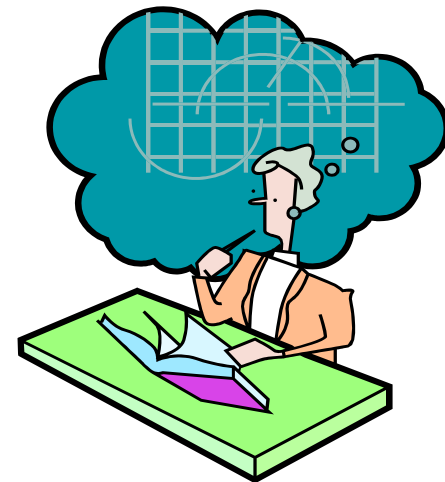


Systems Analysis and Design

- Systems analysis and design refers to one aspect of the process of creating or modifying an information system in order to meet the needs and goals of a given system.
- Analysis is the phase in which the requirements for a new information system are identified
- Design is the phase in which those requirements are used to create actual plans for a new system.
- Whenever we speak of systems analysis and design, the word “system” refers to both the real world system and its information system since neither can exist without the other.
- Information systems of all types go through a predictable series of phases from birth to death.

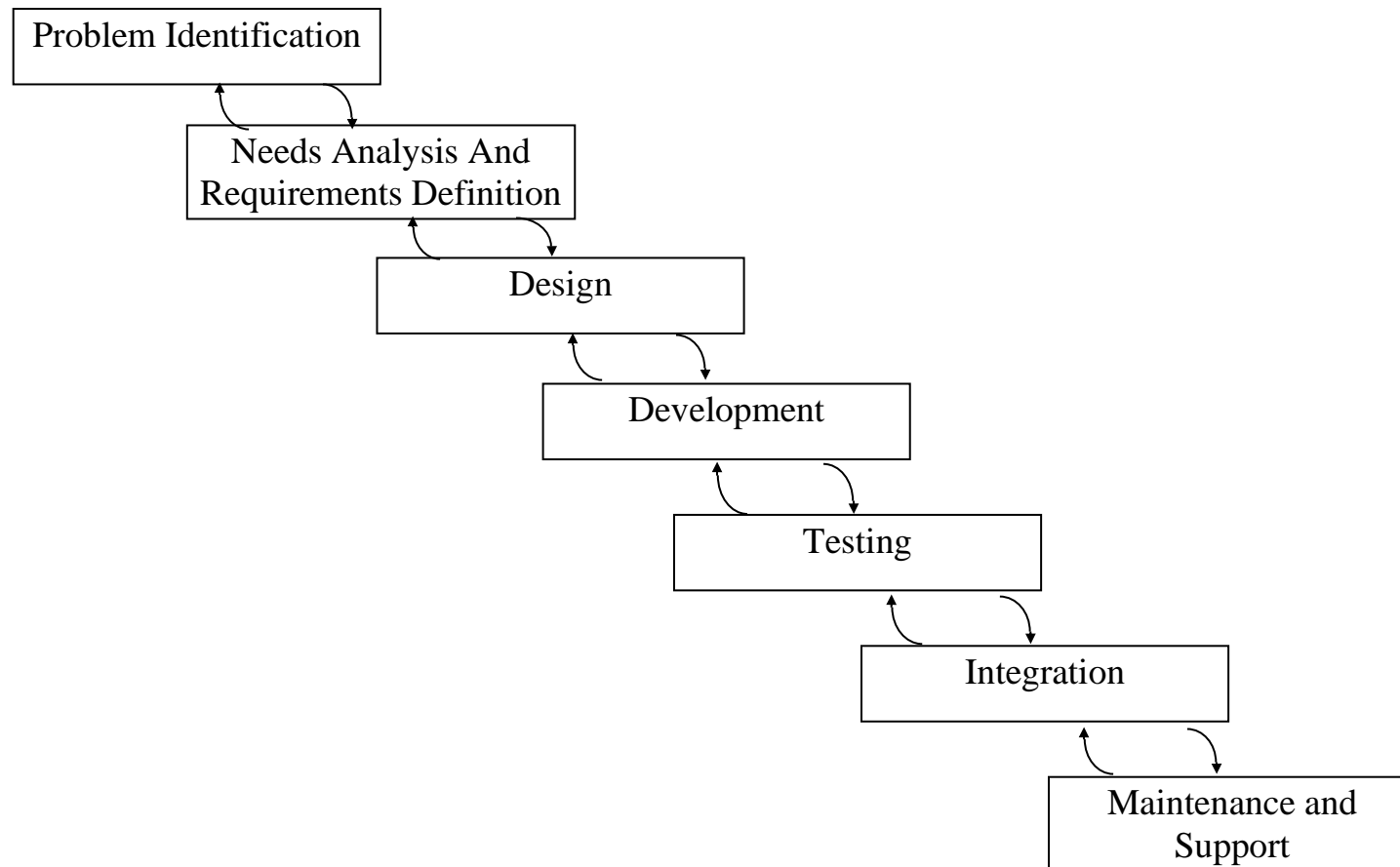
This cycle is known as the “life cycle” and all systems have a life cycle.

