INFO 799
Independent Study: Advanced Requirements Analysis
Guide: Dr Susan Gasson
Term Report
How Should We Manage Information Systems Design

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1. Examination of design as organizational “problem-solving.”

In this section, the focus is on requirements analysis as part of design i.e. gathering requirements for a solution to an organizational “problem.” The design process of any system is as good as solving an organizational problem. Following are the meanings of few terms used and the assumptions followed in this report:

- The design process includes the entire lifecycle development of a product for a community.
- Community could vary from the very formal corporate organizations to the users of everyday things.
- The design process could be carried out by the design team of an organization for a client; or user; or another organization or for the same organization.
- Design process approximately includes identification of organizational or user’s problem; gathering requirements to attack the problem; formally build up the problem; analyzing the possible solutions; choosing one solution; formulating low and high level design of proposed solution / product; implementation of solution and deployment of product in the market.
- Lastly, the entire process is iterative with blurred boundary among phases.

The focus of this section are the three phases (identification of organizational or user’s problem; gathering requirements to attack the problem; formally build up the problem) of design; which are altogether termed as requirements analysis.

Following diagram represents the aforementioned assumptions:

![Diagram showing the process of design problem-solving]

1.1 Requirements Analysis and General Design Psychology

As mentioned above, requirements analysis phase includes identification of organizational or user’s problem; gathering requirements to attack the problem; and formally building up of the problem. There is no natural end to this phase as there is no natural end to design problem. Goal keeps changing and designer understands more about design solution by working on the design process.
A design problem is the product of requirements analysis phase. A design problem is comprised of interaction of one requirement over the other and the constraints which further enhance subside or modify the requirements. Designer is not the only composer of design problem; clients, users and legislators have their own say in specifying requirements and constraints. But, no design problem can be comprehensively stated.

1.2 Requirements Analysis and Opportunism in Design

It is believed that requirements engineering problems are most frequently faced problems during the design process of large systems for an organization or solving of organizational problems. An IS (Information Science) approach of minimizing these problems is to analyze the process of requirements analysis at all human levels of organization and all sections of stakeholders and then identify the reasons for extremely conflicting and frequently changing requirements.

The phase of requirements gathering is very prominent in design problems that are well defined; but this phase is very obscure for ill-structured problems. The three tasks of identification of organizational or user’s problem; gathering requirements to attack the problem; and formally building up the problem; are difficult to perform for problems which are uncertain, complexly defined and improperly bounded.

Ill-structured problems rely more on opportunism rather than a straight-line requirement driven structured design method. In such cases, requirements analysis functions are intertwined in the high-level design phase of the design process. While performing high-level design, experts rely on rich knowledge, and work towards a design solution by performing ‘on-the-fly’ requirements analysis. This gives rise to an entirely approach of requirements analysis. Unstated goals and evaluation criteria in the requirements, discovered during high-level design phase, deeply impacts the design process. Designers advertently try to bind the design problem by creating additional preferred evaluation criteria. Interleaving requirements analysis functions within the concentrated design phase reduces the number of possible candidate designs to consider and choose from. Moreover, high reliability, simple solution and simple design are the preferred evaluation criteria of the expert designers.

1.3 Requirements Analysis and Informal Information

Effective use of IT as a source of internal information is hampered by problems such as lack of flexibility to changing requirements. Both formal and informal aspects of information systems are interdependent and deserve equal stress during requirements analysis. Requirements analysts and designers should be aware of the not so obvious facts about users; e.g. users may require information to satisfy curiosity; users also value information for the content they already know; users may turn to informal systems for a great deal of their information; users need information space. While formalizing of a design problem, information should be treated like any other resource important in designing an IT or IS system.

1.4 Requirements Analysis and Interactive Systems Design

In the field of design of highly interactive systems, there always exists a community of common users looking forward to a ‘smart’ design. The word ‘smart’ implies that a product should be decipherable by its users and simulate an intelligent human expert or coach.

