1987

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Inger Eriksson

Abo Akademi

Rlitta Kalmi

University of Turku

Markku I. Nurminen

University of Turku

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Inger Eriksson
Researcher
Abo Akademi
Turku, Finland

Riitta Kalmi
Researcher
University of Turku
Turku, Finland

Markku I. Nurminen
Professor
University of Turku
Turku, Finland

ABSTRACT

In this paper, we present an educational intervention carried out in one of the object organizations of our research project.[1] This type of education provides users with knowledge and qualifications which can compensate defects in the IS. The method focuses on organizational communication and coordination. Five phases of intervention are described: interviews, group discussions, lectures, simulation, and personal guidance. We evaluate the method by discussing the results and effects of the intervention.

1. INTRODUCTION

In this paper, an educational intervention among a group of users of a particular information system (IS) is reported. We tell what was done, how it was done, why it was done, and what kind of results we received. However, the intervention gives rise to several questions of a more general and theoretical character. These questions originate partly from the fact that the intervention has been performed as part of a case study for the research project "Knowledge and Work" (K&W). The problem area is structured under four groups:

1. What a user should know
2. Theoretical relevance of the approach
3. Practical relevance of the approach
4. Plan for supporting learning

Each group is discussed briefly before the concrete description of the intervention is presented.

1.1 What a User Should Know

Any educational activity aims at a change in the qualifications of the object group. The educational topics are then determined according to the intended change. We should therefore discuss the desired qualifications of an IS user before planning the content of the educational activity.

The material generally included in the first courses may be divided roughly in two categories: general introduction to information technology and knowledge of the particular system that will be used.

The first category might include, for example, some general principles of the functioning of the computer and its subunits. A brief introduction to simple tools for application development, such as BASIC or a spreadsheet program, is also quite common. The development tools probably have an illustrative nature; the users are rarely expected to develop their own applications with such tools. Thus

the main objective of the topics of the first category seems to be improved general, understanding. If the user knows something of information technology, the resistance against the change may be reduced even if such knowledge is not necessarily very useful in a concrete use situation.

The second category, knowledge of the particular application, is, on the other hand, a pure necessity; without any training and instructions, reasonable use of a system would not be possible at all. User training policy often aims at changing the users' attitudes, teaching the use of apparatus, and improving the use situation by manipulating user-interfaces. Training is usually arranged when a new IS is implemented -- sometimes during the systems development process. The extent of this kind of training may vary from mechanical button pushing to more comprehensive understanding of the principles of the particular application. We think it is necessary for the users to have a reasonable overview of the IS and to understand its meaning to the organization. In our opinion, it is essential for the users to know a good deal about how EDP affects the work organization, while to know something about the computer's inside on a very abstract level is enough. Our objective is thus summarized as

> **Thesis 1:** The users should know and understand the structure and functioning of the information systems they use.

In the practice of using ISs, one single factor is often very difficult to isolate as the object of study. Organization and IS, systems development and use, user qualifications and quality of the IS are but a few mutually dependent features. Here we are interested in improving user qualifications. Therefore we have tried to control the environmental variables as much as possible.

We have performed an educational intervention in order to improve the use situation of a group of users of a particular IS. During this change process, the system has been unchanged. Also the organization of work has remained intact. The division of labor has not been changed even if we otherwise emphasize the close relationship between IS and work. The primary object of change has been the knowledge of individual users. The unofficial organization has naturally remained a non-controlled factor.

This strategy is designed according to the classical empirical research setting: one variable is varied while the others are kept constant (*ceteris paribus*). The controllability of organizational behavior is not very high. If, however, we can record some significant changes as a result of our intervention, we can make conclusions about the importance of users' knowledge or about the relevance of a particular kind of knowledge.

1.2 Theoretical Relevance of the Approach

The research setting described above may be put into the context of the K&W project. The entire program of the project is derived from a clear vision: information technology and its use constitute an inherent part of work. The basic functions of computerized ISs -- storing, processing, and transmission -- can thus be regarded as indivisible parts of the users' entire jobs by incorporating these functions with actors. The "system functions" do not remain anonymous; they may be regarded as human acts and the subjects of these acts can be identified. In other words, ISs should be perceivable enough so that their basic functions could be interpreted as meaningful job tasks, e.g., transmission as communication for task coordination and organizational cooperation.

Integrated ISs, dominant in practice, hide the communication aspects as well as the human actors. A conceptual deintegration is our most important technique to make relationships between men visible. A deintegrated interpretation makes each user capable of identifying where information comes from and where it goes, not only in terms of transmission network but also in terms of human actors: who sends and receives messages?

The case studies of the project serve as empirical studies around the basic vision. Let us take a normal, integrated IS in use which is not designed according to the vision. Two challenges emerge immediately: 1) Can we give a work-centered reinterpretation to the system? 2) Can we convey this reinterpretation to the users? We think that we have been able to answer the first question positively. The educational intervention is an attempt to answer the second question. The subjective bias of the research group becomes weaker if the reinterpretation can be shared with the users, the persons who are experts in their work by definition. The experiment also lends itself to assessing the practical significance of the view.

1.3 Practical Relevance of the Approach

These theoretical aspects are not only academic; they also materialize in everyday use. This has become apparent in our case studies. To analyze the situation before the intervention, we interviewed the users and observed them at their work. There were indeed several problems, e.g., in managing the stock. This is not surprising because the computer programs which support information flow do not follow the logic of the material flows. Also, the domains of responsibility for information and material handling are mingled. As a result of this complexity, the users did not always know what the consequences of their action and inaction were. The workers were not very well informed about the dependencies between different departments. In other words, they could not fully and correctly utilize their IS. Inefficient and incorrect utilization of the IS is not only a question of inconvenience. It also results in unnecessary and double work, which of course means extra expenses and waste of time. Managing exceptional and erroneous situations as well as one's ordinary work is important to get the whole work process in the organization flow. We further state that improved understanding of the IS and its impacts on the organization of work, not only on one's immediate environment, can complement some of the shortcomings and gaps of the IS and make a non-perfect IS work. This gives us

> **Thesis 2:** Knowledge and qualifications provided by adequate education can partly compensate for defects in the IS.

The practical relevance may be seen from two perspectives: that of an individual user and of the organization.

For the individual, the improved knowledge about and understanding of the IS makes him/her capable of having control and responsibility of his/her job. The IS no longer is a part of work which he/she does not grasp; it is included in the professional competence required for the job. This is likely to improve job satisfaction and to reduce alienation at work. All this means that our approach may be seen as a further step in the humanization of work as it demands that the autonomy of technology be challenged and that technology should be integrated to work.

It is well known that job satisfaction has often been in the interest of the organization and the

management; improved satisfaction is likely to stimulate higher productivity. Our frame of reference, however, gives us a more powerful instrument. When all tasks, even the computerized ones, are regarded as human acts, we find it reasonable to regard all these tasks as one entity. An interesting object of analysis now is how these tasks are organized. Which tasks are performed by means of the computer and which are not? How are errors detected and corrected? How is work in exceptional situations handled?

1.4 Plan for Supporting Learning

We do not use the concepts "teaching" or "training," but rather *supporting learning* in order to emphasize the nature of our educational intervention: the users are regarded as learning subjects rather than objects of training. The goals, content, and method are presented here. A more detailed description of the educational intervention, within this particular case study can be found in the next section. Not only the actual description of each phase, but also its motivation, purpose, and some results are given. The steps are also evaluated with regard to the goal settings according to the recording/measuring performed.