- There are several ways of representing a system development life cycle
- The general steps in the system development life cycle are:
 1. Problem Recognition
 2. Feasibility Study
 3. Analysis
 4. Design
 5. Construction
 6. Conversion
 7. Maintenance



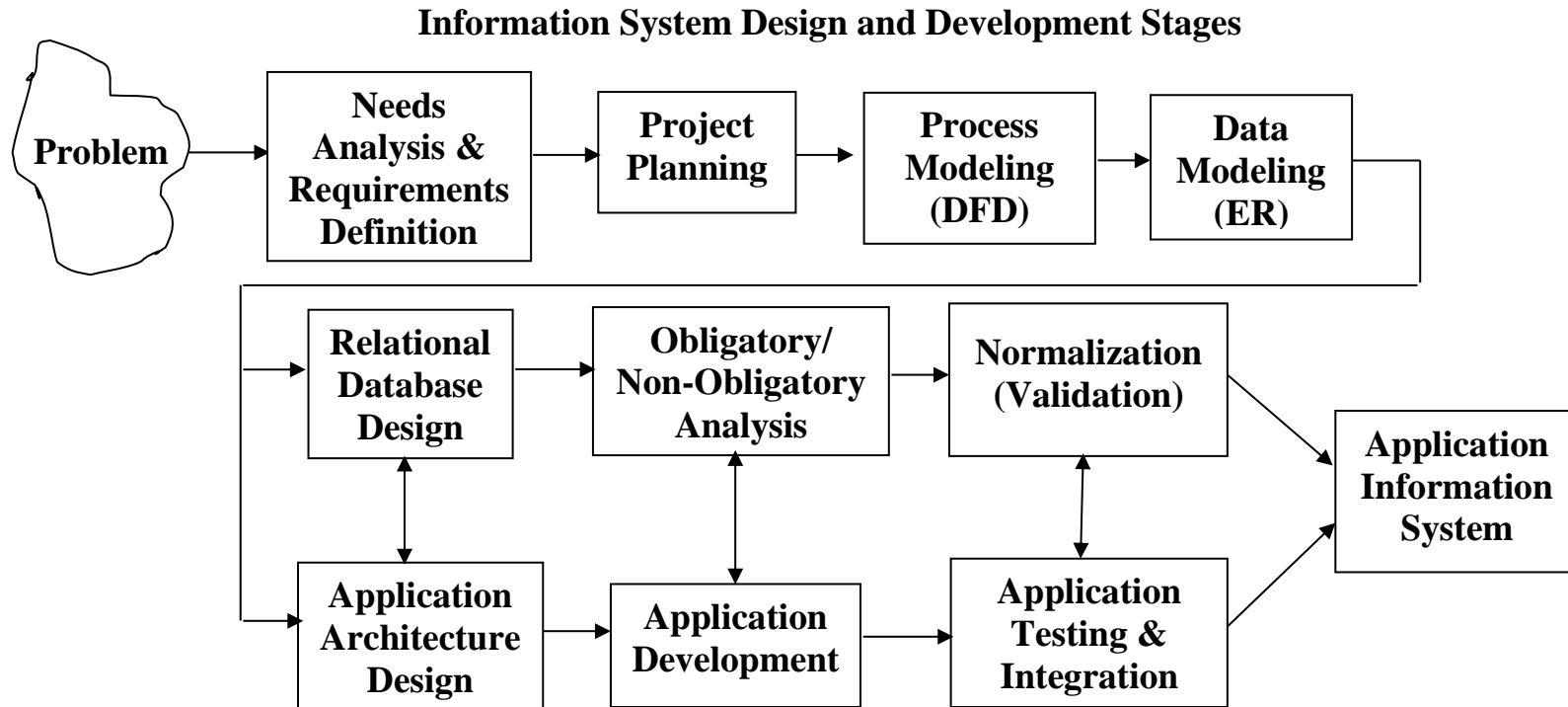
Systems Analysis and Design (Cont.)

- The software development life cycle is often represented as follows:



This is known as the “Waterfall Model” and the steps are not necessarily sequential.

Systems Analysis and Design (Cont.)



Systems Analysis and Design (Cont.)

- Steps in the information system life cycle:

1. Problem Definition

2. Needs Analysis

3. Requirements Definition

4. Project Planning

5. Process Modeling

6. Data Modeling

7. Application Architecture Design

8. Relational Database Design

9. Obligatory / Non-obligatory Analysis

10. Validation (Normalization)

11. Application Development

12. Application Testing, Integration



Systems Analysis and Design (Cont.)