Requirements engineering for such a system is closely related to social science. In order to initiate the design process it is important to understand the motives of planned and situated portions of purposeful actions, so that they match with the functionality of desired system. The primary requirement is that the operations should be discoverable without extensive training. The familiarity with the basic concepts of planning model and situated actions is vital to understand the problem or the need of a design product. Domain knowledge, common sense, experience and knowledge resources together build up background knowledge. Social beings bring order by taking every course of action depending on mutual and social circumstances. The science of situated actions suggests that
not every thing could be planned and hence not all the requirements of a design could be pre-
specified. Formally building up of design problem could also be inspired by studying the problems
human beings face while communicating with an interactive device such as copier machine. For
example, these problems aid in listing some important factors to be considered while designing
human machine communication such as Engineering an appropriate response; System’s situations:
plans and detectable states; the user’s resource: situated inquiry; Conditional relevance of response;
Communicative breakdowns: false alarm and garden path. The initial design phases should help the
entire design process to be directed by the fact that problems of human machine communication are
because of the differences between human interaction and machine operation; and these problems
could be resolved by understanding and considering these differences while engineering interacting
machines.

1.5 Requirements Analysis and Everyday Things Design
The existence of requirements engineering is suspected when users fail to easily use the simple
everyday things. Designers of everyday things need to understand the proper balance between the
two types of knowledge- knowledge in the head and knowledge in the world. A balanced use of both
leads to a usable design and precise user action. Complex design of modern everyday things could be
made usable by features such as Affordance, Constraints, Visibility and Feedback. Also, dealing with
errors made by users is also vital in understanding the design problem. Forces that work against
effective requirements analysis are: demands of time, pressure to be distinctive, individuality
(represent a company’s style) and economic pressures. Effective requirements analysis implies an
analysis that rightly affects the entire design process such that the rest of the phases can solely
depend on results of requirements analysis. But, designers usually deviate their paths from away the
principled design direction. This is because the reward structure of design community tends to put
aesthetics first. Also, designers aren’t typical users; and designers need to please clients and clients are
not always users.
The complexity of design process is that even simple designs such as pens, hair pins, have hundreds
of requirements; and varied and obscure uses. Designing of an item for special people also needs to
be taken care of as all sorts of people are expected to use that item. A deadly temptation for
requirements analysts is the tendency to add number of features that a device can stand. Users keep
requesting new features in every device and analysts simply tend to oblige them. Each new feature
adds complexity and invisibility and hence a strong violation of design principles.

1.6 Requirements Analysis and Organizational design problems
As mentioned before, requirements analysis is also a part of design problems such as organizational
problem solving or organizational learning. Current models and theories in use hinder requirement
gathering because many things are not publicly discussed or stated by stakeholders of design process.
Factors that prevent members to collaboratively inquire into defects of development process are:
practice to treat interpersonal and inter-group conflict as undiscussable; ban on public analysis of
corporate failures; and wish to avoid direct interpersonal confrontation.
The root of requirements analysis problems lies in the fact that -- People in society are programmed
to work according to Model I theories (which reinforce conditions of errors prevalent in Model O-I
limited learning system,) which appear to create continuity, consistency and stability to achieve
objectives within desired costs. But organizational designs are imperfect and require continuous
monitoring to face challenges from external and internal environments. The problem is not that
these differences and rivalries exist but that they are not discussable.
The resulting state of requirements gathering process is as shown in the diagram:
2. Do Methods support the designer point of view of design?

This section discusses whether the formal and in-use design methods give enough chance to the designers to design the way they like to design. As mentioned before, there are several requirements analysis mini phases which precede the systems analysis and higher-level design phase. The question is - Do designers actually use the inputs in performing the concentrated high and low level design? The answer is - up to some extent results are always used by designers in the design phase and the extent depends on factors such as the expertise of designer; complexity of problem and the quality of results of requirements analysis. In this section, an argument, of designer's view of design process and its coherence/non-coherence with the design methods I've encountered in my design experience and in the reference readings, is being presented.
2.1 Designer's Design Psychology and General Design Psychology

A Design problem is a product of inputs from the generators of design problems; Domain of design constraints; and the function of design constraints. Design process works its way from the problem to the solution.

Design Process is:
- Process is endless
- There is no infallibly correct process
- Process involves finding as well as solving problems
- Design inevitably involves subjective value judgment
- Design is prescriptive activity
- Designers work in the context of a need for action (time limit)

With numerous properties of design process, there hardly exists a case wherein design process will confirm with the design view held by a designer. Most designers employ strategies which are heuristic in nature.