As was stated above, we think it is necessary for users to have a reasonable overview of the IS and to understand its meaning to the organization. Our goal with the education is

o to provide the users with both theoretical understanding and practical ability
o to improve the use situation without any technical changes in the IS
o to make communication visible when it is mediated by the computer
o to help the users perceive the role of communication when coordinating tasks
o to make the workers aware of the importance of knowledge work for themselves, the department in question, and the whole organization

We have chosen to provide the users with visions about the IS as a means for mediating organizational communication and thus coordinating tasks. The IS, its use, and various use situations are presented as inherent parts of jobs. A very central goal is emphasizing the importance and contextual meaning of all jobs and the organizational dependencies between different jobs and tasks. Besides selecting the contents in a specific manner we also

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wanted to minimize the time necessary for the education; the intervention is planned to require just two working-days. The contents of our learning program are:

o presenting the view of an IS as a personal or collective tool-like facility for communication and, in that sense, for coordination of tasks
o explaining the available applications of the particular department in the context of the organization, its IS as a whole, and the subsystems and their interconnections
o clarifying the idea of communication mediated by computers
o explaining and answering questions about general EDP-knowledge when necessary or when asked

When composing our educational method we have paid attention to different *cognitive styles*. Various styles of teaching strengthen different learning processes: we have used visual, auditory, and activity oriented techniques. We base our approach on the idea of individual activity, learning by doing, and the importance of dialogues and discussions. There are different kinds of knowledge and different kinds of techniques/methods will be needed for supporting these. Three kinds of knowledge can be distinguished: *factual knowledge, skill* or *proficiency*, and *tacit knowledge*. Factual knowledge can be "learned in or taught out" by ordinary lectures, and skills by training. Tacit knowledge, on the other hand, is something very difficult to articulate: it evolves from experience, observations, feelings, maybe from intuition. Tacit knowledge constitutes an essential part of a person's qualifications in working life. If it is possible to mediate this kind of knowledge at all, it is surely not by lectures, but perhaps by discussions and by doing. Consequently, we have chosen techniques for supporting learning, techniques which facilitate communication between people and which require activity of all participants. The whole method for supporting users' comprehensive learning consists of five steps which are discussed below.

Interviews and other preliminary investigations are conducted to collect background information about the organization and its IS. In order to get acquainted with the users and their jobs, we interview them and observe them at work. We collect data about the users' attitudes towards the IS and about their ability to use it before the actual education starts. This is important for the assessment of the effects of the intervention. An investigation like this can serve educational purposes as well: besides providing us with information, it may start an autonomous learning process.

Group discussions can be used as an educational technique. In addition to discussions with individuals, it is helpful to hear collective opinions, apprehensions, and wishes. An important goal in this phase is to emphasize the role of interdepartmental knowledge and understanding. One necessary condition for motivating and starting theoretical learning is that the workers get a total picture of the work processes and of the connections to their own job tasks within these. Group discussions are well suited for the purpose.

The main goal with *lectures* is to give the participants some general knowledge about the organization and its IS. This will, though, adopt the workers' point of view and concern just the specific organization in question, not any detailed EDP-knowledge. The total picture of the work process and the communication aspects discovered during the group discussion are elucidated and summarized. Lectures also form the theoretical introduction to further activity.

The next step is *simulation*. It includes role-playing, simulation of the computer's working principles, discussions and short presentations. The most important function of this phase is to make the discussions from earlier steps concrete and obvious, and to provide theoretical knowledge, although embedded in the context of action. Cooperation between different departments and the role of IS as a mediator of communication are stressed. The IS often appears as a *black box*, and this is an attempt to create transparency. Simulation shows what happens within the IS, e.g., how data is picked out from different files (database) to support the tasks people perform with the help of information from their terminals.

After these phases it is possible to give the users an ordinary theoretical interpretation of the IS and its functioning. As the workers adopt some terminology and theoretical EDP-knowledge, they have better qualifications to discuss EDP-related problems and further development of the IS.

Personal guidance consists mostly of hands-on training and follow-up at the terminals. This is done immediately after the earlier phases as well as after

some "digesting" time has passed. The purpose is to improve the users' ability to utilize all the existing functions in the accessible applications. This step also gives us valuable data on the users' progress.

In various contexts we have stressed our vision of ISs as mediators for organizational communication and coordination. This is important in order to make the real actor recognizable and the formal versus informal spheres of responsibility visible. An overview as well as a tool-like apprehension of the IS are other essential matters in this context. Education which treats only EDP and ISs is consequently not covering enough. We state and will demonstrate that our approach with all the steps taken together provides the users with the necessary knowledge to utilize and manage the existing IS. Both theoretical understanding and practical ability are needed and are supported by the learning program. The content of the education assures that the users are aware of the cooperative character of their actions with different organizational levels both horizontally and vertically.

2. SUPPORTING LEARNING: A CASE STUDY

The organization in which this case study was carried out is in the food industry. Our particular case is the inventory department, but other functional units are included. The so-called secondary departments are the order processing department, the manufacturing units, and the packing department, due to the close collaboration with inventory. Some connections to the export department, subcontractors, and customers have been of interest as well.

The inventory department is divided into two distinct sectors: the bulk inventory and the buffer inventory. The former serves as a long-term stock, the latter as a short-term one. The bulk inventory functions are computer-supported; for example the FIFO-order of stored goods is taken care of by the computer. Also the organization of shelf position usage is computerized. These two sectors are tightly interconnected, and thus the workers are tied to continuous cooperation. Some computerized functions, which influence the labor processes in the inventory, have been distributed so that task coordination with, for example, the manufacturing and packing department is unavoidable. The inventory department, on the other hand, is responsible for storing the products as well as for distributing them to customers. Some lots arrive

from subcontractors, some from the organization's production units. As a consequence, a rather complicated network of tasks and task priorities can be seen.

In this case, all persons whom we interviewed or whose work we observed were selected to participate in the education. This resulted in three parallel groups. In one respect the composition of the participant groups exhibits adaption to the specific conditions within the organization. The groups were organized so that they all would be as homogeneous as possible. Here homogeneity means

o groups of approximately equal size
o participants from all departments concerned
o participants from different organizational levels
o same groups throughout the course of group discussions, lectures, and simulation

It is important to pay attention to the wide range of users who participate. Supporting learning covers many levels of the organization; knowledge of other worker's jobs and tasks accumulates throughout the hierarchy.

The educational occasions for all groups were as uniform as possible. The group discussions, lectures and simulation were arranged on subsequent days. This schedule aimed at minimizing gossip which could have been harmful to the ideas in our method. The simulation phase was divided into two periods: first we explored ordinary tasks and then we concentrated on exceptions, special situations and errors.

All interviews, lectures, and group discussions were tape-recorded. This facilitates our empirical work considerably; we need not concentrate on making notes. Having exact quotations may help in drawing conclusions later.

2.1 Interviews

Interviews and other preliminary investigations were not originally regarded as something which should/-could be called an educational phase in our research work (it is, of course, basically analysis for further action). We do not stress their importance in the context of education now either, but our opinion has slightly changed during the process. The preliminary studies equipped us with information about our case, but it also started autonomous learning processes. Interviews and observations

especially seem to arouse interest in one's own duties and routines -- the reason and rationality of performing tasks in a certain way. Genuine interest brings sophisticated conclusions and relevant suggestions for change from within the organization. This observation justifies our choice of the concept "learning" instead of "training".