Steps 7 and 11 in the information system life cycle can be elaborated further as follows:

7. Application Architecture Design

- 1. Develop a function Hierarchy Diagram**
- 2. Develop a function Dependency Diagram**
- 3. Design the Function / Entity Matrix**
- 4. Perform entity life cycle analysis (CRUD)**
- 5. Perform an affinity analysis**
- 6. Decide on the number of applications, scope of each application, etc.**

11. Application Development

- 1. Design and Develop Processes**
- 2. Design tables, columns, keys and relationships**
- 3. Design and Develop Forms**
- 4. Design and Develop Reports**
- 5. Design and Develop Queries**
- 6. Design and Develop Menus and User Interfaces**

- **As part of step 11, you will learn to use Microsoft Access for creating tables, columns, keys, relationships, forms, reports, queries, and application menus**
- **But we will not cover step 4, which is Project Planning, as it will take a separate course such as Engineering Project Management to cover it**

Systems Analysis and Design (Cont.)

- **Problem Recognition**

How do we recognize a problem?

When managers or users realize either that an information system is needed for a new business or an existing information system is no longer adequate.

Business expansion can create problems that may require new information systems to be developed.

New methods may have been developed that may require new information systems.

Response time of an existing system may be too slow.

The major function of this step is to establish that a problem exists.

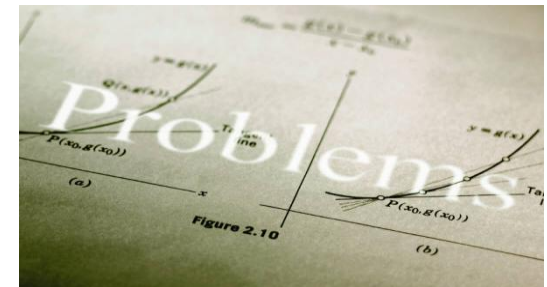
There are no special tools available for recognizing a problem.

Most problems are identified manually by experienced users or managers.

But for the purpose of aiding in the process of identifying a problem and its scope, brainstorming exercises are often used

One such brainstorming exercise is called “**Concept Mapping**” or “**Concept Diagramming**”

Other similar approaches are “Idea Mapping”, “Brain Mapping”, “Mind Mapping”, etc.



Systems Analysis and Design (Cont.)

- **Concept Mapping**

A concept map is a graphical or visual representation of an idea or a concept for the purpose of understanding, discussion, and analysis

Concept maps are useful for studying, comprehending difficult concepts, thinking about problems or issues, outlining ideas, scoping problems, and exercising creativity

Concept mapping is the process of developing a concept map

The first step in developing a concept map is to come up with a focus question or concept or idea of interest

The focus question or concept can be about anything of interest such as process defects, indexes, happiness, purchasing a car, etc.

Several kinds of concept maps can be found on the web and some of them are listed below:

Spider – has a central concept or unifying theme linking contributing factors or issues

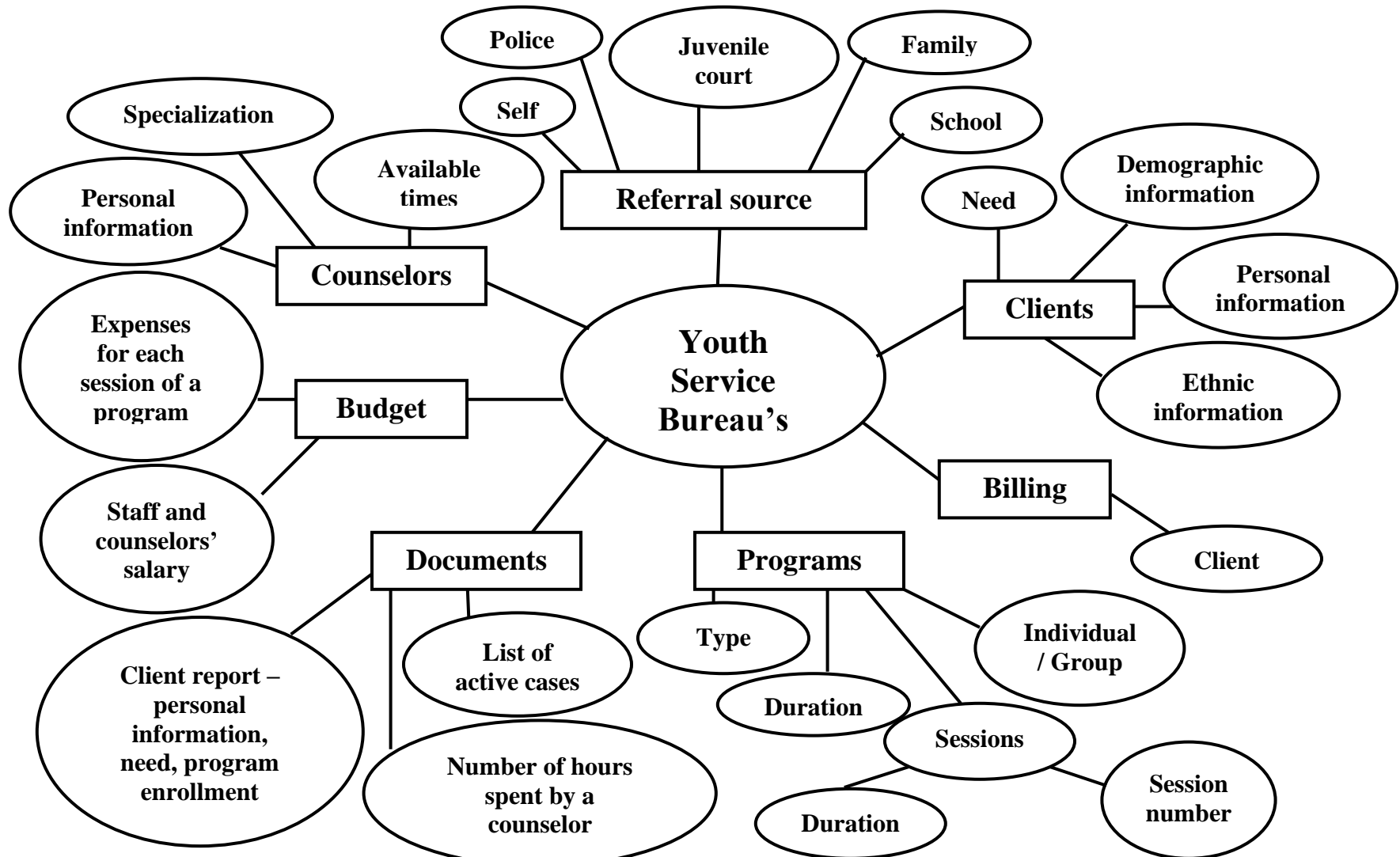
Flow chart – decision charts or diagrams showing flow of information or decision

