Lecture Notes

Structured Systems Analysis

Lecture 2

General Systems Concepts

Information or Data?

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What is a System?
A system has at least two components, and every system component is connected directly or indirectly to every other system component.

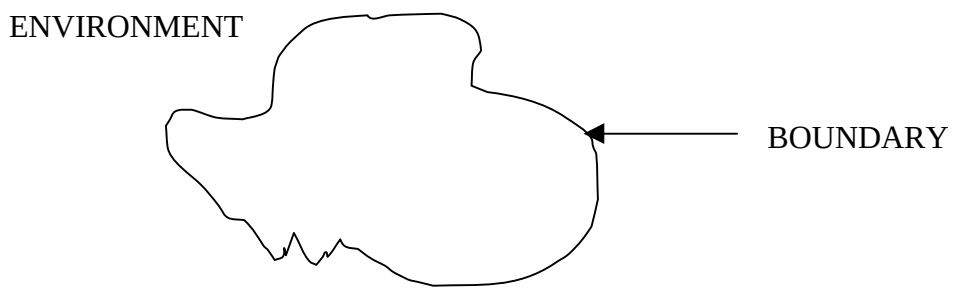
System Synergism
The whole is greater than the sum of its parts. The cooperative action of system components is such that the total effect is greater than the sum of the effects taken independently. This is a major impetus for systems analysis. Subsystems defined and designed independently may not produce optimum benefits even if the individual system components are optimal.

Holistic Approach
This systems approach focuses on systems considered as a whole, not as a collection of separate parts. Such an approach is concerned with total system performance even when a change is contemplated in only one or a few system components. We are concerned with the relationships between components of a system and how these components interact and fit together. All modifications must be viewed in the context of the whole system.

For example, consider the following two tasks (system modifications) in a business organization. One manager is told to establish a summer work schedule for reduced work hours. The requirement is to have two work days off in each of the summer months (June, July and August). A second manager is given the assignment to complete some file reorganization tasks. The first manager decides to give all the affected employees every Friday afternoon off. The second manager decides to use Friday afternoons for the file reorganization task. Thus the conflict. Had the entire organizational system been considered, this conflict would have been avoided.

System Scope
At any time we have to be aware of the scope of a system, i.e., what is in the system. Thus a system boundary exists, inside of which are all the system components.

System Environment
The environment of a system is a set of components which are not in the system scope but which interact with the system. Thus a change in an environmental component may cause a change in the system state and vice versa. If a non-system component has no interaction with the system, then it is of no interest, and it is not in the environment.



In an order processing system, the customer is in the environment. The customer interacts with the system by sending orders and receiving invoices. Customer may have an insurance broker with which it interacts. However the insurance broker is of no interest to the order processing system. The insurance broker is not in the order processing system environment.

System components interact with environment components but have no control over the environmental components. A system does not control what an environment component will do with what the system sends. It also does not control when or if an environment component will send something to the system. However, there must be an understanding that such flows will take place or else why would they interact.

System components may move across the system boundary. But at any time, the system scope and the system environment are clearly defined. For example, originally the accounting functions (A/R and A/P) were inside the system. Later it was determined that the A/P will be handled outside of the system.

Given a group of components, different owners may conceptualize them into different systems and environments. For example consider a house and its occupants. An architect may view the house together with its electrical, plumbing, and heating as one system with the outdoors and the family as its environment. A mechanical engineer may consider the heating system and the house and its occupants the environment. To a sociologist the occupants form a family system and the house is its environment. The heating, plumbing and electrical systems are irrelevant to the sociologist.

Every system can be viewed as a subsystem of another system.

State of a System

System components will have a set of relevant properties or attributes. The values of these properties constitute the state of the system. For example, if the system is a room which has 2 lamps, 2 windows and 1 door. The state of this system might be that lamp 1 is on, lamp 2 is off, window 1 is closed, window 2 is open and the door is closed.

Open and Closed Systems

A closed system has no environment. An open system has an environment. Closed systems are of little interest because they do not have any effect outside of their scope. However closed systems are very difficult to construct. Examples of closed systems are a vacuum bottle ("Thermos"), or an anechoic chamber (no sound enters or leaves). Virtually all systems that a systems analyst encounters are open.

Static and Dynamic Systems

An event occurs when there is a change in the state of a system (or environment). For example, a lamp is turned on, a window is opened, or the door closing are events in the room system (discussed above).

A static system has a single state, i.e., no events occur. For example, a table is a static system of four legs, a top, screws, etc. A dynamic system has multiple states, i.e., events occur. Static systems are not very interesting and virtually all systems that we will analyze are dynamic.

A system might be static to one observer and dynamic to another. Consider a bridge. To most of us this is a static system. However to a structural engineer, it is a dynamic system as it vibrates under load and in the wind.

Homeostatic System

A homeostatic system maintains (as static) some part of its state under changes in other components or its environment. It accomplishes this by changing the state of the system and/or the environment. For example, a house maintains a constant temperature during changing environmental temperature by the heating system going on and off. Another example is a business system maintaining a constant gross profit percentage by changing price and/or cost.

System Changes

A **reaction** is a deterministic event caused by another event. For example, moving a light switch causes the light to go on or off deterministically. Every time we move the switch the light must go on or off.

