

Approaching Group Communication by means of an Office Building Metaphor

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ABSTRACT

This is a description of what one might call an environment for cooperative work. The work falls in two parts: First a conceptual framework for cooperative work is approached by way of the transaction cost theory of organizations [4]. The rest of the paper describes ideas for a system that supports cooperation as it is outlined in the first part.

Framework. A transaction cost approach on information systems.

Since the emergence of the term cooperative work a lot of consideration has been given to the question of what cooperative work is. It is not the aim of this work to contribute to this discussion. Rather the term cooperative work is used to describe work that goes on in organizations be it offices, firms, research laboratories or whatever. A very limited part of such work can be said to be totally individual. Even when an employee is writing a letter or a report he is building on a set of shared concepts, shared information within the organization which he is part of and thus in a sense he is cooperating. Thus in this paper the term cooperative work is given very wide limits.

One of the key issues in systems for support of cooperative work is communication. Sørgaard [15] operates with two forms of communication: Explicit - and by means of shared material. These two forms of communication work together, it is not a matter of one or the other. Also Thompson [16] emphasize the need to share information in order to be able to communicate. This implies that a communication system should not only support electronic mail, conference systems and other forms of explicit communication. Rather these should just be facilities in a system based on a shared and well-structured representation of all the information - all the shared material - of the organization. Thus an information system along these lines forms the basis of the environment system described later. Here cooperative work in terms of communication within an information system will be addressed.

A fundamental aspect of the theory of organizations is that people do not necessarily share goals and perspective, but rather opportunistic behaviour must be anticipated (See [4] among others). No matter how broad or narrow one chooses to define the term cooperative work this element of opportunistic behaviour among participators is inherent. One must be conscious of this fact when designing systems for cooperation, and when discussing a theoretic approach to cooperative work. To this end a theory of organizations that recognizes this opportunistic behaviour must be employed in order to obtain a theoretical framework for cooperation. We have stopped at the transaction cost approach, because its classifications of organizations into market bureaucracy and clan correspond somewhat to the broad variety of different cooperative work settings, as will be further argued below.

Ciborra and others distinguishes between three mechanisms for controlling economic transactions: Market, Bureaucracy and Clan.

- A market is an assemblage of persons desirous of exchanging property, with prices serving both as incentives and coordinating guides to producers. Market requires very little knowledge of the participants, i.e. their own needs and the prices, and no necessity for a central all-knowing authority.

- In a bureaucracy, market transactions are eliminated and in their place we find an entrepreneur-coordinator who is the authority.
- Finally, there are situations where products and services are so complex, transactions so ambiguous that the parties involved in the exchanges have to trust each other and give up any attempt at a shortsighted calculation of the reciprocal cost and benefits acquiring from the exchange. In a clan networks of exchanges are governed in a stable manner by informal relationships of trust.

Transactions well suited for a market are characterized by low uncertainty and the market organization are able to tolerate a high degree of opportunistic behaviour, whereas clans are vulnerable to opportunistic behaviour and are better suited to control transactions with a high degree of uncertainty. Bureaucracies are in between these two extremes, characterized by a formal hierarchical organization.

As computer technology develops and more and more information processing power is made available to organizations, information is becoming the key asset of organizations. So what we want to look at is the transaction of information and the characteristics of the organizations controlling these transactions. In other words: In stead of viewing information as something that helps control transactions, information itself is viewed as the subject for transaction. Thus in the following, when clan, bureaucracy or market organization is mentioned, what is meant is that the organization controlling information transactions have clan, bureaucracy or market characteristics. Now, just as opportunistic behaviour is realized in systems of economic transactions, conflicting interests of users of the information system is recognized as rational and legitimate.

Consider an information system controlled exclusively by market. A user of the system might for example have one or more of the following reasons for submitting a piece of information to the information system.

- He is explicitly asked to do so.
- He wants to express an opinion on a certain matter or in other ways influence other members of the organization.
- He wants to obtain recognition for a certain piece of work.
- He needs critique or other feedback on some work.

All these reasons give way for a relative straightforward - although not all that rational - cost benefit analysis for the persons submitting the information. "Considering my aim, is it worthwhile to make this contribution or not?" In the first case he will probably expect something in return for the information which he provides, and in the last three explicit gains are acquired. Markets are characterized by allowing such simple cost benefit analyses.