Hierarchical – example: organizational structure

System – with inputs, outputs, processes, etc.

Systems Analysis and Design (Cont.)

- In designing information systems, concept mapping can be useful to understand the problem situation and scope the problem to be addressed. Below is a concept map developed by an ISyE student in 2006.



Systems Analysis and Design (Cont.)

- **Concept Mapping (cont.)**

When developing concept maps, let the ideas flow and do not restrict to any particular type of map

The key to drawing a good concept map is to approach it from how you conceptualize a problem

Use the map as a brainstorming tool to describe the problem and represent related issues

Note in the sample concept map the information is represented hierarchically, that is, Youth Service Bureau's Client Services has Programs, Billing, Clients, etc., and Programs has Type, Duration, etc.

Each level of information should be indicated by a different graphical symbol such as rectangle, ellipse, etc., or by a different color for ease of readability

As many levels of the concept map should be drawn as possible to understand the problem and the map may have to be redrawn several times to clarify the problem among project team members

A concept map is not intended to be a tool for arriving at a solution for the problem

A concept map can be used to “scope” the problem for a particular project

But the scope of a problem may depend on a number of constraints including time, funds, etc.

There are a number of free software products on concept mapping available on the web

Do not draw the concept map as an afterthought, that is, after conducting needs analysis, etc.

Systems analysis and Design (Cont.)

- **Needs Analysis**

After a problem has been recognized, the next step is to analyze users' needs in solving the problem

This process is known as “Needs Analysis”

Needs analysis involves analyzing a problem and identifying its needs to meet the objectives of solving the problem

Objectives of the solving the problem may be refined as the problem as it is understood and users' needs are identified

These steps are not necessarily sequential and are often cyclical until the issues are satisfied

Needs analysis is necessary for all problem solving activities and the process steps are generally similar while some of the methods may have to be tailored for each problem solving situation

Needs analysis process also helps to clarify what the problem is and what the users' needs are before exploring further

Needs analysis is one of the critical skills of an analyst and the need analysis process cannot be automated or captured in a software

Therefore, it is essential that information system designers understand and experience the process so that they can effective in their roles

Systems analysis and Design (Cont.)

- But what is a NEED?

A need is a statement of the problem that establishes the focus and rationale for a project

It is in essence a brief problem statement **without offering a particular solution**. The actual solution may depend on a number of factors such as the availability of time, funds, people, technology, etc.

Need is a statement of “what is needed” to address a problem but not offer a particular solution

A need statement should be factual and not have jargons, acronyms, assumptions, or emotional appeals

A need statement should not have circular reasoning, that is, stating the absence of a particular solution is the problem e.g., The problem is we don’t have a database, and so we need to design a database system

- Good Examples of a Need Statement

1. Problem: I cannot get to school on time. I find walking in the cold weather difficult.

Need: I need a way to get to school on time.

2. Problem: Shop floor supervisors cannot keep track of defective products and share the data.

Need: We need a mechanism to keep track of defective products and share that data.

3. Problem: Manual record keeping of employees’ sick leave information is resulting in errors.

Need: We need an approach to keep track of employees’ sick leave information.

Systems analysis and Design (Cont.)

- **Bad Examples of Need Statements**

1. **Problem:** I cannot get to school on time. I find walking in the cold weather difficult.

Need: I need a Ferrari to get to school on time.

