COGNITIVE MODELS

Cognitive models represent users of interactive systems.

- Hierarchical models represent a user‘s task and goal structure.
- Linguistic models represent the user–system grammar.
- Physical and device models represent human motor skills.
- Cognitive architectures underlie all of these cognitive models.

GOAL AND TASK HIERARCHIES

To achieve this goal we divide it into several subgoals, say gathering the data together, producing the tables and histograms, and writing the descriptive material. Concentrating on the data gathering, we decide to split this into further subgoals: find the names of all introductory HCI textbooks and then search the book sales database for these books. Similarly, each of the other subgoals is divided up into further subgoals, until some level of detail is found at which we decide to stop. We thus end up with a hierarchy of goals and subgoals.

We can go on decomposing tasks until we get down to the individual hand and eye movements of the user, or we can stop at a more abstract level. Where do we start? In a similar way, we can start our analyses at different points in the hierarchy of goals. At the extreme we could extend our analysis to larger and larger goals: _light hob‘ is a subgoal of _boil peas‘ and so on to goals such as _have my dinner‘, _feed‘ and _stay alive‘.

These two questions are issues of granularity, and both of the methods described below leave this to some extent in the hands of the designer. Different design issues demand different levels of analysis. However, both methods operate at a relatively low level; neither would attempt to start with such an abstract goal as _produce a report‘ which will involve real creativity and difficult problem solving. Instead they confine themselves to more routine learned behavior. This most abstract task is referred to as the unit task. The unit task does not require any problem-solving skills on the part of the user, though it frequently demands quite sophisticated problem-solving skills on the part of the designer to determine them. What do we do when there are several ways of solving a problem, or if the solutions to two subgoals interact? Users will often have more than one way to achieve a goal and there must be some way of representing how they select between competing solutions.

GOMS

The GOMS model of Card, Moran and Newell is an acronym for Goals, Operators, Methods and Selection

Goals These are the user‘s goals, describing what the user wants to achieve. GOMS the goals are taken to represent a _memory point‘ for the user, from which he can evaluate what should be done and to which he may return should any errors occur.

Operators These are the lowest level of analysis. They are the basic actions that the user must perform in order to use the system. They may affect the system (for example, press the _X‘ key) or only the user‘s mental state (for example, read the dialog box). There is still a degree of flexibility about the granularity of operators; we may take the command level _issue the SELECT command‘ or be more primitive: _move mouse to menu bar, press center mouse button .

Methods There are typically several ways in which a goal can be split into subgoals. For instance, in a certain window manager a currently selected window can be closed to an icon either by selecting the _CLOSE‘ option from a pop-up menu, or by hitting the _L7‘ function key. In GOMS these two goal decompositions are referred to as methods, so we have the CLOSE-METHOD and the L7-METHOD:

GOAL: ICONIZE-WINDOW
. [select GOAL: USE-CLOSE-METHOD
. . MOVE-MOUSE-TO-WINDOW-HEADER
. . POP-UP-MENU
. . CLICK-OVER-CLOSE-OPTION
GOAL: USE-L7-METHOD
. . PRESS-L7-KEY]

The dots are used to indicate the hierarchical level of goals. Selection From the above snippet we see the use of the word select where the choice of methods arises. GOMS does not leave this as a random choice, but attempts to predict which methods will be used. This typically depends both on the particular user and on the state of the system and details about the goals.

Rule 1: Use the CLOSE-METHOD unless another rule applies.

Rule 2: If the application is _blocks‘ use the L7-METHOD.

The goal hierarchies described in a GOMS analysis are almost wholly below the level of the unit task defined earlier. A typical GOMS analysis would therefore consist of a single high-level goal, which is then decomposed into a sequence of unit tasks, all of which can be further decomposed down to the level of basic operators:

GOAL: EDIT-MANUSCRIPT

GOAL: EDIT-UNIT-TASK repeat until no more unit tasks The goal decomposition between the overall task and the unit tasks would involve detailed understanding of the user‘s problem-solving strategies and of the application domain.

Cognitive complexity theory

Cognitive complexity refer to the number of mental structures an individual uses, how abstract they are and how they interact to shape his discernment or an individual difference variable linked with a wide range of communication skills and associated abilities.

Individuals with high cognitive complexity have the capacity to analyze a situation to discern various constituent elements and explore connections and possible relationships among the elements. These individuals think in a multidimensional way. The assumption of the complexity theory is that the more an event can be differentiated and parts considered in novel relationships, the more sophisticated the response and successful the solution. Whereas less complex individuals can be trained to understand a complicated set of detailed differentiations for a specific context, highly complex individuals are highly flexible in creating distinctions in new situations.

Individuals with high cognitive complexity are open to new information, attracted to other individuals of high complexity, highly flexibility, socially influential, problem solvers, strategic planners, highly creative, effective communicators and generally good leaders.

Problems and extensions of goal hierarchies

The formation of a goal hierarchy is largely a post hoc technique and runs a very real risk of being defined by the computer dialog rather than the user. One way to rectify this is to produce a goal structure based on pre-existing manual procedures and thus obtain a natural hierarchy . GOMS defines its domain to be that of expert use, and thus the goal structures that are important are those which users develop out of their use of the system.the conceptual framework of goal hierarchies and user goal stacks can be used to express interface issues, not directly addressed by the notations above. For instance, we can use this to examine in more detail the closure problem with early automated teller machines (ATMs) mentioned in the Design Focus box These early ATMs gave the customers the money before returning their cards. Unfortunately, this led to many customers leaving their cards behind. This was despite on-screen messages telling them to wait. This is referred to as a problem of closure. The user‘s principal goal is to get money; when that goal is satisfied, the user does not complete or close the various subtasks which still remain open:

GOAL: GET-MONEY

. GOAL: USE-ATM

. . INSERT-CARD

. . ENTER-PIN

. . ENTER-AMOUNT

. . COLLECT-MONEY

<< outer goal now satisfied goal stack popped >>

. . COLLECT-CARD – subgoal operators missed

LINGUISTIC MODELS

The user‘s interaction with a computer is often viewed in terms of a language, so it is not surprising that several modeling formalisms have developed centered around this concept. BNF grammars are frequently used to specify dialogs.

The models here, although similar in form to dialog design notations, have been proposed with the intention of understanding the user‘s behavior and analyzing the cognitive difficulty of the interface.

BNF

Representative of the linguistic approach is Reisner‘s use of Backus–Naur Form (BNF) rules to describe the dialog grammar . This views the dialog at a purely syntactic level, ignoring the semantics of the language. BNF has been used widely to specify the syntax of computer programming languages, and many system dialogs can be described easily using BNF rules. For example, imagine a graphics system that has a line-drawing function. To select the function the user must select the _line‘ menu option. The line-drawing function allows the user to draw a polyline, that is a sequence of line arcs between points. The user selects the points by clicking the mouse button in the drawing area. The user

double clicks to indicate the last point of the polyline.

```
draw-line      ::= select-line + choose-points
                   + last-point
select-line    ::= position-mouse + CLICK-MOUSE
choose-points  ::= choose-one
                   | choose-one + choose-points
choose-one     ::= position-mouse + CLICK-MOUSE
last-point     ::= position-mouse + DOUBLE-CLICK-MOUSE
position-mouse ::= empty | MOVE-MOUSE + position-mouse
```

The ames in the description are of two types: non-terminals, shown in lower case, and terminals, shown in upper case. Terminals represent the lowest level of user behavior, such as pressing a key, clicking a mouse button or moving the mouse. Non-terminals are higher-level abstractions. The non-terminals are defined in terms of other non-terminals and terminals by a definition of the form name ::= expression The ‗::=‘ symbol is read as ‗is defined as‘. Only non-terminals may appear on the left of a definition. The right-hand side is built up using two operators ‗+‘ (sequence) and ‗|‘ (choice). For example, the first rule says that the non-terminal draw-line is defined to be select-line followed by choose-points followed by lastpoint. All of these are non-terminals, that is they do not tell us what the basic user actions are. The second rule says that select-line is defined to be position mouse (intended to be over the ‗line‘ menu entry) followed by CLICK-MOUSE. This is our first terminal and represents the actual clicking of a mouse.