We started these investigations with one primary subsystem and expanded our analysis to the neighboring ones (snowball sample). This turned out to be necessary in order to trace the communication and coordination channels and procedures. A special area of interest to us is the management of exceptional situations. The communication and coordination aspects between workers, as well as cooperation factors, are highly visible whenever performances conducted in an erroneous manner occur. This is also the case with exceptional situations.

The current state of the system and its internal structure were first analyzed by studying available documentation (organization charts, job descriptions, memorandums, annual reports, program flowcharts, file schemas, menu layouts, user-interface descriptions, etc.), running the programs of the inventory application, and discussions with EDP personnel. Unofficial material was very useful. It showed local features of the IS, features which are not apparent when studying documentation for the system.

The analysis of the job structures, cooperation rules, division of labor and responsibilities, etc. was carried out by conducting discussion-like semi-structured theme interviews of users and managers. The results of the interviews were complemented by careful, non-participative observations in each department.

Consolidating the themes, whether in the context of the interviews or the observation, the main question to the users could be formulated "What do you do when taking care of your job, including robust strategies and fine details, routine and exceptions, here-and-now versus possibly next month, autonomous versus collaborative tasks, formal and informal, and so on?"

Analyzing and consolidating all that is created by using the investigation techniques mentioned above produces a certain picture of the current situation of the organization. All this is documented by means of various techniques such as ISAC-graphs (Information Systems work and Analysis of Change), tables for task properties, and thematic reports.

2.2 Group Discussions

The idea of arranging group discussions was motivated by the following arguments:

o discussions can confirm the analysis, assumptions, and conclusions made so far
o group dynamics and different roles can be observed
o collective opinions can be distinguished from those of individuals
o communicative and coordinative aspects of work can be considered together
o totally new information can be obtained
o future educational wishes and requirements can be determined

The purpose of the group discussions was educational as well as complementary to earlier research work. The treatment of the themes was directed so that it was specific to the current/future conditions of this organization. Themes for discussions covered the topics of interviews with individual workers (some themes specific to this phase were added). The setting was quite different, however. Collective opinions can be very different from those of individuals, and ideas produced together can be fruitful: the quality principle of group works and workshops becomes visible.

We aimed at maintaining a good atmosphere, free of tension, with discussion proceeding fluently. We adopted different roles ourselves. We had a "matter-of-fact" chairperson who was familiar to the participants, a "provocateur" who was well known, and an observer who was most distant.

The groups consisted only of users from the operational level of the organization. The decision to exclude management was reached by considering pure confidentiality factors. Presentation of some normally implicit ideas and opinions might have suffered from anxiety or a stiff atmosphere if we had not restricted the group membership.

The discussion topics were arranged thematically. For practical reasons, we started from difficulties in work (easy initialization) and tried to finish with future development (natural time dimension). The original themes with some subtitles are presented in Appendix 1.

In addition to being informative, the discussions aimed at supporting learning in the sphere of the topics treated. The result of the discussions could be stated as: The workers experienced immediate apprehension of several coordinative procedures, which had earlier seemed rather peculiar to them. Comments like "Oh, that is why I report this stuff to your department every day!" or "I did not know you also have such tasks in your job." or "It never crossed my mind that my doing this all at once might disturb your work!" were not rare. We gained support for our idea of increasing interdepartmental knowledge and understanding. These comments laid a solid basis for the next phases of our intervention: lectures and simulation.

The participants considered the group discussion phase suitable for obtaining *both* theoretical *and* practical knowledge. We were slightly surprised that the workers regarded this step as very useful for practical purposes as well. We had assumed that deepened general knowledge would be the main effect.

2.3 Lectures

The contents of the lectures were designed from a point of view which emphasizes perceiving the nature of the IS *in this particular subsystem* rather than special or detailed EDP-knowledge. Typical EDP-jargon was eliminated as much as possible. We divided the presentation into five sections:

1. The inventory as a part of the whole organization
2. Division of labor and tasks
3. Work and knowledge work
4. Communication and coordination
5. The computerized information system

The basic contents of the lectures, and our message in the context of each title, are described in Appendix 2. These topics contain ideas originating from our research theses in general and our principles of supporting learning in particular. Our approach was more contextual than specific to certain situations. Overall views and relations between organizational units were covered. Communication between workers for supporting task coordination was again emphasized. Division of labor between various instances and levels was focused on in order to deepen the analysis of coordination. The division of labor between humans and computers was of interest, since this has

significant consequences on different aspects and dimensions of communication.

As the inventory department is a functional unit in a firm, which in turn belongs to a group of companies, several courses of action are dictated. Some transactions conducted, as well as some formal features, may seem irrelevant or even disturbing to the end users. The information system appears to the users as a complicated network (where integration often hides *actors*), but an information flow tree can also be distinguished, though embedded. According to this background information, some concrete and visible consequences were presented in the context of everyday work situations. Some major functions from the point of view of the inventory department were presented, as well as many exceptional and erroneous incidents. Perceiving the existence of such major functions can facilitate experiencing some tasks and procedures in a new way.

The lectures were designed to present a theoretical introduction to the next phase: simulation. During simulation, cross-references to lecture topics were made. We wish to remind the reader that all phases in the course of supporting the users' learning were based on the earlier ones. So, in addition to our message, some "visions" mediated to the users originated from their own experiences and requests. Each group of users, forepersons and management invited to participate had one lecture session. Wall graphs were used to demonstrate departmental relationships and information/material flows within the organization (Figure 1).
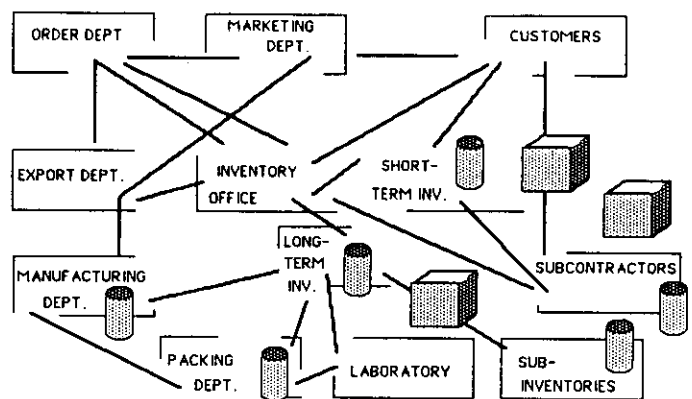

Figure 1. A Simplified Wall-Graph Layout over Departments and Outside Organizations Involved

According to the participants, lectures were adequate for acquiring general knowledge. Half of the inventory personnel ranked this step equal to simulation in this respect, so lectures are justified.

2.4 Simulation

The main goal with simulation was to make cooperation between different departments visible. The role of the IS and its function as mediator of communication was stressed. The simulation phase was designed for further exploring and analyzing the main functions and the exceptional and erroneous incidents which were presented in the lectures. One of our special goals was to elucidate the operative principles of the computer and to explain the algorithm for placing products in the warehouse. We also wanted to encourage participants' activity and to make them explain their work to each other. Role-playing was chosen to help them get involved and to guarantee wider and more fluent descriptions of job contents. This technique provides a high degree of involvement and action.