2. **Problem:** Shop floor supervisors cannot keep track of defective products and share the data.

Need: We need an easy to use, effective quality control system to prevent defects.

3. **Problem:** Manual record keeping of employees' sick leave information is resulting in errors.

Need: We need an efficient database system to keep track of employees' sick leave information.

4. **Problem:** I have no place to live.

Need: I need a beautiful condo on Lake Shore Drive in Chicago.

- There is difference between needs and wants and this must be clearly identified at this step.

- What is **WANTED** may not be what is **NEEDED**!

NEED

All I need is a bike to get to school on time

All I need is a two-room apartment to rent

All I need is to use the lab PC to do homework

WANT

But I want a Ferrari to get to school on time

But I want to build a 4-bedroom house

But I want to buy a multimedia gaming PC

Systems Analysis and Design (Cont.)

- **Needs may not be clear at first, and may have to be refined as the system development steps progress**
- **All information system projects require a needs-analysis document.**
- **How to conduct needs analysis?**

The problem recognition step may allude to a problem, but not necessarily confirm it.

The needs analysis step helps to confirm the problem and the need for a solution.

There are several steps in conducting a needs analysis or needs assessment.

The first step is to identify the information needed to analyze and understand the problem fully.

The information could be obtained from several sources:

Historical records

Business records (transaction records)

Performance reports (trend data, spreadsheets, etc.)

Data capture forms (forms used for collecting or recording data in the

Qualitative documents (memos, letters, policy handbooks, procedural manuals, etc.)



Systems Analysis and Design (Cont.)

- **How to conduct needs analysis (Cont.)?**

Information for needs analysis could also be obtained from people through:

Interviews

Focus groups

Consultations with key personnel

Direct observations

Tests

Work samples of personnel

Questionnaires



- **Interviewing for needs analysis**

- 1. Read background material – organizational chart, what the organization is about, etc.,**
- 2. Establish interview objectives – list the purpose of the interview**
- 3. Decide whom to interview – people at all levels is helpful**

Systems Analysis and Design (Cont.)

- **Interviewing for needs analysis (cont.)**
 - 4. Prepare the interviewee – Inform in advance the people to be interviewed what the meeting is about, how long (not more than an hour), where the meeting could be held without interruptions, etc.**
 - 5. Decide on question types and structure, type the questions, review and refine them**
 - a. Open ended questions – “What’s your opinion of the current system?” “What are some of the common problems encountered?” – puts the interviewee at ease**
 - b. Closed questions – “How many transactions/hour?” “Who prepares reports?” “Who records data” – elicits specific answers, can also be range or multiple choice questions**
 - c. Probing questions – “Why does this happen?” “Can you give me an example of that?” “What makes the system perform that way?”**
 - d. Avoid leading questions – “I am sure you agree with me when I say....”**
 - e. Avoid double-barreled questions – “What decisions are made and who makes them?” – poor choice of questions, confuses the interviewee**
 - 6. Organize and ask the questions in a logical sequence so that the interviewee can think clearly**
 - 7. Decide on how to record responses (tape recorder, note taker?)**
 - 8. Conduct the interview and get samples of information (forms, records, etc.)**

Systems Analysis and Design (Cont.)

- **Interviewing for needs analysis (cont.)**

9. Prepare a summary – type up a summary of the interview and send it to the interviewee, if necessary

10. Follow-up – follow-up with the interviewee for clarifications, additional information, etc.

- **Using Surveys or Questionnaires to assess needs**

1. Questionnaires or surveys are especially useful if:

- **the people to be interviewed are spread out in the organization and cannot be met easily**
- **a large number of people have to be interviewed or contacted**
- **opinions and needs of people at different levels have to be explored**
- **current problems and specific needs have to be identified**

2. Writing questions is not easy; Choice of words is important, they should be clear and understandable, and the educational/literacy background of respondents should be considered

3. When writing questions, decide how the results will be analyzed and used. Do not ask unnecessary questions or information that you will not use in your analysis

4. Order the questions in such a way that the respondents can logically think about the issues related to the questions, and begin with easy-to-respond questions (using scales, yes or no, etc.)

Systems Analysis and Design (Cont.)

- **Using Surveys or Questionnaires to assess needs (cont.)**

For example, if the questionnaire is to find out problems in a system, then organize the questions logically by asking first issues such as:

The respondent's role in the current system

The respondent's involvement in the current system

How the respondent uses the system or what he or she does in the system

The respondent's perspectives on the effectiveness of the system

What changes to the system can help the respondent's use of the system

Then ask about the problems or deficiencies of the current system

5. **Include open-ended questions at the end** for respondents to write additional information, comments, suggestions, or even concerns
6. **Use of scales for responses requires consideration**
 - scales should be simple, logical, clear, and easy for the respondent to decide which one to select
 - If possible, avoid using both text and numerical scale and making respondents check what each number stands for

Systems Analysis and Design (Cont.)