Position-mouse is, we look at the last rule. This tells us that there are two possibilities for position-mouse (separated by the ‗|‘ symbol). One option is that position-mouse is empty – a special symbol representing no action. That is, one option is not to move the mouse at all. The other option is to doa MOVE-MOUSE action followed by position-mouse. This rule is recursive, and this second position-mouse may itself either be empty or be a MOVE-MOUSE action followed by position-mouse, and so on. That is, position-mouse may be any number of MOVE-MOUSE actions whatsoever. Similarly, choose-points is defined recursively, but this time it does not have the option of being empty. It may be one or more of the non-terminal choose-one which is itself defined to be (like select-line) position-mouse followed by
CLICK-MOUSE.

The BNF description of an interface can be analyzed in various ways. One measure is to count the number of rules. The more rules an interface requires to use it, the more complicated it is. This measure is rather sensitive to the exact way the interface is described. For example, we could have replaced the rules for choose points and choose-one with the single definition choose-points ::= position-mouse + CLICK-MOUSE | position-mouse + CLICK-MOUSE + choose-points

Task–action grammar

Measures based upon BNF have been criticized as not _cognitive‘ enough. They ignore the advantages of consistency both in the language‘s structure and in its use of command names and letters. Task–action grammar (TAG)

THE CHALLENGE OF DISPLAY-BASED SYSTEMS

hierarchical and grammar-based techniques were initially developed when most interactive systems were command line, or at most, keyboard and cursor based. There are significant worries, therefore, about how well these approaches can generalize to deal with more modern windowed and mouse-driven interfaces. Pressing a cursor key is a reasonable lexeme, but moving a mouse one pixel is less sensible. In addition, pointer-based dialogs are more display oriented. Clicking a cursor at a particular point on the screen has a meaning dependent on the current screen contents. This problem can be partially resolved by regarding operations such as _select region of text‘ or _click on quit button‘ as the terminals of the grammar. If this approach is taken, the detailed mouse movements and parsing of mouse events in the context of display information (menus, etc.) are abstracted away. Goal hierarchy methods have different problems, as more display-oriented systems encourage less structured methods for goal achievement. Instead of having well-defined plans, the user is seen as performing a more exploratory task, recognizing fruitful directions and backing out of others. Typically, even when this

exploratory style is used at one level,

WRITE_LETTER

. FIND_SIMILAR_LETTER

. COPY_IT

. EDIT_COPY

PHYSICAL AND DEVICE MODELS

Keystroke-level model

The human motor system is well understood. KLM (Keystroke-Level Model) uses this understanding as a basis for detailed predictions about user performance. It is aimed at unit tasks within interaction – the execution of simple command sequences, typically taking no more than 20 seconds. Examples of this would be using a search and replace feature, or changing the font of a word. It does not extend to complex actions such as producing a diagram. The assumption is that these more complex tasks would be split into subtasks (as in GOMS) before the user attempts to map them into physical actions.

The task is split into two phases:

Acquisition of the task, when the user builds a mental representation of the task;
Execution of the task using the system‘s facilities.

During the acquisition phase, the user will have decided how to accomplish the task using the primitives of the system, and thus, during the execution phase, there is no high-level mental activity – the user is effectively expert. KLM is related to the GOMS model, and can be thought of as a very low-level GOMS model where the method is given.

The model decomposes the execution phase into five different physical motor operators, a mental operator and a system response operator:

K Key stroking, actually striking keys, including shifts and other modifier keys.

B Pressing a mouse button.

P Pointing, moving the mouse (or similar device) at a target.

H Homing, switching the hand between mouse and keyboard.

D Drawing lines using the mouse.

M Mentally preparing for a physical action.

R System response which may be ignored if the user does not have to wait for it, as in copy typing.

The execution of a task will involve interleaved occurrences of the various operators. For instance, imagine we are using a mouse-based editor. If we notice a single character error we will point at the error, delete the character and retype it, and then return to our previous typing point. This is decomposed as follows:

1. Move hand to mouse H[mouse]
2. Position mouse after bad character PB[LEFT]
3. Return to keyboard H[keyboard]
4. Delete character MK[DELETE]
5. Type correction K[char]
6. Reposition insertion point H[mouse]MPB[LEFT]

COGNITIVE ARCHITECTURES

The concept of taking a problem and solving it by divide and conquer using subgoals is central to GOMS. CCT assumes the distinction between long- and short-term memory, with production rules being stored in long-term memory and _matched‘ against the contents of short-term (or working) memory to determine which _fire‘. The values for various motor and mental operators in KLM were based on the Model Human Processor (MHP) architecture of Card, Moran and Newell. Another common assumption, which we have not discussed in this chapter, is the distinction between linguistic levels – semantic, syntactic and lexical – as an architectural model of the user‘s understanding.

The problem space model Rational behavior is characterized as behavior that is intended to achieve a specific goal. This element of rationality is often used to distinguish between intelligent and machine-like behavior. In the field of artificial intelligence (AI), a system exhibiting rational behavior is referred to as a knowledge-level system. A knowledge-level system contains an agent behaving in an environment. The agent has knowledge about itself and its environment, including its own goals. It can perform certain actions and sense information about its changing environment. As the agent behaves in its environment, it changes the environment and its own knowledge. We can view the overall behavior of the knowledge-level system as a sequence of environment and agent states as they progress in time. The goal of the agent is characterized as a preference over all possible sequences of agent/environment states. The search proceeds by moving from one state to another possible state by means of operations or actions, the ultimate goal of which is to arrive at one of the desired states. This very general model of computation is used in the ordinary task of the programmer. Once she has identified a problem and a means of arriving at the solution to the problem (the algorithm), the programmer then represents the problem and algorithm in a programming language, which can be executed on a machine to reach the desired state. The architecture of the machine only allows the definition of the search or problem space and the actions that can occur to traverse that space. Termination is also assumed to happen once the desired state is reached.

The new computational model is the problem space model, based on the problem-solving work of Newell and Simon at Carnegie–Mellon University. A problem space consists of a set of states and a set of operations that can be performed on the states. Behavior in a problem space is a two-step process. First, the current operator is chosen based on the current state and then it is applied to the current state to achieve the new state. The problem space must represent rational behavior, and so it must characterize the goal of the agent. A problem space represents a goal by defining the desired states as a subset of all possible states. Once the initial state is set, the task within the problem space is to find a sequence of operations that form a path within the state space from the initial state to one of the desired states, whereupon successful termination occurs.

We can highlight four different activities that occur within a problem space: goal formulation, operation selection, operation application and goal completion. The relationship between these problem space processes and knowledge-level activity is key. Perception that occurs at the knowledge level is performed by the goal formulation process, which creates the initial state based on observations of the external environment. Actions at the knowledge level are operations in the problem space which are selected and applied. The real knowledge about the agent and its environment and goals is derived from the state/operator information in the problem space. Because of the goal formulation process, the set of desired states indicates the knowledge-level goal within the problem space. The operation selection process selects the appropriate operation at a given point in time because it is deemed the most likely to transform the state in the problem space to one of the desired states; hence rational behavior is implied.

Interacting cognitive subsystems (ICS) provides a model of perception, cognition and action, but unlike other cognitive architectures, it is not intended to produce a description of the user in terms of sequences of actions that he performs. ICS provides a more holistic view of the user as an information-processing machine. The emphasis is on determining how easy particular procedures of action sequences become as they are made more automatic within the user.

ICS attempts to incorporate two separate psychological traditions within one cognitive architecture. On the one hand is the architectural and general-purpose information-processing approach of short-term memory research. On the other hand is the computational and representational approach characteristic of psycholinguistic research and AI problem-solving literature.

The architecture of ICS is built up by the coordinated activity of nine smaller subsystems: five peripheral subsystems are in contact with the physical world and four are central, dealing with mental processes. Each subsystem has the same generic structure. A subsystem is described in terms of its typed inputs and outputs along with a memory store for holding typed information. It has transformation functions for processing the input and producing the output and permanently stored information. Each of the nine subsystems is specialized for handling some aspect of external or internal processing. For example, one peripheral subsystem is the visual system for describing what is seen in the world.