Simulation as a research method is not unique. It has long been used by engineers, work researchers and sociologists. Traditionally, simulation can be divided into three types: game simulation, field simulation, and role-playing simulation. There is also a distinction between role-*playing* and role-*taking*. We chose role-playing and added some ingredients of our own.

To conjure up the IS and, especially, departmental subsystems and their functioning in accordance with the division of labor and coordinating tasks, we operationalized this rather unusual method in EDP-education and training context. We manually built a model of the system and simulated the flow of information and material/products. Usually tasks are simulated by computerized prototypes, while we simulated partly computerized jobs manually.

Job tasks in the inventory department (and other closely cooperating departments in the manufacturing chain) were elucidated by simulating different events, where the participants performed their "normal" tasks. However, instead of using terminals, they communicated directly with each other, read documents belonging to the current context, and, if necessary, asked for instructions and made decisions. The heterogeneity within the groups and the homogeneity between the groups made cooperation between different positions and different depart-

ments visible and operative and also allowed comparison. A manuscript for the simulation was composed and, to get the "show" going, one of the researchers acted as a director. Where computer tasks were simulated, written lines were distributed to the "actors," but otherwise group members could improvise (they mostly played their own working roles). Roughly one working day was assigned to this step, but it was divided into two separate occasions.

The acts were designed to demonstrate the following functions:

1. Material and information flows (orders -> shipments)
2. Export shipments as a special case
3. Management of stock bookkeeping

The basic idea was to systematically proceed from the normal/usual transactions to more rare/exceptional/erroneous ones. A portion of the manuscript is presented in Appendix 3.

Act 1 was to demonstrate the normal case: all transactions flowed fluently without any unfortunate incidents. The workers had roles extracted from reality. We were slightly anxious about possible difficulties in engaging the workers in role-playing initially, so we took the first roles ourselves. Our anxiety about such problems was ungrounded, though.

Act 2 dealt with export shipments. Workers from different departments explained how export shipments influenced their jobs and how these were handled. The users from the order processing department were unable to participate in the simulation phase; therefore, their tasks were partially explained by other participants and the researchers assumed their roles and completed the descriptions.

Act 3 consisted of several parts. Normal production and its effects on stock bookkeeping and managing the flow of goods in and out of quarantine were illustrated by role-playing. Exceptions and special situations raised lively discussion. Consequences of merging errors were also exemplified: three serious errors and exceptions were mingled. This "tragedy" provoked some mirth, but the users did not deny that something equally horrible could sometimes happen in real life. A summary of possible faults and errors was made in advance (Figure 2) and a

COMMON ERROR SITUATIONS			
A parcel enters the main inventory without a parcel label			
A parcel label has a faulty product number			
A shelf position is empty when status information is 'occupied'			
A shelf position is full when status information is 'empty'			
Products listed on a consignment note are not available			
Customers receive wrong products and/or wrong amounts of them			
ERROR HISTORY			
ORIGIN	IMMEDIATE EFFECTS	CURE	LONG-RANGE EFFECTS

Figure 2. Error Analysis was Performed by Constructing Tables

discussion based on it was raised. Causes for different error situations and management of these were also discussed.

A meeting room served as a mini-world: a "model" of the departments concerned was built. The following items were used as demonstration properties:

o shelves with positions and position categorization
o parcels and mini-platforms
o original documents (parcel labels, consignment notes, etc.)

To present the IS and its functioning it was disentangled to pieces and converted to manual functions: electronic files to card files (Figure 3),

PRODUCTS
product #
product name
categories
parcels/platform
quarantine status
export status

CATEGORIES
category id.
shelf addresses

AMOUNT ON STOCK
product #
amt. on main stock
amt. in quarantine
amt. of advancies
total amount

ORDERS
order #
customer #
order lines
repeat order lines

INVENTORY BY PRODUCT
product #
shelf address

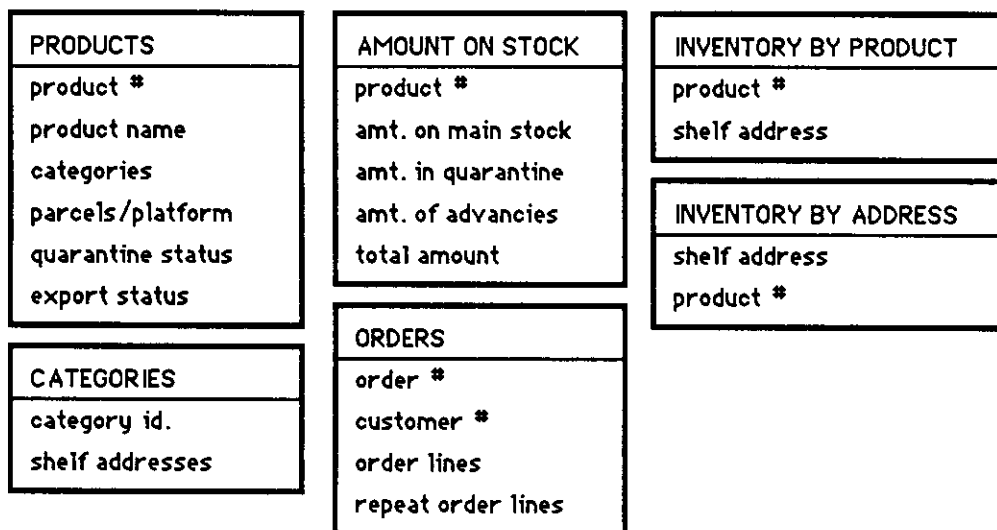| INVENTORY BY ADDRESS |
|---|
| shelf address |
| product # |

Figure 3. Radically Simplified Files

some important algorithms to rules written in everyday language, and computerized functions to human actions. Of course, not all files were converted nor all records included, but entities from the most essential ones were. In this special case, we considered it reasonable that researchers should take "the role of the computer." The EDP-system was *simulated manually.*

Short lectures were given to explain the logic of an algorithm which allocates places to products in the warehouse according to the categorization of the shelf positions. In order to demonstrate the functioning of the categorization, products were positioned in and drawn out of inventory. The categories imply on which shelves the product in question may be placed. Shelves belonging to certain categories are specified in the category file. The categorization is arranged according to

o parcel weight
o velocity of parcel circulation
o dimensions of parcels
o number of consecutive parcels of the same product entering at a time

Besides simulation and short lectures, the participants held discussions. Some of these discussions were spontaneous, some were "planned" in advance. The spontaneous discussions often resulted from unclear or contradictory situations in the role-playing. The discussions which we initiated dealt with such topics as errors and mistakes. The management of some penetrating functions (such as export shipments) concerning all participating departments were also treated this way. Wall graphs (Figure 1) were used to exemplify the information/material flows/sets. These were illustrated by using different colors, symbols, and short text comments. The graphs were also suitable resumes over the simulation acts.

We had planned that users, forepersons, and management from all departments concerned would participate. We considered this necessary, especially during this phase of the learning process, because one of the main ideas was to clarify the relations between the jobs and information flow. It should be possible to follow the whole process from order until the shipment is ready for transportation.

The aim of simulation was to make discussions from earlier phases concrete. Observations made during these occasions support our interpretation that this

goal was fulfilled. Another important goal was to make the computer and its functioning less mysterious. The workers feel more comfortable at the terminal; they request realistic improvements and have a better understanding of the communication characteristics (fewer errors in stock). This phase was primarily theoretical, which was the original intent, although a very concrete method of presentation was chosen.