- **Using Surveys or Questionnaires to assess needs (cont.)**

Example below requires respondents to remember or look up what each number stands for:

Current system is difficult to use (circle one) 6 5 4 3 2 1

Example below does not require one to remember or look up what each number stands for:

Current system is difficult to use (circle one below)

Strongly agree Agree Neither Agree nor disagree Disagree Strongly Disagree Not applicable

7. Decide how, when, and where to administer the survey or questionnaire and collect responses

Depending on the respondents, the questionnaire can be administered online or using paper

Include an introduction to the questionnaire and a deadline for completing the questionnaire

Use organizational support to administer the questionnaire and get support

- **It is a good idea to pilot-test the questionnaire with a small number of intended respondents and use their feedback to refine the questionnaire further**
- **Exercise caution in the tone and language of the questions so that the questionnaire does not unintentionally offend the respondents or ask for personal information unnecessary to the project**

Systems Analysis and Design (Cont.)

Sample of a Needs Analysis Questionnaire

The **purpose** of this questionnaire is to collect information about your experience with the current system and your needs related to the proposed system. Your constructive responses will be very much appreciated and only a summary of your responses will be shared with the management. Please return the completed questionnaire to **<enter name> by <enter date>**. Thank you.

1. Do your responsibilities involve any of the following? Check all applicable responses below.
☐ Collect data ☐ Enter data on paper or computer forms ☐ Prepare reports ☐ Other (related to data) ☐ If none, go to 7.
2. Approximately how many hours do you spend weekly collecting, recording, or organizing data? Check one:
☐ 0-5 ☐ >5-10 ☐ >10-20 ☐ >20-30 ☐ >30-40 ☐ Other (explain): _____
3. Check below all the methods you currently use for collecting, recording or organizing data:
☐ Paper forms ☐ Computerized forms ☐ Devices (explain) _____ ☐ Other (explain): _____
4. If your responsibilities involve using computers, check below all the software you use:
☐ Word processing ☐ Spreadsheet ☐ Databases ☐ Presentation (PowerPoint) ☐ Other _____
5. Approximately how many people in your department are involved in data collection and recording activities? Check one:
☐ None ☐ 1-5 ☐ 6-10 ☐ 11-20 ☐ 21-50 ☐ >51
6. Approximately how many data records do you collect or record per week? Check one below.
☐ None ☐ 1-20 ☐ 21-50 ☐ 51-100 ☐ 101-200 ☐ 201-500 ☐ 501-1000 ☐ >1000
7. List below some of the difficulties encountered in the current data management activities:
8. List below which data management activities can be improved to assist you with your responsibilities:
9. How many years have you worked in your current position? Check one below.
☐ 0-1 year ☐ >1-2 years ☐ >2-5 years ☐ >5-10 years ☐ >10 years
10. Please indicate below any other useful information that will assist us in this project.

Systems Analysis and Design (Cont.)

- Analyzing the information collected

This involves a four-step process:

1. Conduct “Gap” analysis
2. Identify priorities
3. Analyze causes of problems and/or opportunities
4. Analyze possible directions

1. Conduct Gap Analysis

A “Gap” is the difference between the actual performance of the organization/system and the existing standards or new standards. The gap shows what is missing or needed.

Identifying gaps requires analyzing the current situation and the desired situation

For this purpose, the information gathered from various sources can be used

The gap analysis should lead to problems, strengths, opportunities, etc., which should lead to needs

Example of gap analysis for a call center service response:

| Expected Standard (“to be”) | Current Standard (“as is”) | Gaps |
|--|---|--|
| Callers shall be provided a quick estimate of wait time if they are on hold for more than 10 seconds | Callers do not know how long they will have to wait before their calls are answered | A mechanism for estimating wait time and providing that information to callers on hold |



Systems Analysis and Design (Cont.)

The identified gap may or may not directly indicate the solutions for resolving the need. For example, the solution could be a database system or change in procedures depending on certain considerations.

Examples of BAD Gap Analyses (a gap should not be a solution)

| Expected Standard (“to be”) | Current Standard (“as is”) | Gaps |
|--|---|---|
| Callers shall be provided a quick estimate of wait time if they are on hold for more than 10 seconds | Callers do not know how long they will have to wait before their calls are answered | A database system to keep track of wait times |
| Students shall find any time the classes to enroll in | Students don’t know which classes they can enroll in each semester | A 24/7 hotline for students to call in and find out which classes to take |
| Shop floor people shall be notified immediately when and where a defect has occurred in a product | It takes a long time for shop floor people to find out if a defect has occurred in a product line | A bar code system for tagging and tracking all components of a product |

The current standard and expected standard statements should be factual and not have ambiguous phrases such as “quickly”, “easily”, “long time”, etc.

The gap should indicate what is needed to go from “as is” state to “to be” state. That is, what is the need but not what a particular solution may be

In some cases, it may be obvious that a particular solution may help you go from “as is” to “to be” state but it may or may not be feasible or even necessary due to a number of other factors and constraints

So, it is critical to keep an open mind during the needs analysis process and not be biased

Systems Analysis and Design (Cont.)