In present information systems the amount of information produced is usually much larger than what one person can consume. Thus also here a clear cost benefit weighing must be utilized: Is the information worthwhile reading or not.

Several authors have discussed ways to overcome the "information overload", eg [13] and [11].

What has been described above is a rather simplified and idealistic picture of an information system. Often the organization in which the system is imbedded has more or less formalized procedures for its use. Thus incentives for reading and submitting items in the system are guided by rules and requirements of the organization. Note however that these rules are often outside the information system itself.

Take as an example a filing system for case files in a public administration office which has rules that prescribes workers to submit certain types of journals for each case. There is no way to tailor a file cabinet or an electronic file server so that it demands journals of every case from the employees. In other words the formal organization or bureaucracy control of information transactions are implemented in the organization surrounding the information system, it is not directly supported in the system itself.

There are other types of motives for reading - submitting information in an information system.

These are of a more irrational kind: Social connectivity, community feeling, mutual responsibility etc. These are not easy to calculate, and are certainly not base for any cost-benefit analysis. These are incentives that characterize a clan organization.

As it is now established that the approach taken is sound, it is clear to see in which type of organization opportunistic behaviour is more common. In a market each individual can make his own cost-benefit analysis without concern of the "common good". In bureaucracies this is in part prevented by the rules governing the transactions. In the ideal clan opportunistic behaviour is in contrast to the incentives mentioned for reading and submitting information.

Based on the above it is argued that information systems by them selves in general only support markets for information transactions, and that bureaucracy and clan characteristics are mainly implemented in the surrounding organization. In many conference systems aspects of clan organizations can be simulated by using a closed conference, but that does not create an actual working environment for clan work. It merely provides a shared space.

Below three examples of ways of cooperating are identified, one example of each sort of cooperation as classified above:

1. Actually working together on a task. A prototypical example of this kind of cooperation is two or more persons sitting and working together on the same material.
2. Divide and combine. Splitting a task into subtasks, performing these in parallel and combining the subtasks.
3. Using the work of others. Drawing on online or offline sources when working on some tasks. Eg. citing published articles when writing a thesis.

These three reflect the different degrees of cooperation, from working very close together down to the point of cooperators not even being aware of each other or even of the fact that they are cooperating. Real cooperative work is often a combination of two or even all three of these modes.

Summary

The following demands have now been established for an information system to support cooperative work:

- It should support both explicit communication and shared material
- It should support the modelling of organizational structures not only for market- but also for clan and bureaucracy type organizations

Below the ideas of a system providing environments for cooperation is presented in which these demands form an important part.

Design

This is the design of a system intended to meet the above criterias for an information system and to support all the various types of cooperation that go on in organizations.

There are two cornerstones on which the design of the system rests: One is the concept of a shared information space represented by a hypertext system in which every information item in the organization is stored in order to support the information market present in the organization.¹ The implications of the hypertext representation will be discussed below.

The other cornerstone is the metaphor used for creating both the developers and the users conceptual view of the system.

The Office building metaphor

A popular metaphor for designing office systems for individuals is the desktop. But when it comes

¹This idea dates back to Vanever Bush in 1945 [3] and later Engelbart in his Augment system actually constructed something similar to this. (See [6] and [7])

to cooperative work this metaphor is no longer sufficient. In a way, it is not large enough. Instead the office building is chosen as a metaphor as it embraces the entire environment of office work.

An office building contains, besides the offices of individuals, several rooms that are more or less shared amongst the "inhabitants": The Hallway, Conference rooms, Group working rooms, Library and Archives, Coffee-room or Canteen, Reception etc.

The concept of a room becomes central in the system.² The system contains a number of different classes of rooms, corresponding to the ones mentioned above. Each of these rooms corresponds to a "section" of the "information space" (These concepts will be explained later) and is equipped with facilities for information management and communication as well as the usual facilities available in office systems such as editors and other applications. Some rooms are shared by the entire organization, others are shared by a few people and yet others are private to one person.

Each individual has his own room, corresponding to the idea of an individual office, where the individual can keep his private documents. The private office room is the normal working environment of the individual.