SOCIO-ORGANIZATIONAL ISSUES AND STAKEHOLDER REQUIREMENTS

There are several organizational issues that affect the acceptance of technology by users and that must therefore be considered in system design:

- systems may not take into account conflict and power relationships
- those who benefit may not do the work

- not everyone may use systems.

In addition to generic issues, designers must identify specific stakeholder requirements within their organizational context.

- Socio-technical models capture both human and technical requirements.
- Soft systems methodology takes a broader view of human and organizational issues.
- Participatory design includes the user directly in the design process.
- Ethnographic methods study users in context, attempting to take an unbiased perspective.

ORGANIZATIONAL ISSUES

Cooperation or conflict?

The term ‗computer-supported cooperative work' (CSCW) seems to assume that groups will be acting in a cooperative manner. This is obviously true to some extent;even opposing football teams cooperate to the extent that they keep (largely) within the rules of the game, but their cooperation only goes so far. People in organizations and groups have conflicting goals, and systems that ignore this are likely to fail spectacularly.

Imagine that an organization is already highly computerized, the different departments all have their own systems and the board decides that an integrated information system is needed. The production manager can now look directly at stocks when planning the week's work, and the marketing department can consult the sales department's contact list to send out marketing questionnaires.

The storekeeper always used to understate stock levels slightly in order to keep an emergency supply, or sometimes inflate the quoted levels when a delivery was due from a reliable supplier. Also, requests for stock information allowed the storekeeper to keep track of future demands and hence plan future orders. The storekeeper has now lost a sense of control and important sources of information. Members of the sales department are also unhappy: their contacts are their livelihood. The last thing they want is someone from marketing blundering in and spoiling a relationship with a customer built up over many years. Some of these people may resort to subverting the system, keeping ‗sanitized' information online, but the real information in personal files.

Changing power structures

The identification of stakeholders will uncover information transfer and power relationships that cut across the organizational structure. Indeed, all organizations have these informal networks that support both social and functional contacts. The official lines of authority and information tend to flow up and down through line management.

The physical layout of an organization often reflects the formal hierarchy: each department is on a different floor, with sections working in the same area of an office. If someone from sales wants to talk to someone from marketing then one of them must walk to the other‘s office. Their respective supervisors can monitor the contact.

In face-to-face conversation, the manager can easily exert influence over a subordinate: both know their relative positions and this is reflected in the patterns of conversation and in other non-verbal cues. Email messages lose much of this sense of presence and it is more difficult for a manager to exercise authority. The _levelling‘ effect even makes it possible for subordinates to direct messages _diagonally‘ across the hierarchy, to their manager‘s peers, or, even worse, to their manager‘s manager!

The invisible worker

The ability to work and collaborate at a distance can allow functional groups to be distributed over different sites. This can take the form of cross-functional neighbourhood centers, where workers from different departments do their jobs in electronic contact with their functional colleagues. If the approach in an organization is _management by presence‘, that is you know someone is working because they are in the office, then there is no way a remote worker is going to be trusted. If, on the other hand, the style is _management by objectives‘, that is you know your subordinates are working because they are doing their jobs and producing results, then remote working is not so problematical.

Who benefits?

In these systems the sender has to do work in putting information into fields appropriately, but it is the recipient who benefits. Another example is shared calendars. The beneficiary of the system is a manager who uses the system to arrange meeting times, but whose personal secretary does the work of keeping the calendar up to date. Subordinates are less likely to have secretarial support, yet must keep up the calendar with little perceived benefit. Of course, chaos results when a meeting is automatically arranged and the subordinates may have to rearrange commitments that have not been recorded on the system. The manager may force use by edict or the system may simply fall into disuse. Many such groupware systems are introduced on a _see if it works‘ basis,

Free rider problem

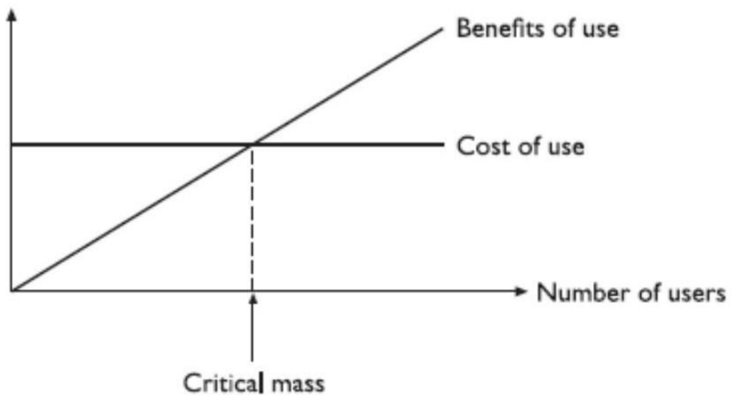
A system may still not function symmetrically, which may be a problem, particularly with shared communication systems. One issue is the free rider problem. Take an electronic conferencing system. If there is plenty of discussion of relevant topics then there are obvious advantages to subscribing and reading the contributions. When considering writing a contribution, the effort of doing so may outweigh any benefits.

The total benefit of the system for each user outweighs the costs, but for any particular decision the balance is overturned. A few free riders in a conference system are often not a problem, as the danger is more likely from too much activity. In addition, in electronic conferences the patterns of activity and silence may reflect other factors such as expertise. It is easy for the number of free riders gradually to increase and the system slide into disuse. It is hard to enforce equal use, except by restrictive schemes such as round-robin contributions (everyone contributes something however short). In the real world, such problems are often solved by social pressure, and the free rider reacts to the collective censure of the group. Increasing the visibility of participants‘ contributions might also help these social mechanisms.

Critical mass

When telephones were only in public places, their use as a form of pervasive interpersonal communication was limited. However, once a large number of people have telephones in their homes it becomes worthwhile paying to have a telephone installed. In cost/benefit terms, the early subscribers probably have a smaller benefit than the cost. Only when the number of subscribers increases beyond the critical mass does the benefit for all dominate the cost .

Figure: Cost/benefit of system use



The telephone was useful for subgroups before it became beneficial for all. Even when only a small proportion of the population had personal telephones, they still formed a significant proportion of their social group, so these cliques of use could grow gradually over time.

Automating processes – workflow and BPR

Organizations have many such processes, and workflow systems aim to automate much of the process using electronic forms, which are forwarded to the relevant person based on pre-coded rules. Some workflow systems are built using special purpose groupware, often based on a notation for describing the desired workflow.

The rigid form of a typical workflow system is an example of global structuring. The danger with any form of global structuring is that it may conflict with or inhibit more informal and less structured patterns of activity which also contribute to the organization‘s free running.

A more radical approach to organizational processes is found in business process re-engineering (BPR). Traditionally, organizations have been structured around functions: sales, accounts, stores, manufacturing. However, the purpose of an organization can be seen in terms of key business processes. The ordering/delivery process described above is a typical and important example. In BPR these processes are recorded and analyzed. Problems in the current process are noted and the whole process may be redesigned in order to make the path of the process more efficient. For example, instead of sending an order to the accounts department to approve, a list of customer credit limits could be given to the sales executives. They could then check the credit rating of the customer whilst on the phone and only forward the order to accounts if there are any unusual problems.

Evaluating the benefits

The benefits from cooperative systems, especially organization-wide systems such as email or electronic conferencing, are in terms of job satisfaction or more fluid information flow. Some, such as the video wall , are expected primarily to help social contact within the organization. It may be possible to measure contentment and job satisfaction using attitude questionnaires.

CAPTURING REQUIREMENTS

Who are the stakeholders?

A stakeholder can be defined as anyone who is affected by the success or failure of the system. It can be useful to distinguish different categories of stakeholder, and the following categorization from the CUSTOM approach is helpful for this:

Primary stakeholders are people who actually use the system – the end-users.

Secondary stakeholders are people who do not directly use the system, but receive output from it or provide input to it (for example, someone who receives a report produced by the system).

Tertiary stakeholders are people who do not fall into either of the first two categories but who are directly affected by the success or failure of the system .Facilitating stakeholders are people who are involved with the design, development and maintenance of the system.