2. Identify Priorities

The needs identified using gap analysis should be prioritized based on a number of factors such as organizational goals, legal mandates, financial constraints, customers' needs, etc.

An organization may not be able to address all the needs at once and may decide to address them in phases based on certain criteria such as health and safety, legal mandates, competition, etc.

3. Analyze causes of problems and/or opportunities

After prioritizing the needs, it is important to identify specific problem areas or opportunities

This is to make sure the priority identified is feasible to tackle; if the cause of the problem is not in the organization's hands, then there is no point in tackling that problem or need

4. Analyze possible directions

Analyzing possible causes of problems and/or opportunities may give some directions on solving the problems or capitalizing the opportunities

- **REMEMBER: Needs analysis does not attempt to discover specific solutions for a problem.**

If the problem is “one cannot get to school on time,” needs analysis may not suggest “buy a car”.

The actual solution that maybe feasible could be one of the following identified later on:

Take the bus, Get a ride, Buy a car, Get up early, etc.

Systems Analysis and Design (Cont.)

- The actual solution that satisfies a need may depend on what is required and what is feasible.
- To conduct needs analysis often several modeling and documenting tools may be used.
- After identifying the need(s), the next step is to define the requirements.
- **Requirement is a need stated with its associated parameters and it provides more specificity.**

Requirements represent formal limits or options to the solutions for a problem.

Requirements should not be confused with wishes, desires, or wants.

A good requirement defines what is necessary, verifiable and achievable.

Necessary means it is necessary for addressing the need or solving the problem and not just something nice to have

Verifiable means will you know if that requirement has been met or accepted

Achievable means the requirement states something that is feasible and possible to accomplish within the time, budget, technology, personnel and other constraints

Each requirement should convey a single issue in a simple, concise and unambiguous manner related to the need. A requirement should not be negative (if avoidable).

A requirement can be an expected standard or the “to be” standard for a system

Systems Analysis and Design (Cont.)

- Some of the common mistakes in requirements definition are:

Stating tasks instead of requirements (that is, stating how to do something instead of what is expected)

Making bad assumptions (because you have not done a good job of understanding the problem)

Missing information (because you have not done a good job of understanding the problem)

Using ambiguous or unclear phrases such as quickly, easily, faster, adequate, usually, optimally, etc.

Over-specifying the requirements or stating unnecessary things or stating negative things

Incorrect sentences, improper grammar, punctuation errors that cause confusion

- There can be several types of requirements:

Functional requirements, physical requirements, behavioral requirements, contractual requirements, etc.

- Standard practice is to state each requirement using “shall”

The system shall handle 400 concurrent users

The unit shall function in temperatures up to 150 degrees Fahrenheit

Each user shall be able to enter at least 5 customers’ data on each data entry screen

Systems Analysis and Design (Cont.)

- **Examples of Need and Requirements:**

Problem 1: A family of four would like a place to live and wants to explore various possibilities.

Need: A family of four needs a place to live.

Two possible requirements related to the need are: **The place shall**

1. Have at least 3 bedrooms and 2 baths, a living room, kitchen, dining, and a garage for 2 cars,
2. Be within 30 minutes driving distance from local high schools and the parents' work places.

Note that the need and requirements do not indicate at this stage if the solution should be to rent, buy or build as they may depend on various other constraints. The need and requirements just state what is necessary to fulfill the void the client has.

User's requirements can also be further analyzed to arrive at System Requirements, such as square feet area of bedrooms, living room, and other overall details.

System Requirements can then be analyzed to arrive at System Specifications such as specific dimensions of the rooms, amenities needed in the rooms, number of levels of the house, type of floor, construction materials to use, etc.

Need → User's Requirements → System Requirements → System Specifications

As the needs are analyzed into system specifications, more details are known

Systems Analysis and Design (Cont.)

- **Examples of Need and Requirements (cont.):**

Problem 2: A department office is currently maintaining its student advising information in a spreadsheet at the secretary's workstation. Whenever faculty in the department have to advise a student, they have to get the files from the secretary instead of being able to access or update it from their offices. This is both cumbersome and time consuming for the secretary, faculty and students.

Need: Faculty need access to student advising information from their offices.

Two possible requirements related to the need are:

- 1. Faculty shall access from their offices student advising information located centrally.**
- 2. Faculty shall be able to update and generate reports of student advising information from their offices.**

Example 3: A local bookstore is manually keeping track of its books and sales. This is both cumbersome and time consuming, and making it difficult to keep track of sales as well as search for particular books. The store manager would like to automate the process to simplify and speed up the operation.

Need: The book store needs an automated process for book inventory and sales.

Two possible requirements are: The process shall allow employees to

- 1. Check if a book is available or not in the store within 1 minute.**
- 2. Print a report of daily, weekly and monthly sales transactions.**

Systems Analysis and Design (Cont.)