A group working room is a construct that allows two or more people to share workspace and working environment. The members of the group can access all information present in the section of the group room and they are able to configure the room with a number of different tools for communication and information management. These tools will be described in a later section; here is just a few examples of their implications. When one enters a group room, it is immediately visible if there are other persons present. If so, one is allowed to look at what the others are doing. The group can define its own bulletin boards corresponding to closed conferences in a conference system, as well as mechanisms for handling incoming mail items. Eg. it should be possible to send a request for some action to a group whose mail distribution rules in turn assign the task to the one best suited to carry it out. On entering the group room all changes to the state of the rooms can be seen in a special window: New entrances to the bulletin boards, new nodes or links in the hypertext section, and other kinds of new objects in the room. The group members are able to work together by sharing screens.

Information is shared in a way that keeps the individual in charge of what information he allows the other group members to see. Thus the contents of the private rooms of the group members are not available to the group.

From outside a group looks the same as an individual; a section of the information space, and a mail address.

With this group construct it becomes possible to model organizational structures such as clans and bureaucracies. A clan structure is simply a group with probably no more than ten members. The group must be small enough to make formal structures unnecessary, and the members must in general know each other and share a certain amount of confidence, or at least be aware of each other's perspectives and intentions. The information transactions are organized by way of the configuration of the room (see below) and by the organization of the section of the hypertext system belonging to the group.

Likewise bureaucracies can be modelled by means of one or more group rooms and by using communication structures (see below) which can control that certain patterns are followed for certain types of communication. See also the example at the end of this paper.

The conference room is where electronic conferences and discussions take place. This corresponds to the open conferences of a conference system. The conference system contains a hierarchy of subconferences corresponding to a hierarchy of subsections of the information system. This is the structure of many conferencing systems eg. CONFER [9]. Andrew [1]

Entrances to a conference are submitted by leaving them in the conference section optionally linked to other objects in the conference, eg by one of the following link types: response, comment, agree, disagree, protest, continue, etc. It is also possible to enter an object by mailing it to the conference. Each subscriber has a facility by which links to new messages are kept. On entering a conference

²The 100 series of Xerox workstations runs a system called "Rooms". This does little more than just enable the user to shift between a number of work areas which are totally defined by himself. Although this system has served as an inspiration, the room concept described in this paper is quite different from Xerox "Rooms".

three windows appear (see fig 1): The browser of the conference section, The container of new messages and a display for reading. When a link is chosen from the container of new messages, the message appear in the display, and it is marked in the browser, in order to show the context.

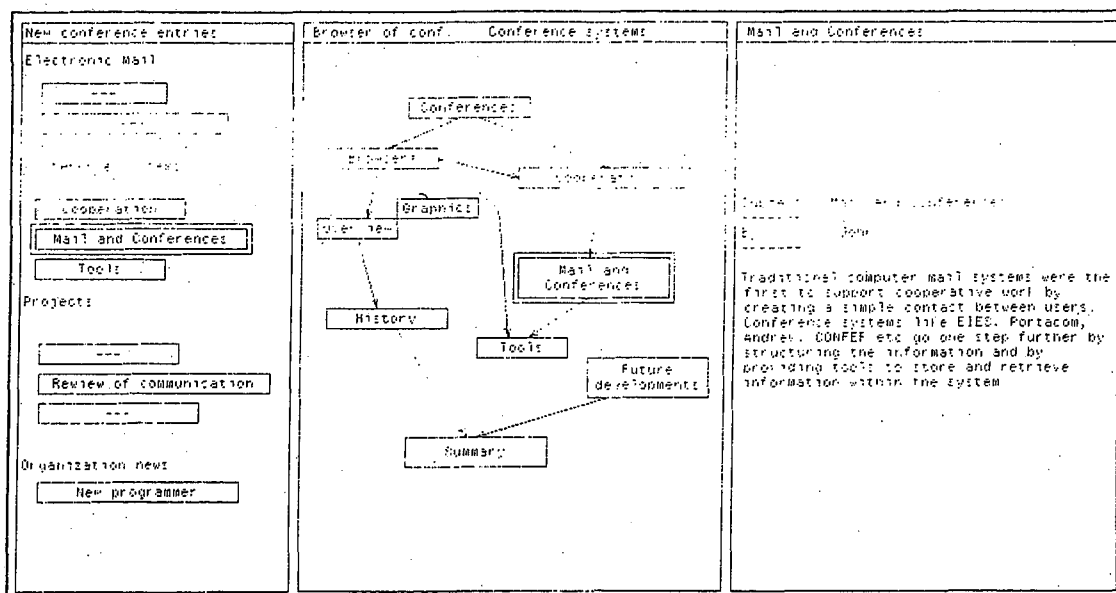


Fig. 1 Conference participation.