The aim of the design team is to meet the needs of as many stakeholders as possible. The reality is that usually stakeholder needs are in conflict with each other. Sometimes this does not matter: a company is unlikely to be too concerned that its competitors‘ requirement to maintain advantage over it is under threat by the new system.

Socio-technical models

The socio-technical systems view came about to counter this technology-centric position, by stressing that work systems were composed of both human and machine elements and that it was the interrelationship between these that should be central.

Socio-technical models for interactive systems are therefore concerned with technical, social, organizational and human aspects of design. They recognize the fact that technology is not developed in isolation but as part of a wider organizational environment. It is important to consider social and technical issues side by side so that human issues are not overruled by technical considerations.

The key focus of the socio-technical approach is to describe and document the impact of the introduction of a specific technology into an organization. Methods vary but most attempt to capture certain common elements:

- The problem being addressed: there is a need to understand why the technology is being proposed and what problem it is intended to solve.
- The stakeholders affected, including primary, secondary, tertiary and facilitating, together with their objectives, goals and tasks.
- The workgroups within the organization, both formal and informal.
- The changes or transformations that will be supported.
- The proposed technology and how it will work within the organization.

- External constraints and influences and performance measures.

CUSTOM methodology

CUSTOM is a socio-technical methodology designed to be practical to use in small organizations. It is based on the User Skills and Task Match (USTM) approach, developed to allow design teams to understand and fully document user requirements. CUSTOM focusses on establishing stakeholder requirements: all stakeholders are considered, not just the end-users.

It is applied at the initial stage of design when a product opportunity has been identified, so the emphasis is on capturing requirements. It is a forms-based methodology, providing a set of questions to apply at each of its stages.

There are six key stages to carry out in a CUSTOM analysis:

1. Describe the organizational context, including its primary goals, physical characteristics, political and economic background.

2. Identify and describe stakeholders. All stakeholders are named, categorized (as primary, secondary, tertiary or facilitating) and described with regard to personal issues, their role in the organization and their job. For example, CUSTOM addresses issues such as stakeholder motivation, disincentives, knowledge, skills, power and influence within the organization, daily tasks and so on.

3. Identify and describe work-groups. A work-group is any group of people who work together on a task, whether formally constituted or not. Again, work-groups are described in terms of their role within the organization and their characteristics.

4. Identify and describe task–object pairs. These are the tasks that must be performed, coupled with the objects that are used to perform them or to which they are applied.

5. Identify stakeholder needs. Stages 2–4 are described in terms of both the current system and the proposed system. Stakeholder needs are identified by considering the differences between the two. For example, if a stakeholder is identified as currently lacking a particular skill that is required in the proposed system then a need for training is identified.

6. Consolidate and check stakeholder requirements. Here the stakeholder needs list is checked against the criteria determined at earlier stages.

Open System Task Analysis (OSTA)

OSTA attempts to describe what happens when a technical system is introduced into an organizational work environment. Like CUSTOM, OSTA specifies both social and technical aspects of the system. However, whereas in CUSTOM these aspects are framed in terms of stakeholder perspectives, in OSTA they are captured through a focus on tasks.

OSTA has eight main stages:

1. The primary task which the technology must support is identified in terms of users‘ goals.

2. Task inputs to the system are identified. These may have different sources and forms that may constrain the design.

3. The external environment into which the system will be introduced is described, including physical, economic and political aspects.

4. The transformation processes within the system are described in terms of actions performed on or with objects.

5. The social system is analyzed, considering existing work-groups and relationships within and external to the organization.

6. The technical system is described in terms of its configuration and integration with other systems.

7. Performance satisfaction criteria are established, indicating the social and technical requirements of the system.

8. The new technical system is specified.

Soft systems methodology

Soft systems methodology (SSM) arises from the same tradition but takes a view of the organization as a system of which technology and people are components. There is no assumption of a particular solution: the emphasis is rather on understanding the situation fully.

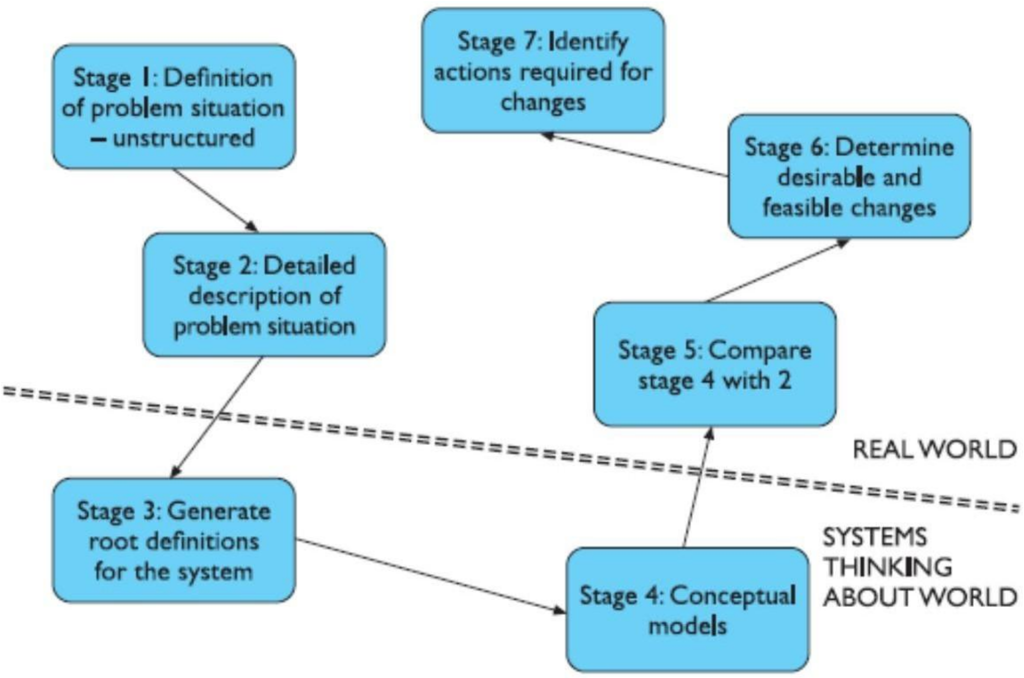


Figure: The seven stages of soft systems methodology

Participatory design

Participatory design is a philosophy that encompasses the whole design cycle. It is design in the workplace, where the user is involved not only as an experimental subject or as someone to be consulted when necessary but as a member of the design team. Users are therefore active collaborators in the design process, rather than passive participants whose involvement is entirely governed by the designer. The argument is that users are experts in the work context and a design can only be effective within that context if these experts are allowed to contribute actively to the design process. In addition, introduction of a new system is liable to change the work context and organizational processes, and will only be accepted if these changes are acceptable to the user. Participatory design therefore aims to refine system requirements iteratively through a design process in which the user is actively involved.

Participatory design has three specific characteristics. It aims to improve the work environment and task by the introduction of the design. This makes design and evaluation context or work oriented rather than system oriented. Secondly, it is characterized by collaboration: the user is included in the design team and can contribute to every stage of the design. Finally, the approach is iterative: the design is subject to evaluation and revision at each stage.

The participatory design process utilizes a range of methods to help convey information between the user and designer. They include

Brainstorming This involves all participants in the design pooling ideas. This is informal and relatively unstructured although the process tends to involve ‗on the- structuring of the ideas as they materialize.

Storyboarding : Storyboards can be used as a means of describing the user‘s day-to-day activities as well as the potential designs and the impact they will have.

Workshops These can be used to fill in the missing knowledge of both user and designer and provide a more focussed view of the design. They may involve mutual enquiry in which both parties attempt to understand the context of the design from each other‘s point of view. The designer questions the user about the work environment in which the design is to be used, and the user can query the designer on the technology and capabilities that may be available. This establishes common ground between the user and designer and sets the foundation for the design that is to be produced. The use of role play can also allow both user and designer to step briefly into one another‘s shoes.

Pencil and paper exercises These allow designs to be talked through and evaluated with very little commitment in terms of resources. Users can _walk through‘ typical tasks using paper mock-ups of the system design. This is intended to show up discrepancies between the user‘s requirements and the actual design as proposed. Such exercises provide a simple and cheap technique for early assessment of models.