After brief scanning a sub-group of overall problem is clustered together and elevated to role of form generator. What differentiates one strategy from other is the kind of constraint which has been used in this focal role. These generators are helpful to create physical forms for two reasons: they are three dimensional and actually suggest form and they are constant and amenable to long term study. Functions fulfilled by these constraints could be practical, formal, radical and symbolic. All can be
used as generators of form. Use and sequence of these constraints differentiates one designer from
other. Approach is mostly analysis through synthesis. Problem is studied in rough way and designer
identifies most critical issue in determining form.
The entire process does not solely depend on designer’s psychology or understanding of design.
Method actually followed is directed by constraints mentioned numerous users, clients and legislators
also.

2.2 Designer’s Design Psychology and Opportunism

As far as opportunism is considered, design methods are consistent with designers’ view of design.
Opportunism is a part of designer’s psychology and therefore design process opportunism always
goes hand in hand with designers’ view of design. Theories related with opportunism need to evolve
and broaden more.
Design is very much an ill structured problem. Ill structured problems have incomplete and
ambiguous goals, have no predetermined solution path and require integration of multiple knowledge
domains. Opportunistic decomposition is better suited to ill-structured problems as compared to
structured decomposition. Opportunities that come up during the design process might change focus
of design problem or might equally confirm the designer’s current focus. During design process,
multiple knowledge domains need to be integrated. Experts exploit their rich knowledge and use
data-driven rules and problem domain scenario simulation (knowledge schema) to enable design
process. Experts make use of problem domain knowledge scenarios to infer new requirement, new
goals and new evaluation criteria.
Design theories have always considered any deviation from top-down approach as opportunism.
Opportunism is a favorable part of design but it has been under-constrained and poorly defined.
Traditionally, based on design practices of experts and novices, deviation from top down
decomposition and breadth first search (structured approach to design) is treated as opportunism and
opportunism is considered abnormal or faulty. But recently, theories have been emerging that
opportunism is favorable to have top-down decomposition along with depth first search. Use of
Depth-first approach shouldn’t be treated as breaking of principles of structured design.

2.3 Designer’s Design Psychology and Informal Information

Both informal and formal aspects of information systems are interdependent and both deserve equal
stress during analysis, development and evaluation of information systems. This theory is not being
formally included in methods and designers partially tend to tacitly follow this theory. But more or
less, designers tend to base their design on oversimplified models of people’s behavior and these are
often derived from their own values and modes of action. Analysts and designers should be aware of
the not so obvious facts about users; e.g. users may require information to satisfy curiosity; users also
value information for the content they already know; users may turn to informal systems for a great
deal of their information; users need information space. These not-so-obvious facts are the informal
aspect of IS design; and they can be a part of design view of designers only if they are formally
included in espoused and in-use design methods.

2.4 Designer’s Design Psychology and Interactive System’s Design

Literature on socio-technical aspects of design of highly interactive systems suggests that it is vital for
designers to have an understanding of purposeful actions (planned and situated) and mutual
intelligibility of these actions. Many problems are faced by designers attempting to simulate
purposeful actions or intelligence in machines. To resolve these issues, it is very critical to
understand the phenomenon of purposeful actions.
While designing such systems, designers design artifacts for a purpose and users need to know
something of that design intent. But practically, a tool should be decipherable by its users and
simulate intelligent human expert or coach. For a system like an expert help system attached to
copier machine, there are many constraints on events. User’s purpose is constrained by machine’s
functionality and action constrained by machine’s design. This implies that designer should adopt strategy to project the course of users’ actions as enactments of a plan. Users’ purposes imply job specification, which implies plan, which in turn is a basis for interpreting users’ actions. Traditional cognitive view states that plan is just an action’s intent and specification of procedure of action is a collection of conditions under which given action is appropriate. Designers tend to follow this view. But, designers should explore the relation of knowledge and action to particular circumstances in which knowing and acting invariably occur. Actions are situated in particular social and physical circumstances and situation is crucial to action’s interpretation. But these theories are currently not a part of designer’s psychology of design.