When the next item is chosen the former is automatically disappears from the display. This is similar to what most conference systems do, except that here the context of the items is visible in the browser.

Besides the conference system, there are three places for information shared by the entire local community: One is the Library where it is possible to retrieve information in a structured manner. The others are the Coffee room and the Hallway which contain information of a more informal or social character.

The library is the place where all publicly available information is stored.

In a library one expects to find information stored in a well-structured manner. When one wants to find a specific piece of information, the first thing to do is to go to the section of the library in which one expects go find the information. Further these sections are divided according to subjects and finally the publications are ordered by author or title. This ordering scheme is kept a long way down the road. The library section is divided into sub sections according to general areas such as person directory, accountance, management and projects - these again subdivided according to different types of projects or other divisions appropriate for the particular organization. To find a particular item one uses a browser - these will be described below - or one can use various search facilities.

The coffee room is sort of a multiple talk facility. There is a window for everyone present where one can then just "type away". The topics are open, but a certain amount of etiquette should be followed. This facility enables people to catch bits of information at random. When a person leaves his window is closed after a few minutes.

The hallway has a similar function. To meet someone in the hallway means that a talk connection is established. When one is in the hallway, eg. in order to get from one room to another, other people are visible and may be addressed by establishing a talk connection. Root [14] describes a similar facility in which video connections are established as well.

Information representation. A hypertext system

The advantages of hypertext systems are well recognized (see eg. [5]). Especially important in this connection are:

- Ease of creating and tracking cross references.
- Information structuring. Eg. for a software project, analysis documents, specifications, programs and documentation can be interlinked in a logical and structured manner.
- Consistency of information. Updates to a document will only have to be made in one place. This is important because of the many different points of entry to the information system.

In this particular case the fact that all information is available from everywhere in the system but within different contexts becomes vital: For example a design document produced within some group space can be submitted to an electronic conference, and there be subject for discussion. Later this document can be inspected from either the group space or the conference space, in a combined context where both conference links and group- or project links are visible.

Sections

One of the fundamental problems of hypertext systems is the difficulty of retrieving relevant information due to the disorientation that easily occurs in an unstructured hypertext system (See eg. [5]). Some sort of structure must be introduced to prevent this disorientation, and this is where the sections mentioned above come in. The organization of sections corresponds quite closely to the directory system of a conventional file system; A hierarchy of sections where a section can contain both subsections and other nodes of the system. However in this system a node can in general only be in one section at a time; the system does not allow multiple copies of the same node.

Thus we have two organizations of the information space which are independent of each other: the hierarchy of sections and the system of links. This structure gives us all the flexibility of the hypertext system, and all the order of the directory system, the best of both worlds. In addition people who are not familiar with the principles of hypertext can start using the system by just filing nodes in sections and subsections, and then start using links along the way.

In the hypertext system everything can be interlinked, so in order to secure the privacy of the individuals and the groups the boundaries between the different "rooms" are made explicit by introducing a special linking convention: Links between different sections of the information space corresponds to submitting the linked-to item into the section from which the link was originated. The link is by default only visible from within that section. If, for instance, an individual creates a link from a conference to an item in his private section, this has the same effect as submitting this item to the conference, whereas if the link goes in the opposite direction, it serves merely as a private reference. By admitting access to an item in a private section permission is implicitly granted to follow the links from this item to other items as long as they belong to the same subsection. Thus one has to be a little cautious about which links are created into ones private area. On the other hand this provides the possibility of letting others view an item in its proper context rather than as an isolated message or text.

Electronic mail

The option to send any node to someone is always close by hand at the same level as "save" "close" or "print". There are two modes of sending a message, either sending the actual text or sending a link to the text. When sending a message one is then prompted for the receiver and for the mode of sending. It is also possible to send a message to a conference, without going to the conference room.