- **Are these good or bad requirements? Why?**
 - 1. The place will be convenient for a family of four to live near their schools and offices.**
 - 2. The system shall withstand exposure to temperatures of -20⁰ F to 140 0⁰ F**
 - 3. The interface shall be user-friendly and accessible to all employees.**
 - 4. The system shall not perform reverse maneuvers.**
 - 5. The unit shall perform with 110 and/or 220 V.**
 - 6. The motor's torque shall be less than 300 lb./ft. when supplied with an input voltage as specified in design manual section 3.2.4.7.1 and while the operating pressure is as specified in design manual section 7.3.1.9.2.**
 - 7. The keyboard interface shall accommodate various types of users in different countries.**
 - 8. The bedroom shall have a walk-in closet.**

Systems Analysis and Design (Cont.)

- A thorough needs analysis is critical to understand users' needs and translate them into valid requirements before deciding if an information system is necessary and feasible for a particular problem

Needs analysis is also essential for planning the information system project and for deciding information system hardware and software requirements for a particular problem

- Project planning usually involves:

Conducting a feasibility study

Defining the objectives and deliverables

Defining the scope of the project

Identifying resource needs and constraints (people, funds, time, etc.)

Defining major tasks and setting deadlines.



- The purpose of a feasibility study is to define the problem and to decide whether or not the project is feasible.
- Usually a feasibility study is conducted within a short time, say a month or two, by one or two people, but it depends on the size of the problem and the risks involved
- Common techniques used for feasibility studies are simulation, prototype development, analysis of similar systems, etc.

Systems Analysis and Design (Cont.)

- **During the feasibility study the magnitude and the scope of the problem are quickly studied.**
- **Next the analysts decide what is needed and required, and determine if the needed solution is feasible technically, humanly, and economically.**
- **Technical feasibility deals with hardware, software, and techniques available for solving the problem.**
- **Human feasibility deals with determining if the organization has adequate personnel to devote to the project.**
- **Economic feasibility deals with cost-benefit analysis that justifies the project is beneficial.**

This is a procedure for evaluating costs to see if they are justified by the benefits delivered by the system.

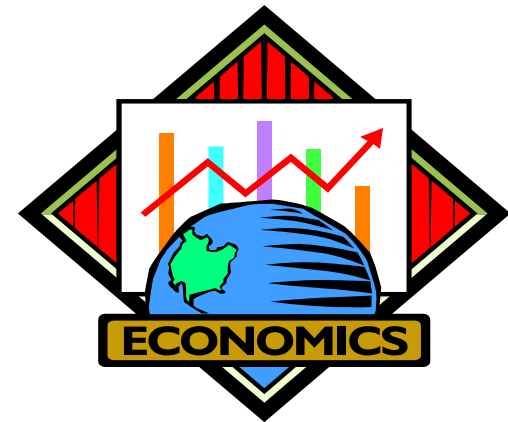
Estimating costs is relatively easy compared to estimating benefits.

How do we estimate benefits of anything?

We have to identify each benefit and assign a monetary value.

We also have to assess costs and risks.

Economic analysis is one way of performing benefit cost analysis.



- **If the outcome of the feasibility phase is positive, the project continues into the analysis phase.**

Systems Analysis and Design (Cont.)

- The analysis phase involves understanding the existing system (if there is one) better and specifying the new system or modifying the current one.
- The function of the analysis phase is to determine the requirements of a proposed new system and the output of the analysis phase is a set of specifications.
- The principal tools of the analysis phase are:

Fact gathering techniques

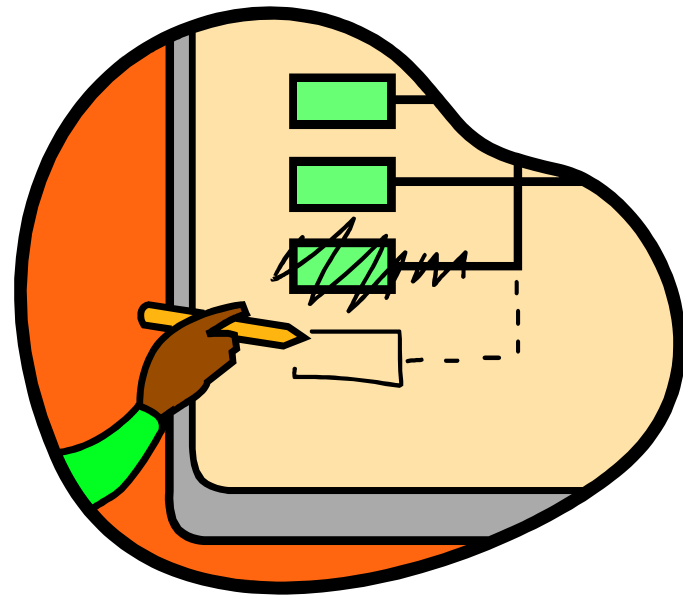
Data dictionary

Data flow diagrams

Process specifications

Data models

Flow charts, etc.



- This phase leads us into design and it is one of the most important phases in information system development.
- There are hundreds of tools available and we will learn about a couple of them next.