Effective Technical and Human Implementation of Computer-based Systems (ETHICS) ETHICS methodology, stakeholders are included as participants in the decision making process. ETHICS considers the process of system development as one of managing change: conflicts will occur and must be negotiated to ensure acceptance and satisfaction with the system. If any party is excluded from the decision-making process then their knowledge and contribution is not utilized and they are more likely to be dissatisfied. However, participation is not always complete. Mumford recognizes three levels of participation:

Consultative – the weakest form of participation where participants are asked for their opinions but are not decision makers.

Representative – a representative of the participant group is involved in the decision making process.

Consensus – all stakeholders are included in the decision-making process.

The usual practice is that design groups are set up to include representatives from each stakeholder group and these groups make the design decisions, overseen by a steering committee of management and employee representatives.

1. **Make the case for change.** Change for its own sake is inappropriate. If a case cannot be made for changing the current situation then the process ends and the system remains as it is.

2. **Identify system boundaries**. This focusses on the context of the current system and its interactions with other systems, in terms of business, existing technology, and internal and external organizational elements. How will the change impact upon each of these?

3. **Describe the existing system**, including a full analysis of inputs and outputs and the various other activities supported, such as operations, control and coordination.

4. **Define key objectives,** identifying the purpose and function of each area of the organization.

5. **Define key tasks:** what tasks need to be performed to meet these objectives?

6. **Define key information needs,** including those identified by analysis of the existing system and those highlighted by definition of key tasks.

7. **Diagnose efficiency needs,** those elements in the system that cause it to underperform or perform incorrectly. If these are internal they can be redesigned out of the new system; if they are external then the new system must be designed to cope with them.

8. **Diagnose job satisfaction needs,** with a view to increasing job satisfaction where it is low.

9. **Analyze likely future changes,** whether in technology, external constraints (such as legal requirements), economic climate or stakeholder attitudes. This is necessary to ensure that the system is flexible enough to cope with change.

10. **Specify and prioritize objectives based on efficiency,** job satisfaction and future needs. All stakeholders should be able to contribute here as it is a critical stage and conflicting priorities need to be negotiated. Objectives are grouped as either primary (must be met) or secondary

Ethnographic methods

Ethnography is based on very detailed recording of the interactions between people and between people and their environment. It has a special focus on social relationships and how they affect the nature of work. The ethnographer does not enter actively into the situation, and does not see things from a particular person‘s viewpoint. However, an aim is to be encultured, to understand the situation from within its own cultural framework. Culture here means that of the particular workgroup or organization, rather than that of society as a whole. Ethnographers try to take an unbiased and open-ended view of the situation. They report and do not like to speculate, so it is often unclear how well their approach can contribute to the design of new systems.

Contextual inquiry

Contextual inquiry has much in common with the ethnographic tradition: it studies the user in context, trying to capture the reality of his work culture and practice. However, it is also an approach rooted in practice and it differs in a number of significant ways from pure ethnographic study: the intention is to understand and to interpret the data gathered, and rather than attempting to take an open-ended view, the investigator acknowledges and challenges her particular focus. In addition, the explicit aim is to design a new system, whereas in a pure ethnographic study, it would be open ended.

The model of contextual inquiry is of the investigator being apprenticed to the user to learn about his work. Interviews take place in the workplace so that the objects, artifacts and relationships of the work can be better understood. Examples of work are collected and both verbal and non-verbal communication is studied. The idea is to be as comprehensive in the data gathering as possible and to be concrete. Another central notion of contextual inquiry is that of partnership: the user is the expert in the workplace and is therefore encouraged to lead the investigation. the investigator is not a passive observer. Her objective is to gain a shared understanding of how the work happens and, to do so, she questions meaning and offers interpretations of what she observes. The aim is to draw out the implications of comments and actions and understand (rather than assume) what they really mean. In order to do this honestly and effectively the investigator must know her focus – her pre-existing beliefs and assumptions about the situation – and be prepared to challenge and adjust them in the face of new information.

A number of models of the work are developed to capture what is important in the user's work situation:

The sequence model elaborates the steps required to complete a specific task, as well as the triggers that initiate that sequence of steps.

- The physical model maps the physical work environment and how it impacts upon work practice, for example, an office plan showing where different work activities happen.
- The flow model shows the lines of coordination and communication between the user and other participants within and outside the workplace.
- The cultural model reflects the influences of work culture and policy and shows the scope of these influences. This may include official or unofficial codes of behavior, common expectations (which may or may not be explicit) and value systems.
- The artifact model describes the structure and use of a particular artifact within the work process.

COMMUNICATION AND COLLABORATION MODELS

All computer systems, single-user or multi-user, interact with the work-groups and organizations in which they are used.

- We need to understand normal human–human communication:

  – face-to-face communication involves eyes, face and body

  – conversation can be analyzed to establish its detailed structure.
- This can then be applied to text-based conversation, which has:

  – reduced feedback for confirmation

  – less context to disambiguate utterances

  – slower pace of interaction but is more easily reviewed.
- Group working is more complex than that of a single person:

– it is influenced by the physical environment

– experiments are more difficult to control and record

– field studies must take into account the social situation.

FACE-TO-FACE COMMUNICATION

Face-to-face contact is the most primitive form of communication – primitive, that is, in terms of technology.

Transfer effects and personal space

When we come to use computer-mediated forms of communication, we carry forward all our expectations and social norms from face-to-face communication. People are very adaptable and can learn new norms to go with new media. However, success with new media is often dependent on whether the participants can use their existing norms. The rules of face-to-face conversation are not conscious, so, when they are broken, we do not always recognize the true problem. We may just have

feeling of unease, or we may feel that our colleague has been rude.

Eye contact and gaze

Normal conversation uses eye contact extensively, if not as intently. Our eyes tell us whether our colleague is listening or not; they can convey interest, confusion or boredom.

Sporadic direct eye contact (both looking at one another‘s eyes) is important in establishing a sense of engagement and social presence. People who look away when you look at them may seem shifty and appear to be hiding something. Furthermore, relative frequency of eye contact and who _gives way‘ from direct eye contact is closely linked to authority and power.

Gestures and body language

When the participants are in the same room, the existence of electronic equipment can interfere with the body language used in normal face-to-face communication. The fact that attention is focused on keyboard and screen can reduce the opportunities for eye contact.

Also, large monitors may block participants‘ views of one another‘s bodies, reducing their ability to interpret gestures and body position. Most computer-supported meeting rooms recess monitors into the desks to reduce these problems.

Back channels, confirmation and interruption

It is easy to think of conversation as a sequence of utterances: A says something, then B says something, then back to A. This process is called turn-taking and is one of the fundamental structures of conversation. However, each utterance is itself the result of intricate negotiation and interaction. Consider the following transcript:

Alison: Do you fancy that film . . . er . . . _The Green‘ um . . . it starts at eight.

Brian: Grea

The nods, grimaces, shrugs of the shoulder and small noises are called back channels. They feed information back from the listener to the speaker at a level below the turn-taking of the conversation. The existence of back channels means that the speaker can afford to be slightly vague, adding details until it is obvious that the listener understands. Imagine making no response as someone talks to you, no little _yes‘es, no nods or raised eyebrows. You could answer questions and speak in turn, but not use back channels. It is likely that your colleague would soon become very uncomfortable, possibly rambling on with ever more detailed explanations, looking for some sign of understanding:

Do you fancy that film . . . er . . . ‘The Green’ um . . . the one with Charles Dermot in . . . you know with that song, er and the black cat on the poster . . . uhh

Turn-taking

Starting to speak in the middle of someone‘s utterance can be rude, but one can say something like _well uh‘ accompanied by a slight raising of the hands and a general tensing of the body and screwing of the eyes. This tells the speaker that you would like to interrupt, allowing a graceful transition. In this case, the listener requested the floor. Turn-taking is the process by which the roles of speaker and listener are exchanged. Back channels are often a crucial part of this process.