2.5 Designer’s Design Psychology and Everyday Things Design
Designers can’t design everyday products the way they want to and the way their pure design lessons and education would guide them. The everyday design principles of provide a good conceptual model; make things visible; provide natural mapping; and provide immediate feedback; are not always applicable by designers.
The everyday accidents and errors committed by common users of everyday things appear to indicate that designer is the real victim of flaws in everyday things. But, the poor designer faces major challenges in trying to cope up with the conflicting demands of manufacturers, store keepers, purchasers, clients and users. Good design comes up in four or five attempts on an average; but new products are very likely to fail because only second or third attempt is encouraged to get induced in market. Eventually, very few good designs are able to reach marketplace. Forces that work against evolutionary design are demands of time, pressure to be distinctive, individuality (represent a company’s style) and economic pressures. Designers usually deviate their paths from away the principled design direction. Moreover, the reward structure of design community tends to put aesthetics first; designers aren’t typical users; and designers need to please clients and clients are not always users.
Therefore, methods followed to design everyday things mostly do not support the psychology of design from a designer’s point of view.

2.6 Designer’s Design Psychology and Organizational Learning
Organizational learning design methods are purely based on the theory-of action which reinforces existing limited learning systems of the organization. These methods are based on requirements analysis results amalgamated by factors such as mistaken assumption, incongruity, incompatibility, vagueness, ambiguity. Eventually, design methods contradict designers’ psychology of pure design, to generate design solution to organizational and deuteron learning problems.
3. Design from the user point of view

3.1 Supporting the situated work processes of users

3.1.1 Highly Interactive Systems:
While designing highly interactive systems, the consideration of situated work processes in design is very valuable. Aligning the design process with situated work processes of users leads to a design product which is easily decipherable by its users and can simulate intelligent human expert or coach. Knowledge of the fact that - users walk into a situation, identify its features and match our actions to it – helps in designing systems which could support situated work processes of users. A system such as an expert help system is based on instructions and it is important to understand the science behind
following of instructions to design such a system. Actions are situated in particular social and physical circumstances and situation is crucial to action’s interpretation. A design is sure to succeed if it takes the approach to explore the relation of knowledge and action to particular circumstances in which knowing and acting invariably occur.

3.1.2 Everyday Systems

Supporting the situated work processes of user actions is also critical in everyday systems. The thoughtful design; which takes cares of visibility, good conceptual model, good mappings, and feedback; positively supports the situational actions of users toward the design. An ideal natural mapping requires no diagrams, no labels and no instructions. A proper balance, between the knowledge in the head and the knowledge in the world, leads to a usable design and precise user action. Additionally, the designer should understand causes of errors in design to minimize errors; make it possible to undo; make it possible to discover the errors that do occur and make them easier to correct; change attitude toward error (i.e. shouldn’t think of users as making errors, think of actions as approximations of what is desired). An intelligent way to avoid errors is the use of forcing functions (e.g. ability to lock a car only with keys). There are three sorts of constraints which forcing functions can apply: interlock (forces operations to take place in proper sequence); lock-in (prevents someone from prematurely stopping it), lockout (prevents someone from entering a place that is dangerous, prevents an event from occurring).

3.2 Providing users with the information for organizational decision-making

3.2.1 IS for Information Requirements Analysis to support for decision making

Organizational decision making problem can be viewed as a design problem. The users (employees/employers) in an organization problem require a design solution for this problem. Like any other design problem, requirements analysis produces information needed for decision making and this process (design process which is otherwise done by designers) can then be carried out by users. Any sort of decision making is a three stage process: Intelligence, Design and Choice. None of the stages could be executed without use of relevant and appropriate information. Many information systems provide decision supporting information; and IS type depends on depend on types of decisions (structured and unstructured) to be taken. Also, each stage of decision making is different; requires different type of information; and hence entails information systems having related features. Information requirements vary depending on the type of decisions to be supported by information systems.

3.2.2 Information requirements analysis in limited learning organizations

An organization is not merely a collection of people/users. It is about making decisions in the name of collectivity; delegating to individuals the authority to act for collectivity; and setting boundary between collectivity and rest of the world. All these activities are performed on the basis on some rules. These rules are mostly tacit. Norms, strategies and assumptions embedded constitute theory of action. In an organization, a decision making process is as good as a design process performed on the basis of requirements gathering methods supported by theory of action, which is in-use in the organization. Factors that prevent users to collaboratively analyze the requirements for a decision making process are practice to treat interpersonal and inter-group conflict as undiscussable; prohibition of public analysis of corporate failures; and wish to avoid direct interpersonal confrontation. Eventually, limited learning systems with scattered organizational memory inhibit the availability of correct and relevant information to decision makers.
3.3 Supporting users in the processes of organizational decision-making.