2.5, Personal Guidance

Up to this point, we had not introduced the computer directly in our educational intervention. This does not mean that we consider hands-on training irrelevant. On the contrary, it is necessary for the users to master all their tools (including terminals) as profoundly as possible. We postponed this phase last in order to stress the importance of understanding prior to performing.

At this stage, we instructed the users individually: both ordinary use situations, exceptions, and error handling were demonstrated. For two weeks, we were present to assist and explain when problematic situations arose. We had terminal sessions for training and expanding the use environment. We did not suggest the creation of new applications but aimed at teaching the users to utilize the existing ones. We had designed five alternatives for additional support:

o encouraging users to ask for advice in a tricky situation (this can be followed by either personal or collective support)
o small-scale information "buffets" in immediate context
o small-scale information "buffets" arranged for treating chosen topics (for users concerned)
o presentations (somewhat larger) over particular topics (for everybody)
o intervening when it seems necessary

We chose a mixture of alternatives which support in-context activities and involve only those users who are concerned. We decided not to interfere with the flow of work by causing artificial incidents. The themes of some of the information "buffets" were:

o how to release the printer and the terminal and to restart the application
o how to "forbid" the computer to choose certain shelf positions or shelf position areas

o how to communicate with other users by utilizing free-format data fields

o how to correct information about the amounts of products manufactured and stored

The idea was to add sophistication to the use situation, to introduce some relatively unknown features, and also to facilitate the ordinary work situation. Abilities as simple as releasing the printer when it jammed (which happened frequently) can be of great use in everyday work. The supervision and follow-up of the use situation strengthened learning. It also gave us opportunities to observe the users' progress.

Personal guidance was designed to give practical help and was at the users' judgement. It has been successful, since many new inquiries and other possibilities embedded in the applications are now used. The error frequency analysis indicates that the usage of terminals has been facilitated.

After an educational program, the immediate results and effects dominate. These can be observed, evaluated, and even measured. Recording is often conducted at this point. Measuring the results of training usually implies conducting knowledge or ability tests of different types. Within cognitive pedagogy, another kind of evaluation is stressed: analyzing the effects within the participants' "home situations." This means *effect evaluation*, i.e., recording changes in the work situations and in the participant's job satisfaction, caused by learning. We consider the effects on concrete work situations to be of greater importance both for the workers and the organization than the immediate training results. These effects are visible only after some time has passed. Consequently, we have planned personal follow-up later on. We expect these long-range effects to be characteristic of our approach for supporting users' learning.

3. EVALUATION

We are interested in the usefulness and acceptance of the approach and each step, since further development and improvement will hopefully result in an educational method for general use. Both immediate results and long-range effects of the intervention are evaluated. We pay attention to users' apprehensions which are important when discussing acceptance. We also rely on more

objective measures such as checking changes in error occurrences.

3.1 Methods for Evaluation of Results and Effects

We primarily use qualitative methods for recording changes, while our quantitative measures are few. Many, however, complement and overlap each other. This gives a better degree of significance for qualitative measurements. The following methods for recording/measuring are used:

o interviews

o observations

o questionnaires

o statistical analysis of error frequencies

o analysis of terminal utilization

Interviews were conducted with the workers before the intervention to obtain data on their individual apprehensions of the IS and their ability to use it. Their knowledge of the organizational dependencies with emphasis on information flows was also surveyed. These interviews will be repeated to record long-range effects. The workers' ideas of their EDP-connected working situations will be interesting. Forepersons' and management's opinion of possible changes will be solicited.

Observations were made in each department and during the group discussions, lectures, and simulation phases. After the simulation, an observation period of three weeks duration (not all or whole days) followed. As we gave personal guidance, we could follow user behavior and changes in the use situation. The observing purpose was facilitated by using particular structured forms. Observations before the intervention serve the same goals as the individual interviews. During the different steps we acquired information about the participants' motivation, their interest and activity, in addition to information about their knowledge of the actual questions.

In this case study we had two questionnaires. The first was used immediately after the simulation phase. We wanted to get the participants' spontaneous apprehensions of the method for each step: the treatment of topics, the usefulness of the content for their own job tasks and for their general knowledge. We were especially interested in their attitudes towards simulation due to its novelty. Users were asked to fill in the second

questionnaire six weeks after the personal guidance. The idea was that they would have time to summarize their experiences. This questionnaire treated personal guidance in detail. A request to evaluate the whole intervention was equally important. The evaluation was performed by marking answers in a matrix, where we asked for their opinions considering the suitability of the different steps for achieving practical versus general knowledge and their own preferences.

Changes in error frequencies are a useful measure of improved knowledge of the cooperative and communicative character of the job tasks as well as of the workers' practical abilities. We investigated error occurrences in stock bookkeeping. The stock is taken twice a year and observed errors in stock are continuously reported and corrected. We checked the corrections for two ordinary stock-takings; for the continuous corrections, we assembled data for four one-month periods. The check points were chosen with respect to how the steps of the intervention were scheduled. The number, type, and origin of the errors (corrections) were considered. These measures will continue in order to test significant trends.

We will measure long-range effects by analyzing how the users manage their terminals. The historical files on terminal usage give us a possibility to follow how much and for what purposes a terminal belonging to a specific person/department is used. Unfortunately, these files are saved only for one day, so we cannot get corresponding material for comparison with earlier usage. Other indicators enlightening the effects of the educational intervention are the workers' ability to adapt to new situations and to learn to use a new IS.

Different techniques for recording changes and measuring the results and the long-range effects of our intervention are thus utilized. In our opinion, a great variety of methods -- supporting, complementing, and overlapping each other -- are as essential as exact quantitative techniques, especially when human and social aspects dominate.

3.2 Recording User Apprehension

After the simulation period the participants (16 persons in all) were asked to complete a partly structured questionnaire. It included questions about their opinion of the education which had taken

place so far. A summary of the answers was made, and the result showed, among other things, that

o chosen topics were regarded as interesting by 69% of the participants, group discussion being the most (75%) and lectures the least (50%) interesting

o treatment of topics was suitably itemized (62%), simulation phase being the best (73%) and group discussion the poorest (62%)

o 80% of participants thought that the phases were useful for their general knowledge at the moment (88% for simulation and 77% for lectures)

o considering the possibility of a new IS, their opinions about the usefulness of the education was more cautious (71%)

o they had no clear opinion about the usefulness of the phases with respect to their own work at the moment (55%), and they were still more uncertain about the future use of it (50%)

o concerning their understanding of the functioning of the IS, 81% of the users declared that it had improved

Conclusions drawn from the replies concerning simulation demonstrate a positive attitude. It was regarded as perspicuous, easy to understand, relevant, and informative by 86% of those who answered. The usefulness of the technique is given by the positive reaction (79%) to the following:

o it helped to understand other workers' tasks
o it helped to understand the information flow
o it clarified the meaning of used information
o it taught new facts

The participants' attitudes toward playing roles were more reserved (57% positive answers), which is not a surprise. Playing in any sense is not generally and publicly done by adults in our society. A positive assessment of simulation is demonstrated by the participants' evaluation of the clarity of computer simulation (93%) and by their comparison between simulation and lectures (73%).

The participants were most disappointed with the absence of management, some forepersons, EDP-staff, and order processing department personnel. These persons did participate in some of the phases,

but not all. They had difficulty rearranging their duties and were unable to participate in all phases.