The role of _um‘s and _ah‘s is very important. They can be used by either participant during the gap to claim the turn. So, if Brian wanted to respond in the middle of the utterance, but had not yet framed his utterance, he might begin _um the one . . .‘. As it was, Brian did not respond, so Alison starts _er‘ which says to Brian _I‘m going to continue, but I‘m thinking‘. Alternatively, Alison could have started to _er‘ as soon as she had said the word _film‘. This would have told Brian not to interrupt. These turn-offering gaps are just the places where the speaker expects some back channel response even if no turn exchange takes place. A total lack of response will be taken, depending on the circumstances, as assent to the speaker, or perhaps as lack of understanding.

CONVERSATION

Conversational analyses are sociological and psychological understandings of conversation.

Basic conversational structure

Imagine we have a transcript of a conversation, recalling from that the production of such a transcript is not a simple task. For example, a slightly different version of Alison and Brian‘s conversation may look like this:

Alison: Do you fancy that film?

Brian: The uh (500 ms) with the black cat – ‗The Green whatsit‘?

Alison: Yeah, go at uh . . . (looks at watch – 1.2 s) . . . 20 to?

This transcript is quite heavily annotated with the lengths of pauses and even Alison‘s action of looking at her watch. it certainly lacks the wealth of gesture and back channel activity that were present during the actual conversation.

Transcripts may be less well documented, perhaps dropping the pause timings, or more detailed, adding more actions, where people were looking and some back channelling. Whilst thinking about the structure of conversation, the transcript above is sufficient.

The most basic conversational structure is turntaking. On the whole we have an alternating pattern: Alison says something, then Brian, then Alison again. The speech within each turn is called an utterance. There can be exceptions to this turn-taking structure even within two-party conversation.

Context

Take a single utterance from a conversation, and it will usually be highly ambiguous if not meaningless: ‗the uh with the black cat – ―The Green whatsit‖‘. Each utterance and each fragment of conversation is heavily dependent on context, which must be used to disambiguate the utterance. We can identify two types of context within conversation:

internal context – dependence on earlier utterances. For example, when Brian says ‗masses‘ in the last transcript, this is meaningful in the light of Alison‘s question ‗and lots of chocolate?‘. This in turn is interpreted in the context of Brian‘s original offer of gateau.

external context – dependence on the environment. For example, if Brian had said simply ‗do you want one?‘, this could have meant a slice of gateau, or, if he had been holding a bottle, a glass of wine, or, if accompanied by a clenched fist, a punch on the nose.

Topics, focus and forms of utterance

Alison began the conversation with the topic of roses. Brian shifts to the related, but distinct, topic of greenfly. However, for some reason Alison has missed this shift in focus, so when she makes her second utterance, her focus and Brian‘s differ, leading to the breakdown in communication. The last two utterances are a recovery which re-establishes a shared dialog focus.

Breakdown and repair

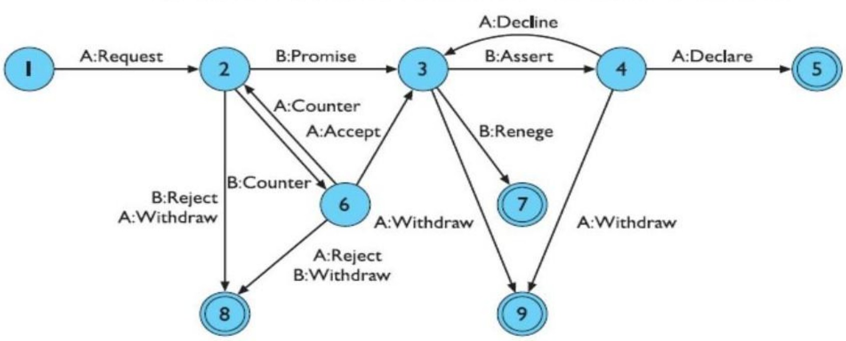
When Alison and Brian were talking about Brian‘s roses, they failed to maintain a shared focus. Brian

tried to interpret Alison‘s utterance in terms of his focus and failed, or rather the meaning in that focus was unusual – greenfly are the symbol of the English summer? He then questioned Alison and the confusion was cleared. This correction after breakdown is called repair.

Speech act theory

Speech act theory, has been both influential and controversial in CSCW. Not only is it an analytic technique, but it has been used as the guiding force behind the design of a commercial system, The basic premise of speech act theory is that utterances can be characterized by what they do. If you say _I‘m hungry‘, this has a certain propositional meaning – that you are feeling hungry. However, depending on who is talking and to whom, this may also carry the meaning _get me some food‘ – the intent of the statement is to evoke an action on the part of the hearer. Speech act theory concerns itself with the way utterances interact with the actions of the participants. The act of saying the words changes the state of the couple. Other acts include promises by the speaker to do something and requests that the hearer do something. These basic acts are called illocutionary points.

Individual speech acts can contribute to a conversation. The basic structure of conversations can then be seen as instances of generic conversations. One example of such a generic structure is a conversation for action (CfA).



TEXT-BASED COMMUNICATION

Text-based communication is familiar to most people, in that they will have written and received letters. However, the style of letter writing and that of face-to face communication are very different. The text-based communication in groupware systems is acting as a speech substitute, and, thus, there are some problems adapting between the two media.

There are four types of textual communication in current groupware:

discrete – directed message as in email. There is no explicit connection between different messages, except in so far as the text of the message refers to a previous one.

linear – participants' messages are added in (usually temporal) order to the end of a single transcript.

non-linear – when messages are linked to one another in a hypertext fashion.

spatial – where messages are arranged on a two-dimensional surface.

Back channels and affective state

One of the most profound differences between face-to-face and text-based communication is the lack of fine-grained channels. Much of the coordination of face-to-face conversation depends on back channels and interpretation of the listener's expressions. Text-based communication loses these back channels completely. speaker would pause to seek back channel confirmation or to offer the floor, the text _speaker' must either continue regardless, or finish the message, effectively passing the turn.

These normally convey the affective state of the speaker (happy, sad, angry, humorous) and the illocutionary force of the message (an important and urgent demand or a deferential request). Email users have developed explicit tokens of their affective state by the use of _flaming' and _smilies', using punctuation and acronyms; for example:

:-) – smiling face, happy

:-(– sad face, upset or angry ;-) – winking face, humorous LOL – laughing out loud.

Grounding constraints

This grounding process is linked strongly with the types of channels through which the conversants communicate. Clark and Brennan describe the properties of these channels in terms of grounding constraints. These include:

Co-temporality – an utterance is heard as soon as it is said (or typed);

simultaneity – the participants can send and receive at the same time;

sequence – the utterances are ordered.

These are all constraints which are weaker in text-based compared with face-to-face interaction.

In a text-based system, different participants can compose simultaneously, but they lack cotemporality. As we saw, even if the messages appear as they are produced, they will not be read in real time. In addition, the messages may only be delivered when complete and even then may be delayed by slow communications networks.

Turn-taking

In a pair of participants, turn-taking is simple; first one person says something, then the other. The only problem is deciding exactly when the exchange should happen. With three or more participants, turn-taking is more complex. They must decide who should have the next turn. This is resolved by face-to-face groups in a number of ways. First, the conversation may, for a period, be focused on two of the parties, in which case normal two-party turn-taking holds. Secondly, the speaker may specifically address another participant as the utterance is finished, either implicitly by body position, or explicitly: ‗what do you think Alison?' Finally, the next speaker may be left open, but the cotemporality of the audio channel allows the other participants to negotiate the turn. Basically, whoever speaks first, or most strongly, gets in. These mechanisms are aided by back channels, as one of the listeners may make it clear that she wants to speak. In this case, either the speaker will explicitly pass the turn (the second option above), or at least the other listeners are expecting her to speak. In addition, the movement between effective two-party conversation (the first option) and open discussion will be mediated by back channel messages from the other participants.

In an unstructured text-based conversation the third option is not available, nor, of course, are the back channels. Paired conversation is quite common and the second option, explicitly naming the next speaker, is possible. This naming is not particularly natural unless a direct question is being asked. In both options, the absence of back channels makes it difficult for another listener to interrupt the conversation. Some systems use more structured mechanisms to get round these problems, perhaps having a round-robin protocol (each participant ‗speaks' in turn) or having a queue of turn-requests. Whether the strictures of such mechanisms are worse than the problems of occasional breakdown depends very much on the context and is a matter of opinion.