Browsers

Manoeuvring within the system is done by using the hypertext browser system and a overview of the available rooms. The latter will be described in the next section.

The browser system is connected to the system of sections, and thus is hierarchical in nature. A browser belongs to a room, and cannot show things outside the section of that room. When a browser of a room is initiated the top level of that section is shown, thus subsections are not expanded. This is just like the ls command in UNIX, except that the browsers show a graphical representation of the nodes and subsections. Besides the links between nodes are shown. Links

between subsections are shown as one link and a number indicating the number of links between the subsections. Links out of the sections are shown with a line to the border of the browser, and the address of the other end. By clicking on a subsection with the mouse this subsection is displayed in the browser. An example of a browser is shown in fig. 2.³

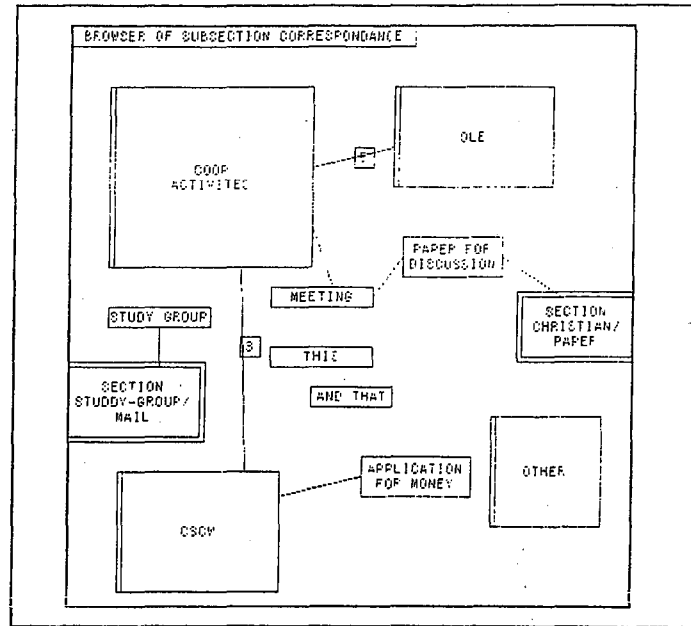


Fig. 2 Browser of section.

The office building map

For manoeuvring between the rooms in the system a special browser is used which contains sort of a map of the organization. It can be individually designed in order to let the user create an individual understanding of the system and the organization. In addition to going from one room to another the browser can be used for obtaining information about the different rooms. Moving from one room to another is done by a simple mouse click. One can either move directly between rooms or go via the hallway.

A simple example of an office building map is shown in fig. 3. Notis that it is possible to see how willing people are to be disturbed by how wide the doors to their offices are opened.

Configuration of rooms

The rooms described above fall in two groups. There are four rooms shared by the entire organization: Library, Hallway, Coffee room and Conference room. These are not tailorable to any note worthy degree. The other type of rooms are those that are open to certain people only. These are individual offices and group rooms. In fact these two types are quite similar; a room of an individual can be viewed as a group room with just one member. This type of rooms can be configured with a number of facilities for communication and cooperation to meet the needs of the owners.

These facilities range from normal texteditors and other programs well known in present working environments over facilities for communication and information management to special tools for close group cooperation.

Below examples of facilities are briefly described.

³Xerox Notecards which is a hypertext system running on the 1100 series of Xerox workstations [10] has a folder concept which is somewhat similar to the section. However, Notecards does not take advantage of the folder in its browser concept.

In order to support communication among group members bulletin boards can be placed in group rooms. This corresponds somewhat to having closed conferences in a conference system, where only members of the group can participate. A bulletin board may also be useful in the individual rooms as a personal reminder or referencer.