In the second questionnaire, we analyzed the users' opinion of the information buffets and the hands-on training. According to the answers (83%), new parts of menus were treated and were learned by this technique. These occasions were arranged in the ordinary working environment and this was experienced as somewhat disturbing (33% of the inventory personnel). The buffets were very short, so not all the users had the possibility of testing the new functions themselves. Such an opportunity would have been appreciated by 55% of the participants (83% of the inventory workers). The new menus are now used by 78% of the workers and 64% of them are capable of doing this without any help. This confirms the fitness for use of the new knowledge. When problems occur, the EDP department is called up by 77% of the persons, while the "manual" we produced is consulted by 69%. New practical skills were learned, but one result as valuable as this is indicated by the replies of those inventory workers (67%) who reported that using terminals is now more meaningful in the context of their total job tasks than it was earlier.

The users' evaluation of the entire intervention was also solicited. Group discussions and personal guidance were considered suitable for achieving practical knowledge (84%). For increased general knowledge, group discussions, lectures, and simulation were regarded to be better (86%). We asked the participants to compare this total educational method with two other, not unusual (in working life) ones: "trial and error" and guidance by colleagues. None of the users thought that the "trial and error" method would have worked, while 25% would have been satisfied by guidance from fellow workers.

3.3 Measuring Changes

Error occurrences in stock bookkeeping were analyzed by studying two different kinds of corrections: those in connection with ordinary stock-taking twice a year (type I) and the continuous ones (type II). The latter type of errors can be detected when some product ought to be shipped and a consignment note is written (because the bookkeeping shows plus), but no such products can be found in the inventory. We made our investigations according to the following schedule where the

educational phases are marked in their corresponding places:

preliminary investigations
type II for one month
type I
group discussions, lectures, simulation
type II for one month
type I
type II for one month
personal guidance
type II for one month

We studied changes in error frequencies. The total number of corrections decreased by 17% between the two occasions for type I stock-taking. We divided the errors into different types (small, medium, and large with respect to the number of parcels). From the beginning, no significant differences between the numbers of errors of each type were seen. By the next stock-taking, i.e., after the intervention (except for the personal guidance), interesting changes were observed. The number of medium size errors had decreased by 43%, they now constituted only 20% of the total.

Small and large errors can have varying causes. For the medium size errors, one essential cause can be *knowing*! When partial product pallets are placed in the inventory, the person taking the positioning addresses has to correct the default values of full product pallets. There had been difficulties with this matter; not all persons were able to manage the procedure. Stress and non-caring attitudes are possible reasons. However, we think the reduction in these errors indicates results from the education.

When analyzing these results for each department (inventory, packing, manufacturing), the inventory department shows the greatest reduction of error occurrences (32%). All types of errors had decreased, the medium size ones representing the greatest reduction (65%).

It is worth noticing that the quantity of products in the inventory between these two stock-takings had almost doubled. The new products are not included in the figures mentioned above. Their bookkeeping and stock-takings are managed separately, but they are placed in the same inventory and are taken care of by the same personnel, although by a larger staff. We had the opportunity of checking the corrections for these new products as well. The stock was not taken at the same time, but if we

add the numbers of faults for the new products and for the old products at the second occasion, the total number of errors increase, but only by 11%. If the number of products can be regarded as being proportional to the number of errors made, the total number of errors could have doubled as well, which it did not. Adding the numbers of the medium size faults of the old and the new products and comparing this sum with the original number at the first stock-taking shows that it has decreased (21%).

Type II corrections (continuous) show a different pattern. The total number of errors has not decreased, but is diminishing. Those departments which used their terminals very seldom before the intervention have increased their total number of errors. It can be explained by their having begun to use their terminal more. Thus, the risk for errors increases. Those departments where the terminal already was in general use before the education have decreased their total number of errors.

All types of errors, small, medium, and large, behave in an almost identical way. Between the first and the second measuring point, a "dramatic" decrease of errors can be observed: 56% (totally). On the next occasion, the numbers increase by 167% (new products have been included in the inventory). After the personal guidance, the number of errors again point downward (-5%). If we were to add the continuous corrections for the new products (taken for the same period as the old products) here, the pattern does not change, but the percentage does (-, 267, -24).

One explanation for the contradiction between less corrections in ordinary stock-takings and more for continuous corrections is that the errors are detected more quickly and more often, and are also corrected immediately. This can be a sign of both increased knowledge and of caring. Before drawing any definite conclusions from these measurements, we will check the frequencies for more periods.

Observations and discussions with the users after the education show many interesting results. Some persons are now very active and call the EDP department when problems occur. Some users became very interested in enlarging their repertoire of inquiries. They have further developed their ability of evaluating the quality of the user interfaces. We have been asked numerous sophisticated questions concerning the inventory application and EDP in general. These examples show that the users have

acquired both practical abilities and theoretical knowledge. Of course, not all persons have been as interested and developed in the same way, but all have gained more understanding. This can also bring forth some hidden problems. When a few of the workers managed the terminal work, they had to help the other workers with these tasks. They now ask everyone to do their own work, because all have equal education.

3.4 Summary

The results can be analyzed along two dimensions, temporal and spatial, which are not independent of each other. The temporal dimension ranges over immediate situations to long-term effects, while the spatial dimensions deal with questions regarding effects on one's own work environment versus dependencies between tasks and departments. The temporal dimension and the IS are thus coordinate, whereas the spatial dimension and the organizational structure are strongly connected. The results are summarized and grouped according to these dimensions (Figure 4). Contents of the different quadrants are listed below.

	mastering immediate use situations	understanding long-range effects of taken measures
personal work environment	I	II
dependences between jobs and departments	III	IV

Figure 4. Dimensions for Structuring Effects of the Intervention

Quadrant I (immediate use situations in one's own work environment)

o understanding that the organizational structure influences transactions and formal features
o knowledge of categorization principles
o correct use of existing menus (all)
o using menus in a more sophisticated way (e.g., combining inquiries)
o using new (parts of) menus

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o capability to use necessary menus without help from others
o ability to manage the terminal

Quadrant II (long-range effects in one's own work situation)

o increased general knowledge
o EDP-connected tasks regarded as meaningful
o correct use of existing menus (e.g., quarantine)
o using new (parts of) menus (e.g., contents of a shelf position)
o using free-format data fields
o asking for improvements in applications
o asking questions about general EDP-knowledge
o asking questions about inventory applications

Quadrant III (immediate effects on dependencies)

o increased interdepartmental knowledge and understanding (knowledge of others job tasks)
o increased knowledge of information flows
o understanding that the organizational structure influences transactions and formal features
o knowledge of categorization principles
o correct use of existing menus (e.g., prohibiting the computer from choosing certain shelf position areas, positioning addresses in advance)
o using new (parts of) menus (e.g., status information for products)
o capability to use necessary menus without help from others
o "refusing" to assist others in terminal work (because all have now received education)
o using free-format data fields
o increased contacts with the EDP department

Quadrant IV (long-range effects on dependencies)

o increased general knowledge
o increased interdepartmental knowledge and understanding (knowledge of other's job tasks)
o asking questions about general EDP-knowledge
o asking questions about inventory applications
o correct use of existing menus (e.g., correction of produced amounts)

We have kept as many environmental variables as possible unchanged. This means that no technical changes have been proposed or made in the IS. The official division of labor has not changed significantly either, but the number of employees has increased because of the enlargement of the inventory. The participant groups were the same

throughout the whole learning process. The educational situations have been as identical as possible for all of them. If the desired effects can be demonstrated after our intervention, these can be considered results of this method.