A **response** is a system event produced by a system or environmental event. It is not deterministic; there is a choice. For example, a person turning on a light (moving a light switch) when it gets dark is a response. He may or may not decide to turn on the light. Moving the light switch, however, is a reaction.

System Outcomes

A **goal** is a preferred outcome that can be attained in a specified time period.

An **objective** is a preferred outcome that cannot be attained in a specified time period, but can be attained over a longer period.

An **ideal** is a preferred outcome that can never be attained in any time period but can be approached without limit.

To achieve an objective you must attain a series of goals, the last one being the objective. For example, passing this course is a goal. If you do all the assignments and pass all the exams, you will pass the course. Passing the next course is also a goal. Passing all the required courses and earning a degree is not a goal, but it is an objective. You cannot be sure when you enroll in a degree program that you will absolutely graduate at a specific date.

We must be sure that we never promise our user an ideal. Also we must make sure that if a specific time period is promised, it is for a goal and not for an objective.

Adaptive Systems

If there is a state change in the environment or a state change in the system that reduces the efficiency of the system in pursuing one or more of its goals, an adaptive system reacts by changing its state or that of the environment so as to regain some (or all) of its lost efficiency.

There are four types of adaptation:

- **environment - environment**: a change in the environment causes the system to lose efficiency; the system attempts to change the environment to regain some of the lost efficiency.
- **environment - system**: a change in the environment causes the system to lose efficiency; the system attempts to change itself to regain some of the lost efficiency.
- **system - environment** - a change in the system causes the system to lose efficiency; the system attempts to change the environment to regain some or all of the lost efficiency.
- **system - system** - a change in the system causes the system to lose efficiency; the system attempts to change itself in order to regain some or all of the lost efficiency.

Organizations

An organization is a purposeful system that contains at least two purposeful elements that have a common purpose. A purposeful system can change its goals under constant conditions. It selects ends as well as means and thus displays will. The common purpose is the important element. Without a common purpose the system components will not work together unless forced to. An organization has a functional division of labor in pursuit of the common purpose.

For example, a car carrying two people stalls. There is a service station down the road. The car occupants decide to push the car to the service station. One gets behind and one gets in front and they both push. Clearly this will not accomplish the desired task of getting the car to the service station. Suppose they both get behind the car and push. This won't work either since the car is likely to veer off the road. The solution is for one to push and the other to steer the car. Then they are organized. There is a synergism. They have used a holistic approach.

A second example is concerned with managing cash flow in the business. The purchasing department agrees to 10-day payment terms to get a good price. Order processing agrees to 90-day terms to get the sale. So what goes wrong? How does purchasing get enough cash in order to pay in 10 days when the source of cash, the payment for an order, is not due for 90 days?

Is it Information or is it Data?

What is data? What is information? Are they synonymous?

It is 86 degrees in Calcutta today. Is this data or is it information?

If you don't know where Calcutta is and have no interest in the fact that Calcutta exists, or have no reason to know the temperature in Calcutta, what is the value to you that the temperature is 86 degrees?

The sound of a train whistle. Four people hear the whistle:

- A saboteur who had hoped to blow up the train
- A person who is expecting that their spouse is returning home on the train
- An unfortunate individual who has a foot caught in the track and the train is rounding the bend
- A person doing some work who has no interest in the train

Which of these are receiving data and which are receiving information?

Overdue Accounts

A system produces a report that lists every customer invoice that is overdue, i.e., the payment due date has arrived but the payment has not. This report is several inches thick (300 plus pages). Whether the amount owed is $.01 or $10,000, they both appear on the report. The intent is to use this report as a basis for collection. Is this data or information?

Before we can answer these questions, we need to understand what is meant by the terms data and information.

A common definition of information is "processed data". Put another way, data is the raw material and information is processed data. These may be true at times, but they are not really the definition that we want. Processed data may still be data. Information must be subjective, i.e., it must be relevant to the recipient. Information produces a response; data does not.

Information systems often produce more data than information.

What are the information requirements, what does the user need, what will the user do with it?

Be careful that you don't merely give the user what they ask for; they usually put their needs request in terms of existing context and availability of "data". This stems from their failure to fully understand the requirements (WHAT) and therefore focus on the way they will use data (HOW).

What is information used for? To make decisions (what to do, when to do it, to whom to do it, etc.), or to reduce uncertainty.

Information is subjective; what is information to one recipient may be data to another.

So, returning to the questions above about data versus information:

Is the temperature in Calcutta data or information? If you have any interest in the temperature in Calcutta or any need to know that, then it is information.

Which of the four recipients of the train whistle are receiving information?
Only the person doing some work who has no interest in the train is receiving data, the rest are receiving information. Why?

Is the overdue-accounts report providing data or information?
If the requirement is to be able to collect overdue accounts regardless of the amount overdue and how long it is overdue, then I guess this provides information. But this is probably not the requirement. The requirement is more likely to maximize the probability of collecting the most money while minimizing the cost of doing so. Then what the user wants to know is which accounts fit that formula.

Furthermore, even if the report has these accounts, how do you contact them? Is there address and/or phone number on the report. Is other information that will help collect the unpaid amounts available?

This principle has been called "exception reporting". Provide only the important information (is there any other kind?).