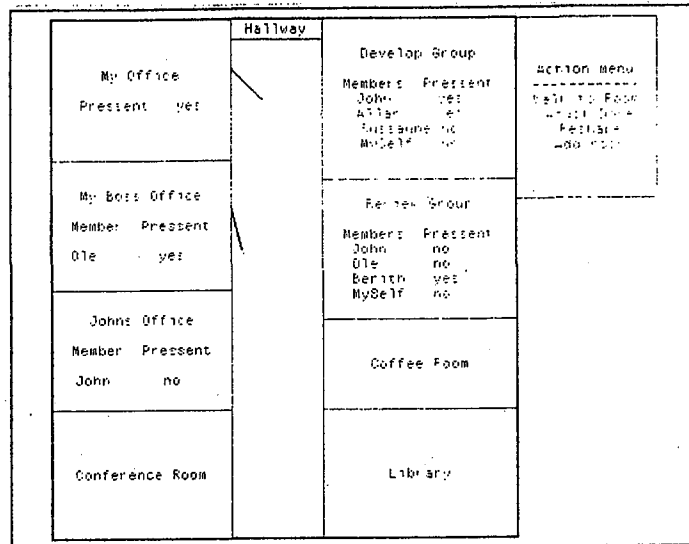


Fig. 3 The office building map.

In a conference system it is customary to have a facility that shows unread entrances. This facility is generalized into a new-link container so that it can be used both in the conference room and in other rooms such as the group room. Its function is quite simple; whenever an item is inserted in the section connected to the new-link container a link to this item is placed in the new-link container. Upon entering a room one may then check to see if any new items have been inserted. Afterwards the links may either be deleted or moved to appropriate places. The facility is often used in connection with a display in which the items are inspected, thus approaching the normal functions of a conference system.

Agents and Communication structures are user programmed features. Agents are inspired by Object Lens [12] and Communication structures by the COSMOS project (See eg. [2] and [17]). Agents are for automatic object manipulation. The user can set up a number of rules that apply to objects in the system. When an object complies with a rule a certain action is carried out by the system. Typically the range of such an agent is a section of the information space. Agents are primarily used by individuals and to a certain extent by groups for managing the information system and the electronic communication items.

A Communication structure controls that a certain exchange of messages goes on in a certain order, and that no step is forgotten. In COSMOS a communication structure controlling a voting procedure is described. Another example could be a structure ensuring that every time a certain type of report was filed the superior was notified. Communication structures are more of a tool for modelling formal organizational structures.

A powerful tool for cooperation is a facility that allows one to link to another terminal and see what is on the other screen. Such facilities come close to implementing a comprehensive shared workspace for participants. Below are some examples.

A whiteboard is a window shared by two or more screens in which two or more people can write, draw and create images simultaneously. This can be used for close cooperation between members of a work group. The work is of course saved for later use.

Another facility that gives some of the same possibilities is the spreadsheet: **The Spreadsheet** is a sort of workspace that is shared between the members of a group. The idea was developed in the SharedARK project presented at EC-CSCW'89. When working with the spreadsheet the screen is split in two, a spreadsheet display and a working area. The display shows a map of the entire spreadsheet, which is much larger than one screen. The screens of everyone working on the spreadsheet is shown as small rectangles on the display. It is possible to move around on the spreadsheet. In the working area one can perform all kinds of usual tasks. The objects that is being worked on can be stationary on the spreadsheet though, meaning that when one moves around, they stay. When two screens overlap in the spreadsheet the screen image that both see is the same. Thus two or more persons are able to collaborate.

In SharedARK both video and audio connection is provided in addition. A telephone line for audio communication would probably be sufficient for most purposes until the more advanced technology becomes generally affordable.

An example of a spreadsheet is shown in fig. 4.