4. DISCUSSION

The educational intervention has been successful and the results support our goal settings. Both practical ability and theoretical understanding have increased. A better use situation, in some sense, has developed: the users utilize their terminals more often and for several purposes. The communication aspects of IS use have become more perceivable to the users. One very important factor is the workers' changed attitudes toward terminal work (more meaningful) in the context of their job tasks as a whole. We have reason to believe that the workers can now cope more adequately in *exceptional situations* and utilize computer support. Reports of long-range effects are few because we have not yet finished our investigations and will need to evaluate this information before making more definite conclusions.

The results give evidence to the theses and demonstrate that *defects in* the technical system, the IS, *can be partly compensated* by improved qualifications of the workers. We do not claim that the quality of the system studied had been low. Any system could be better in some respect, implementation and training could have been done better, etc. In our perspective, "defect" means a deviation of an idealized view of the IS structure which completely supports individual and collective work processes. It seems that only a few applications are so deterministic that they can be modelled without any residue and exceptions. People must take responsibility for such variances. Appropriate qualifications must be given to the workers if high quality performance at work is desired.

Once we have been able to record some changes, we should ask what has caused them. The *ceteris paribus* research setting, i.e., leaving the computerized IS and the organization of work unchanged, suggests that our intervention is an obvious candidate for this. It is true that experiments in social sciences cannot be controlled to the same extent as in natural sciences. With this reservation, we think that it is justified to make some conclusions which have relevance for the K&W research project and user training in particular.

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5. CONCLUSIONS

1. **It is possible reconstruct an alternative view of the IS which emphasizes its relation to work and collaboration. Such a view can easily be conveyed to the users of the system.**

This conclusion is directly confirmed by what the users have told us and what we have seen in their actions. The ease with which this is conveyed to users is based on their familiarity with their tasks.

2. **The use situation of an IS may be improved by improving the users' qualifications *alone*, without modifying the technical system, not even the man-machine interface.**

This statement emphasizes the importance of user education and training. It is often a neglected, even an ignored, task. Yet comprehensive learning may prove an effective, perhaps a profitable, (sub)-strategy in any system development project, not only in reducing the resistance to change (i.e., affecting the attitudes), but also in creating necessary prerequisites for appropriate use. This conclusion is stressed by the fact that the time required for each user was less than two working days.

3. **User education can be successful even when the technical content is rather small and partly replaced by the material of the role of the IS in work and coordination.**

This statement makes us suspect that traditional, technically oriented introductory courses still dominate the market of user education due to the strong supply rather than the demand based on a real need.

6. PROBLEMS

Even if we think that the experiment with our approach was successful, we are well aware that it is by no means a final product. But if we develop it further to be applied in other organizations and as an independent education technique, we should analyze carefully the problems encountered in our approach. At least three problems are obvious:

1. **It may be (and actually was) difficult to free the users from their duties to participate in the education.**

Problem 1 is not very serious. It must be solved independently of content or method of education. If we are to provide education, the participants must be able to participate. In the world of employers and employees, this is likely to take place during working hours. A natural solution is to be found in a strong commitment by management. This may be achieved when the approach is sufficiently established, i.e., its costs and benefits can be demonstrated.

2. **The basic analysis of the existing IS and the work system (division of labor, coordination, etc.) was very resource consuming.**

Problem 2 was not an obstacle in this particular case, because a useful description of the IS and of the work system was readily available. The K&W project, with its public financing, had performed the analysis for other purposes. However, it is doubtful whether any organization would be willing to pay the real cost of such an analysis as part of an education program. The solution to this problem must therefore be based on finding other benefits for performing the basic analysis. This idea points in a certain direction.

The basic analysis must be integrated with system development. If an old IS is to be developed, its structure and functioning must be analyzed (if it is not already extremely well documented). Furthermore, if we want to apply some of the principles of our project (see Section 1.2.), we must analyze the tasks, jobs and coordination in order to be able to make a new, preferably improved, job design. This strategy of integration of education and system development opens two new possibilities: 1) the structure and functioning of the future IS may become better, and 2) the future users participate actively in the analysis, which makes the analysis a simultaneous user participation and user education. In doing this, the variety of different techniques we experimented with may be utilized creatively. An interesting aspect is that this integrative strategy will probably need less external expert intervention. The people inside the organization, unlike external intervenients, know much of the work and its organization in advance. In addition, they do a large part of the analysis as part of the education.

3. **Planning many different phases of the educational approach was resource consuming. This was true in particular for the simulation phase.**

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Problem 3 is, like problem 2, a question of resources. In our intervention, even this problem was actually solved by means of external financing. We must remember that the education presented in this paper was an experiment, where the intervenients learned continuously. The problem will never disappear totally, but two alternatives for a partial solution emerge. 1) Some parts of the approach may be streamlined. This has obvious limits, since streamlining will probably be different in different environments. The adaptation always has its price, as here, for example, in adapting ready-made software packages. 2) The users may be asked to make the work themselves. If they know the objectives and the rules of the game, they certainly can act themselves. They need a director, but not a ready-made manuscript.

Finally, the significance of the theoretical frame of reference should be emphasized. The basic idea of the essence of the IS as something social rather than technical leads to a certain view of desired properties of the IS. Reinterpreting integrated ISs as comprehensible parts of work has important consequences on users' qualifications. This further determines the emphasis in the educational intervention, the central topics and techniques for supporting users' comprehensive learning.

7. ACKNOWLEDGEMENTS

ENDNOTES

Editor's Note: An extensive bibliography for this paper is available from the authors.

APPENDIX 1. GROUP DISCUSSION THEMES

1. EDP -- for better or for worse?

   o in this organization and in general
   o user qualifications
   o users versus EDP-department

2. Errors and mistakes: because of users or computers?

   o reliability of EDP
   o flexibility of EDP

3. Learning to program versus general understanding over EDP

   o end-user computing
   o an integrated IS in use

4. Work is not only EDP -- or is it?

   o organizational changes
   o job rotation and EDP
   o technical development in general

5. Do workers need, want, or have to know something about other jobs?

   o communication and coordination
   o foreperson's and management's knowledge
   o consequences of errors and mistakes

6. EDP-training in this organization

   o experiences and opinions differ
   o learning by doing

7. Future education/support to learning

APPENDIX 2. LECTURES

The inventory as a part of the whole organization

The major functions from the point of view of the inventory department, both logically and functionally, are

o the flow of transactions from the order processing department on, until the shipment is ready for transportation -- especially collecting the items that have been ordered
o management of stock bookkeeping
o management of the FIFO-order of the goods

The list has to be interpreted so that, although the workers of the inventory department do not directly take care of all the tasks included in these functions, their impact on the job contents is considerable.