Context and deixis

Utterances are highly ambiguous and are only meaningful with respect to external context, the state of the world, and internal context, the state of the conversation. Both of these are problems in text-based communication.

The very fact that the participants are not co-present makes it more difficult to use external context to disambiguate utterances. This is why many groupware systems strive so hard to make the participants' views the same; that is, to maintain WYSIWIS (‗what you see is what I see').

Whatever the means of direct communication, remote participants have difficulty in using deictic reference. They cannot simply say ‗that one‘, but must usually describe the referrant: ‗the big circle in the corner‘. If their displays are not WYSIWIS then they must also ensure that their colleague‘s display includes the object referred to and that the description is unambiguous. Asynchronous participants have even more problems with deixis as there is no opportunity for their colleagues to clarify a reference (without extremely lengthy exchanges). The objects referred to by a message may have changed by the time someone comes to read it! Similarly, group pointers are not really an option, but one can use methods of linking the conversation to its context, either by embedding it within the objects as annotations or by having hypertext links between the conversation and the object. The trouble does not end with external context; there are also problems with deictic reference to internal context. In speech, the context is intimately connected to linear sequence and adjacency. As we have seen, even in linear text transcripts, overlap breaks the strict sequentiality of the conversation, and thus causes problems with indexicals and with context in general.

1. Alison: Brian‘s got some lovely roses.
2. Brian: I‘m afraid they‘re covered in greenfly.
3. Clarise: I‘ve seen them, they‘re beautiful.

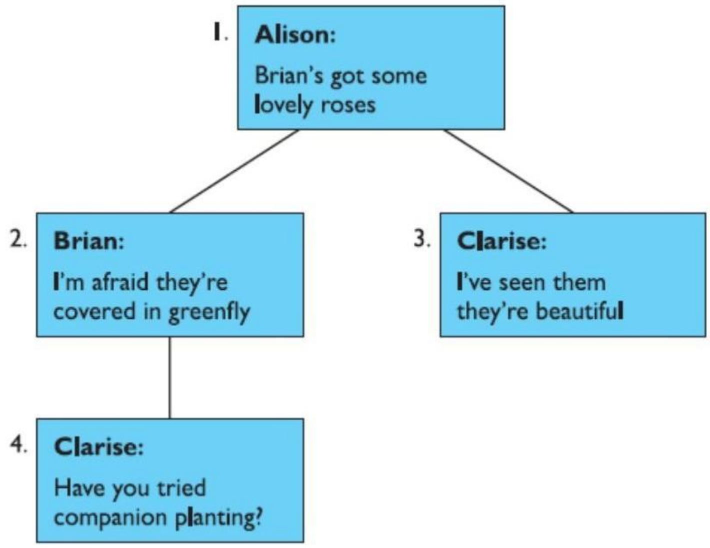


Fig: Hypertext conversation structure

Pace and granularity

The term pace is being used in a precise sense above. Imagine a message being composed and sent, the recipient reading (or hearing) the message and then composing and sending a reply. The pace of the conversation is the rate of such a sequence of connected messages and replies. Clearly, as the pace of a conversation reduces, there is a tendency for the granularity to increase. To get the same information across, you must send more per message. However, it is not as easy as that. We have seen the importance of feedback from listener to speaker in clarifying meaning and negotiating common ground. Even most monologs are interactive in the sense that the speaker is constantly looking for cues of comprehension in the listener. Reducing the pace of a conversation reduces its interactivity.

In a hypertext-based system one can expand several branches of a conversation tree, but in speech or in a linear text transcript the conversation follows one branch. To overcome these limitations, people adopt several coping strategies. The simplest strategy is just to avoid conversation. This can be done by delegating parts of a task to the different participants. Each participant can then perform much of the task without communication. They must still communicate for large-scale strategic decisions, but have significantly reduced the normal communications. Of course, this approach reduces communication by reducing collaboration. More interesting in a cooperative work setting are two coping strategies which increase the chunk size of messages in order to reduce the number of interactions required to complete a task. These strategies are frequently seen in both text-based conferences and in letter writing.

The first of these coping strategies is multiplexing. Basically, the conversants hold several conversations in parallel, each message referring to several topics. In terms of the conversation tree, this corresponds to going down several branches at once.

Linear text vs. Hypertext

Multiplexed messages can be represented as updates to several parts of the hypertext, thus reducing the likelihood of breakdown and lost topics. In addition, if the messages themselves can be mini-hypertexts, then eager messages listing several possible courses of action can be explicitly represented by the message.

Even static hypertexts, which have been carefully crafted by their authors, can be difficult to navigate. A hypertext that is created _on the fly‘ is unlikely to be comprehensible to any but those involved in its creation. Conklin and Begeman, themselves associated with the hypertext based argumentation tool gIBIS, conclude that _traditional linear text provides a continuous, unwinding thread of context.

For the asynchronous reader trying to catch up with a conversation, a linear transcript is clearly easier, but it is precisely in more asynchronous settings where overlap in linear text is most likely to cause confusion.

GROUP WORKING

Group behavior is more complex still as we have to take into account the dynamic social relationships during group working. We will begin by looking at several factors which affect group working, and then discuss the problems of studying group working .

Group dynamics

organizational relationships such as supervisor/supervisee are relatively stable, the roles and relationships within a group may change dramatically within the lifetime of a task and even within a single work session. For example, studies of joint authoring have found that roles such as author, co-author and commentator change throughout the lifetime of a document. This means that systems, such as co-authoring systems, which use a formal concept of role, must allow these roles to change together with the socially defined roles.

A person may be an author of a book or paper, but never write the words in it, acting instead as a source of ideas and comments. A particular case of this is the biographical story where the individual

concerned and a professional writer co-author the book, but only the professional author writes. A co-authoring system such as Quilt would call the non-writing author a

_commentator' or a _reviewer', but not an _author'. One can imagine some of the social friction such naming will cause.

Physical layout

The designers of Capture Lab, an eight-person meeting room, considered all these features and many other subtle effects. However, the users still had some difficulty in adapting to the power positions in the electronic meeting room. At first sight, the electronic meeting room is not unlike a normal conference room. If the shared screen is a whiteboard or an overhead projector, then the most powerful position is toward the front of the room . Managers would normally take this seat as they can then easily move to the whiteboard or overhead projector to point out some item and draw the group's attention.

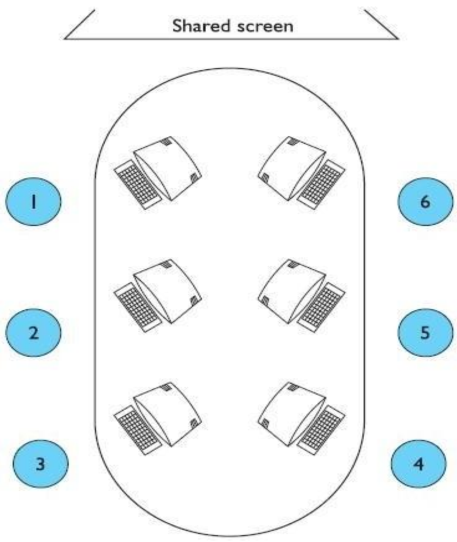


Figure: Meeting room layout

Distributed cognition

Traditional views talk about the movement of information between working memory and long-term memory: it is not so difficult then to regard bits of paper, books and computer systems as extensions to these internal memory systems. Similarly, many models of human cognition regard the mind as a set of interacting subsystems. The step to regarding several people as involved in joint thinking is not difficult.

HYPERTEXT, MULTIMEDIA AND THE WORLD WIDE WEB

- Hypertext allows documents to be linked in a nonlinear fashion.
- Multimedia incorporates different media: sound, images, and video.
- The world wide web is a global hypermedia system.
- Animation and video can show information that is difficult to convey statically.
- Applications of hypermedia include online help, education and e-commerce.
- Design for the World Wide Web illustrates general hypermedia design, but also has its own special problems.
- Dynamic web content can be used for simple online demonstration

Hypertext.