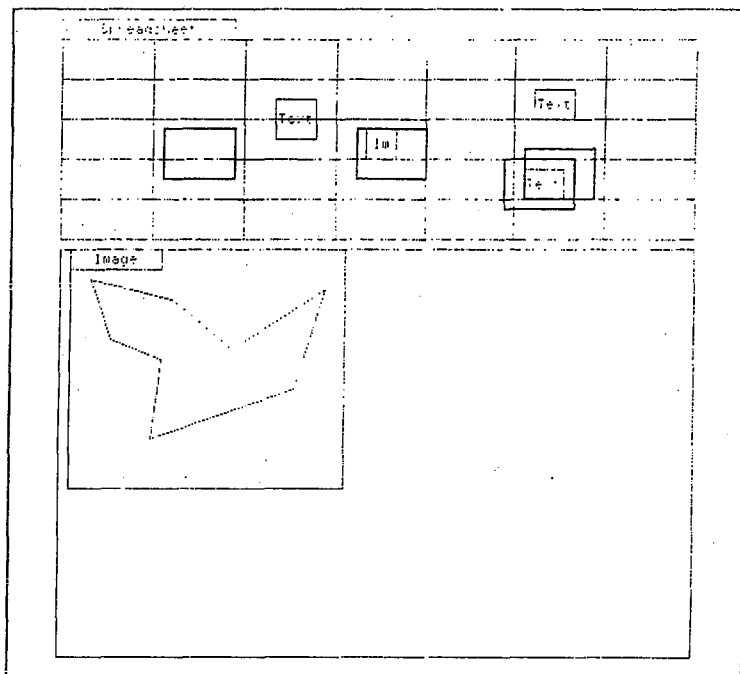


Fig. 4 Spreadsheet.

Tailorability. The object hierarchy

Seen from an implementation point of view the system is a collection of objects, most of which are persistent, working together. Everything is represented as objects: Rooms, sections, nodes, links, text, messages, browsers, agents, etc. These are arranged in a class hierarchy shown in fig. 5. ⁴

One can create new instances of objects by selecting them from a special browser containing this class hierarchy, and then filing in its properties using an editor. Afterwards the new object can be put to work by starting it as a new process. In addition new classes can be created by editing one of the existing class definitions. In this way every aspect of the system can be tailored and further developed by advanced users and developers.

Example

A somewhat larger example of how the groups may be configured and used will now be presented.

⁴Object Lens [12] has a similar method for creating new objects and object types.

In an organization an analysis of, say, the communication structures is to be conducted. For this purpose a project organization is established which looks as follows:

- Group 1 consisting of one worker from each of the three departments of the organization to be investigated. They are picked because they have previously worked together and know each other quite well.
- Group 2 consisting of a representative for management and two from the local union.
- Project management group consisting of a worker, a manager and a consultant from outside of the organization.

The two working groups are to work on two separate parts of the project, which in the end will be joined together. Meanwhile the project management group makes sure that no redundancy occurs, gives advice, and direct the work towards the essential issues. The whole project group conducts an ongoing discussion about the process of the project.

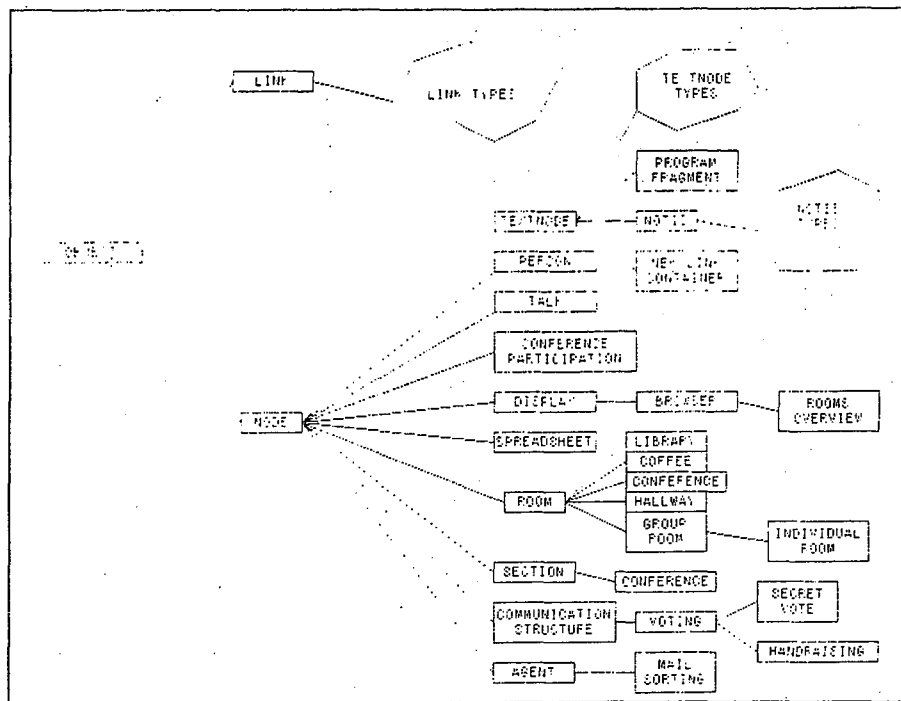


Fig. 5 The Class Hierarchy.

