated papers
- laser printers
 - operate at 30,000 lines per minute
- color printers
 - allow users to produce hardcopy output of color graphics, usually by an inkjet approach with three colored and black inks
- photographic printers
 - allow the creation of 35-millimeter or larger slides (transparencies) and photographic prints