•The term hypertext means certain extra capabilities imparted to normal or standard text.

•Technical documentation consists often of a collection of independent information units.

•It consists of cross references which lead to multiple searches at different places for the reader.

•Hypertext is text which is not constrained to be linear and it contains links to other texts which is known as hyperlinks.

•Hypertext is mostly used on World Wide Web for linking and navigating through different web pages.

•A hypertext consists of two different parts: Anchor and link

•An anchor or node is an entry point to another document. In some cases instead of a text an image a video or some other non-textual element.

•A link or pointer provide connection to other information unit known as target documents.

Multimedia refers to using computers to integrate text, graphics, animation, audio, and video into one

application. Most multimedia applications are interactive, so that users may choose the material to view, define the order in which it is presented, and obtain feedback on their actions.

Interactivity also makes multimedia very suitable for video games, electronic newspapers and magazines, electronic books and references, simulations, virtual reality, and computer-based training.

Multimedia applications can be created by using a multimedia authoring software. Many multimedia applications are also deliverable via the World Wide Web.

Graphics

A graphic is a digital representation of information such as a drawing, a chart, or a photograph.

Graphics were the first media used to enhance the originally text-based Internet. Two of the more common graphical formats on the Web are JPEG and GIF. Other graphical formats such as BMP and TIFF have larger file sizes, and may require special viewer software to display on the Web. To reduce download times for graphics, some Web sites use thumbnails, which is a smaller version of a larger graphical image that a user may click to display the fullsized image.

Audio

Audio can be music, speech, or any other sound. Common audio formats include WAV, MID, and MP3. Some Web sites use streaming audio, which allows a user to listen to the sound as it downloads to the computer. Two accepted standards for streaming audio on the Web are Windows Media Player and RealAudio.

Video

Video consists of full-motion images that are played back at various speed. Most video is also accompanied with audio. MPEG is a popular video compression standard defined by the Moving Picture Experts Group (MPEG). Streaming video allows a user to view longer or live video images as they download to the computer from the Web. Two popular streaming video formats are Windows Media Player and RealVideo.

Animation is the appearance of motion that is created by displaying a series of still images in rapid sequence. Animated GIF is a popular type of animation format, which combines several images into a single GIF file.

Multimedia Authoring Software

Multimedia authoring software combines text, graphics, animation, audio, and video into an application. Multimedia is widely used in video games, electronic newspapers and magazines, electronic books and references, simulations, virtual reality, and computer-based training. Popular multimedia authoring software includes Macromedia AuthorWare, Macromedia Director, and Macromedia Flash. Multimedia computers have facilities for handling sound and video as well as text and graphics. Most computers are now sold with a multimedia capacity.

Web - World Wide Web

The Web, or World Wide Web, is basically a system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (HyperText Markup Language) that supports links to other documents, as well as graphics, audio, and video files.

This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

The Internet is a worldwide collection of networks that links millions of businesses, government offices, educational institutions, and individuals. Data is transferred over the Internet using servers, which are computers that manage network resources and provide centralized storage areas, and clients, which are computers that can access the contents of the storage areas. The data travels over communications lines. Each computer or device on a communications line has a numeric address called an IP (Internet protocol) address, the text version of which is called a domain name. Every time you specify a domain name, a DNS (domain name system) server translates the domain name into its associated IP address, so data can route to the correct computer.

An Internet service provider (ISP) provides temporary Internet connections to individuals and companies. An online service provider (OSP) also supplies Internet access, in addition to a variety of special content and services. A wireless service provider (WSP) provides wireless Internet access to users with wireless modems or Web-enabled handheld computers or devices.

Employees and students often connect to the Internet through a business or school network that connects to a service provider. For home or small business users, dial-up access provides an easy and inexpensive way to connect to the Internet. With dial-up access, you use a computer, a modem, and a regular telephone line to dial into an ISP or OSP. Some home and small business users opt for newer, high-speed technologies. DSL (digital subscriber line) provides high-speed connections over a regular copper telephone line. A cable modem provides high-speed Internet connections through a cable television network.

The World Wide Web (WWW or Web) consists of a worldwide collection of electronic documents called Web pages. A browser is a software program used to access and view Web pages. Each Web page has a unique address, called a URL (Uniform Resource Locator), that tells a browser where to locate the Web page. A URL consists of a protocol, domain name, and sometimes the path to a specific Web page or location on a Web page. Most URLs begin with http://, which stands for hypertext transfer protocol, the communications standard that enables pages to transfer on the Web.

A search engine is a software program you can use to find Web sites, Web pages, and Internet files. To find a Web page or pages, you enter a relevant word or phrase, called search text or keywords, in the search engine‘s text box. Many search engines then use a program called a spider to read pages on Web sites and create a list of pages that contain the keywords. Any Web page that is listed as the result of the search is called a hit. Each hit is a link that can be clicked to display the associated Web site or Web page.

There are six basic types of Web pages. An advocacy Web page contains content that describes a cause, opinion, or idea. A business/marketing Web page contains content that promotes or sells products or services. An informational Web page contains factual information. A news Web page contains newsworthy material including stories and articles relating to current events, life, money, sports, and the weather. A portal Web page offers a variety of Internet services from a single, convenient location. A personal Web page is maintained by a private individual who normally is not associated with any organization.

Many exciting Web pages use multimedia. Multimedia refers to any application that integrates text with one of the following elements: graphics, sound, video, virtual reality, or other media elements.

A graphic is a digital representation of information such as a drawing, chart, or photograph. Two common file formats for graphical images on the Web are JPEG (Joint Photographic Experts Group) and GIF (Graphics Interchange Format), which use compression techniques to reduce the size of graphics files and thus speed downloading.

Animation is the appearance of motion created by displaying a series of still images in rapid sequence. One popular type of animation, called an animated GIF, uses computer animation and graphics software to combine several images into a single GIF file.

Audio is music, speech, or any other sound. A common format for audio files on the Web is MP3, a popular technology that compresses audio. More advanced Web audio applications use streaming audio, which transfers audio data in a continuous and even flow, allowing users to listen to the sound as it downloads. Video consists of full-motion images that are played back at various speeds. Video files often are quite large in size. The Moving Pictures Experts Group (MPEG) defines a popular video compression standard. Streaming video allows you to view longer or live video images as they are downloaded.

Virtual reality (VR) is the use of computers to simulate a real or imagined environment that appears as a three-dimensional (3-D) space. A VR world is an entire 3-D site that contains infinite space and depth.

A variety of services are used widely on the Internet, including e-mail, FTP, newsgroups and message boards, mailing lists, chat rooms, and instant messaging. E-mail (electronic mail) is the transmission of messages and files via a computer network. You use an e-mail program to create, send, receive, forward, store, print, and delete messages. To receive messages, you need an e-mail address, which is a combination of a username and a domain name that identifies a user.

FTP (File Transfer Protocol) is an Internet standard that allows you to upload and download files with other computers on the Internet. An FTP server is a computer that allows you to use FTP to upload files to, and download files from, an FTP site. With anonymous FTP, anyone can transfer some, if not all, available files. A newsgroup is an online area in which users conduct written discussions about a particular subject. The computer that stores and distributes newsgroup messages is called a news server. You use a program called a newsreader to access a newsgroup, read previously entered messages (called articles), and add (post) messages of your own.

A thread consists of the original article and all subsequent related replies. In a moderated newsgroup, a moderator reviews articles and posts them, if appropriate. A message board is a popular Web-based type of discussion group that does not require a newsreader and typically is easier to use than a newsgroup. A mailing list is a group of e-mail names and addresses given a single name. To add your e-mail name and address to a mailing list you subscribe to it; to remove your name, you unsubscribe.

A chat is real-time (meaning everyone involved in the chat is online at the same time) typed conversation that takes place on a computer. A location on an Internet server that permits users to chat is called a chat room. Some chat rooms support voice chats and video chats, where you can hear or see others and they can hear or see you as you chat. A chat client is a program on your computer that allows you to connect to a chat server and start a chat session. Instant messaging (IM) is a real-time Internet communications service that notifies you when one or more people are online and then allows you to exchange messages or join a private chat room.