Four Group rooms are configured in the system. A Project group room, of which all are members. This room contains a conference in which the discussion about the process takes place. Group 1 decide that they want to work as closely together in performing their task as possible, they even want to help each other formulate central paragraphs of the report. For this purpose they configure their room with a spreadsheet for very close cooperation. Furthermore each is equipped with a container of new links, so that they can follow very closely what the others are doing. One bulletin board for discussing various parts of the work is installed and another for internal discussion about the work process. Also a scheduler for planning the work is included. Such a facility is needed in almost any kind of project. They decide that there should be no secrets amongst them, so all work in the project should be performed in the group room. It should be clear that the flow of information is controlled by a clan organization formed by the three group members.

Group 2 on the other hand recognize the inherent conflict of interests among the participants; they

choose a more formalized form of cooperation. They want to be able to prepare contributions in privacy which are then entered into a preliminary structure where it is possible to comment on each others contributions. To comply with these needs they choose a different configuration of their work setting. They each sit in their own private rooms preparing their contributions. These are then brought to the group room and placed in the group section. The group members use a bulletin board for telling each others what they have contributed with and where they think it fits in with the rest. The others now have several options for commenting: They can do it on the bulletin board, they can link a comment to the contribution in the group section if it is the context of the contribution they are unhappy with, or they can send a message to the other two members arguing for changes.

The project management group need primarily a scheduler to help them control the progress of the work and secure that deadlines are met. Bulletin boards for discussing individual pieces of work as well as the project in general are also necessary. The way in which they interact with the two groups differ significantly: Group 1 allow the management group free access to their section of the hypertext system by providing them with a link to the main section. This means that they are free to inspect the finished text nodes in there and create and interlink comments. They cannot see unfinished nodes which are still at the spreadsheet.

Group 2 being more concerned with privacy will not allow this form of inspection. Instead they mail finished parts to the management group who in turn mail back their comments. For this purpose a communication structure is set up which ensures that any piece sent off to the management group is in fact commented upon and that the comments are associated with the right piece.

At a certain point group 2 decide to send an enquiry to every member of the organization. They set up a voting structure to ensure that the results of the enquiry are collected and counted correctly and that the answers are anonymous. The structure sends the questions by e-mail to everyone in the organization and collects the answers from everyone. These are counted. As the enquiry is considered important and since it is anonymous, it is decided that everyone should answer the questions, and therefore people who delays their respons receive reminders from the structure until their answer is received. Finally the results of the enquiry are sent to the working group who can then use them for further work.

At the end the two reports are merged together and the project management group write a short conclusionary report of the project. For this purpose they add a spreadsheet to their room, so that they can all work together on the report. It turns out that the report is very easy to write because any reference to the main report is just a matter of inserting a hypertext link. The entire work - the main report and the final, shorter report are now placed in the library section. In addition the shorter report is submitted to an appropriate conference in the conference system. People reading it there who want to look at the main report can find it by following the referential links within the submitted shorter report.

This example has included aspects of all three categories of organizing cooperative work: Group 1 was organized as a clan, group 2 and also the project group seen as a whole were more bureaucracy-like, although other aspects were involved as well, and finally, the information market was used during the enquiry and in the final publication of the work.

Conclusion

This paper sees cooperative work as processes characterized by communication and by opportunistic behaviour among participators. In order to provide tools to cope with the opportunistic behaviour the transaction cost theory (see [4] and others) is used to categorize organizations controlling information transactions.

A system is designed which among others things provides an environment in which communication - both explicit and in the form of shared material - is well supported as are both synchronous and asynchronous communication. It is very easy to send all kinds of objects to each other. The system makes wide use of bulletin boards and has as part of it a conferencing system. The hypertext system used for storing all information encourages people to make their work available to the public by linking it into the public area.

A group construct is provided enabling the construction of bureaucracies and clans as information

transaction control structures in addition to the market structure that is supported by the hypertext and conference system.

For the design of the system a new design metaphor - the office building - is introduced, and the concept of users moving between different rooms of the system becomes central, thus providing users with a familiar conceptual understanding of the system.

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