These tasks or duties constitute also a source of problems and errors. The tasks are to a large extent performed by means of EDP, but the IS is far from "watertight": introducing new options and functions may disturb integration. The result is a puzzle, which is influenced, for example, by the following (more or less regular) incidents:

o arranging shipments directly from subcontractors
o managing the flow of goods in and out of quarantine (food industry)
o managing export shipments and export quarantine as a semi-autonomous process
o managing minor defects of the FIFO-order
o coping with inadequate shipments in case of contradictions between the automated stock bookkeeping and the real situation
o coping with advances (goods are sold before they are manufactured)
o transferring goods *logically*, not physically, from one subinventory to another (performing bookkeeping tricks)
o doing "the whole thing" without EDP support: the computer system can go down, or it is completely jammed and cannot provide assistance in urgent situations
o knowing or finding out what to do and how to do it in new situations

Organizing the tasks, managing exceptional situations and mistakenly conducted performances, and trying to cope with the integrated IS at the same time is not always simple, especially when knowledge and responsibility of the transactions and material flow have been distributed as they have.

Division of labor and tasks

The way of dividing the tasks has consequences in terms of job contents. Automation often causes fragmentation and alienation, especially in those cases where the "computer chooses first." Designing meaningful and attractive jobs which are neither too complicated nor simple and dull requires special attention and care. People should be able to choose first. The division of labor appears in this organization on several levels, all of which are affected by the existence of the computerized IS:

o workers (e.g., the foreperson, a chaser)
o groups of workers (e.g., chasers, truck drivers)
o departments (e.g., the inventory, the packing department)
o *people and the computer*

Not everything can be formalized for automation. Further, all formally describable tasks *need* not be automated. In this subsystem, much routine work has been computerized and large amounts of data are stored. Many tasks which would give the jobs some flavor of autonomy, and the jobholders a feeling of power and/or control, have been automated. Some residual tasks have been created. In the sphere of the

inventory and its neighboring departments, hardly any jobs exist which would not directly or indirectly contain computerized information tasks.

As mentioned earlier, many new and exceptional situations occur. Managing these requires concentration, communication with other workers in order to coordinate tasks, and inventing new strategies. Many arrangements for surviving can be seen, as well as clues to an informal organization. The four-level division of labor with a computer creates a rather challenging environment. Work is sometimes done in a satisfying way applying *rules of thumb*. Much of this work could also be called invisible: it becomes visible only if it is left undone. Here, a good overview and general knowledge about the transaction flow are valuable qualifications. The computer is a good tool, but its capacity, creativity and intelligence is limited compared to those of a human being.

Work and knowledge work

No matter which jobs in these departments are in question, several kinds of tasks can be distinguished in each:

o planning tasks
   -- the foreperson: planning the throughput
   -- the forklift truck drivers: rational collecting of goods
o decision making tasks
   -- everybody: managing without the computer's support
o operational tasks
o *knowledge work*

Adjusting to one's everyday duties creates an atmosphere of routine work. In the inventory department, the main tasks appear to be simply transferring material goods from one place to another and sometimes using the terminals for *data* input/output. As a matter of fact, however, the work would not get done and the flow of transactions would not proceed fluently without knowing how to do things and finding necessary information, having experience, being able to solve tricky situations and plan new strategies, and understanding what is being done and why. This can be called knowledge work, in addition to the other kinds of tasks everybody has.

Parts of knowledge work have here been computerized (stock bookkeeping, the FIFO-order of goods, giving the products positioning addresses in the inventory according to shelf categorization, etc.). However, knowledge work has not vanished altogether. Daily work does include knowledge-oriented tasks by definition, and when the computer is not in use, the workers have to take over these tasks as well. It is a question of reconciling data or information with the current reality. Ultimately it is the workers who can, do, act, know, remember, communicate, coordinate, and so on. Being conscious of this is important.

Communication and coordination

Discrete tasks have to be coordinated. This is often carried out by means of communication. Communication for coordinating tasks can be performed by the computer or directly (person-to-person). Computer mediated communication is frequent in this subsystem: we only need to think about the stock bookkeeping again. Here, data (within the same domain) input, output, and usage happens in different departments, is conducted by different persons and for different purposes (amount in stock: consignment notes, production planning, marketing, etc.) One piece of information serves many integrated ends and it has to be available with or without the computer: if information does not flow, the products will not either! Communication in this sense takes place at many different levels of this organization and has several dimensions:

o users in the same department
o groups of users in the same department
o single users in different departments (neighboring and more distant)

o whole departments in a functional sense
o own functional units and outside organizations (customs, customers, subcontractors, etc.)

The computerized information system

A computer is more than a set of equipment and software. It is an issue of organization culture and a component of a wide-ranging entity: an IS. It is a tool or an instrument for performing information tasks, a very sophisticated tool, the use of which requires special qualifications. Besides well-known dequalification and skill polarization, certain requalification trends appear. In addition to general EDP-knowledge, users should understand how the IS really functions. This is, first of all, knowing what happens and where: knowing, for example, how tasks are related to each other. Comprehending the connections which are embedded in the integrated whole is knowledge of a pragmatic nature, not theoretical.

Making the IS perceivable to the users can be achieved during the systems work process by participation. The prerequisite qualifications for this are often quite vague and this is why participation becomes difficult to operationalize. Some other reasons may block participative design, such as organizational tension and conflicting interests. Participation or not, general knowledge about the working environment has to be obtained in order to create meaningful and comprehensible jobs and tasks. The simulation phase will focus on enlightening the functional and structural connections and their consequences in terms of integration within this organization.

APPENDIX 3. SIMULATION

The algorithm controlling shelf position usage and the FIFO-order of goods

Lecture: All steps of the algorithm have to be explained. They have to be written in everyday language, and these rules have to be visible when the algorithm is used in a scene. A scene is the context in which concrete examples are given.

Goods are collected from the buffer inventory and the bulk inventory

Roles: forklift truck driver (bulk)
forklift truck driver (buffer)
computer

Properties: shelf position card index (according to products)
shelf position card index (according to shelf positions)
bulk inventory with goods
a consignment note
folders

Scene: The forklift truck driver has a consignment note. He is supposed to tell everybody how he plans to collect the goods and construct the shipment. He collects the goods and marks these lines in the consignment note, until something cannot be found in the buffer inventory.

1. He then goes to the computer (a person) and gives the product number and the amount of the product that is needed from the bulk inventory.

2. The computer browses the card index with shelf positions (according to product numbers) and chooses all cards which have this product number. He (the computer) takes out as many cards as needed (the oldest ones) -- a certain amount of each product is stored in one position.

3. The computer browses the card index with shelf positions (according to shelf positions). All cards which have the shelf position mentioned on the cards selected during Step 2 are treated: the shelf positions are marked empty and the cards are returned to the empty-card-department in the index.

4. The cards selected in Step 2 are now given to the forklift truck driver (buffer). He gives them to the forklift truck driver (bulk).

5. The forklift truck driver fetches the products from the bulk inventory and brings them to the buffer inventory. The cards which served as a memo list are disposed.

This is done with every product, if enough cannot be found from the buffer inventory. When all lines on the consignment note have been marked, the forklift truck driver signs the note and puts it into a folder for further action on it.

Direction: The connections to the previous scene and to the following one have to be pointed out. The fact that a person executes all the computer's tasks should be emphasized. Care has to be taken that the computer acts clearly. The forklift truck driver has to be asked to explain what happens if he receives from the bulk inventory slightly more products than immediately needed.

Goods are temporarily stored somewhere else, and the shelf position card indexes are useless.

Discussion: The workers concerned are supposed to explain this, particularly on behalf of their jobs and their departments. They should tell what happens, where, why, how, when, and by/for whom.

Direction: Everybody has a right to have enough time. The discussion should follow the flow of real transactions.