3.3.1 Use of IS in decision-making process:
As already mentioned, any sort of decision making is a three stage process: Intelligence, Design and Choice. Decision making process is a purely concentrated design problem. By concentrated I mean it is the actual ‘design’ portion, of the entire product development cycle, wherein different design solution paths are evaluated; one of them is chosen; and the chosen one’s details are specified. It is very much dependent on information input to this process as well as on the emergent requirements information. As already mentioned, any sort of decision making is a three stage process: Intelligence, Design and Choice. Information systems help in a lot in decision making by providing input information to decision making process. But, all decisions cannot be made by a totally programmed computer system. Information system failures occur when people misunderstand this act of life and attempt to impose highly formal information systems on situations where they are not suitable.
Identify Problem

Requirements Analysis Phase

Formalize problem

Gather Requirements

Study formalized problem

Work on low and high level design of solution

Analyze possible solution paths and choose one

Remaining Processes

DESIGN PROBLEM

SYSTEMS ANALYSIS

PRESENTATION

LIMITED LEARNING SYSTEM — SINGLE LOOP LEARNING — MODEL I THEORY OF ACTION
4. What to change about organizational Information Systems design?

Following changes are desirable in order to uplift of design theories, IS professionals and the poor users of ever changing technology designs.
4.1 IS professionals (Designers/ Analysts/ Employees of organizations)

- Designers should have the knowledge of situated actions. The initial design phases should help the entire design process to be directed by the fact that problems of human machine communication are because of the differences between human interaction and machine operation; and these problems could be resolved by understanding and considering these differences while engineering interacting machines.
- Designers and requirements specialists should understand that the primary purpose of everyday thing is TO USE and just TO USE everyday things as a habit. The designers need to help fight the battle for usability. This is the time to stop in the rat-race of technology and complexity; and re-consider the primary purpose of having everyday things
- Designers should also learn to handle user errors by adding constraints and locking functions.
- IS professional should understand that every decision making task can’t be replaced by a computer system.

4.2 Users

- Users should not continue to prefer aesthetics over usability and shouldn’t pretend not to realize the heavy inconvenience caused to them by non-usuable products.
- Users should take the initiative to change reward structure of design community and begin giving more credence to usability.
- Also, they should raise their voice to demand usable products and boycott unusable design.

4.3 Theories

- Requirements and design theories should incorporate informal information along with formal information. Information Systems used in decision making should allow the use of informal knowledge and informal systems as well.
- Design theories have always considered any deviation from top-down approach as opportunism. Opportunism is a favorable part of design but it has been under-constrained and poorly defined. Traditionally, based on design practices of experts and novices, deviation from top down decomposition and breadth first search is treated as opportunism and opportunism is considered abnormal or faulty. But recently, theories have been emerging that opportunism is favorable to have top-down decomposition along with depth first search. Use of Depth-first approach shouldn’t be treated as breaking of principles of structured design. These emerging theories proposing opportunism can make a lot of difference in the science of design.
- A new learning system called as Model O-II supports double loop learning and is guided by Model II theories of action. A map is required to evolve from O-I to O-II. People have little difficulty in espousing and believing in Model II but they do have enormous difficulties in making it their theory in use and they tend to be unaware of this fact. Through intervention Model I and O-I could be replaced by Model II and O-II and a good organizational dialectic could be achieved. One of the objectives of interventionist mapping if to bring scattered organizational memory into a unified picture organized for the purpose of learning and action. The biggest challenge to current researchers and interventionists in developing practice of Model II and O-II is the tension among different views of clients and interventionists. Therefore, there are three purposes which should guide work of interventionists: help the clients become aware of and unfreeze their existing Model I theories-in-use and O-I learning systems; educate clients to use Model II and O-II; and to use this new knowledge for the purposes of good organizational dialectic. This would automatically lead to other changes such as providing current and correct information during requirements analysis phase and make conflicts and failures publicly discussable.
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