

# Participation of Heterogeneous User Groups: Providing an Integrated Hospital Information System

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## ABSTRACT

Integrated information systems require new approaches to participatory design because of the heterogeneity of the user groups involved.

This applies especially to the context of work settings with complex cooperation and joint tasks as in hospitals. Integrated systems for these work settings should provide explicit cooperation support besides „simple“ integration of sub-systems. Since joint tasks consist of a number of individual tasks being performed by workers from different departments and professions in close cooperation, the understanding of the underlying cooperation needs the contribution of representatives of each participating department. This requires new techniques for the active participation of heterogeneous user groups.

Thus, in this article we evaluate experiences with heterogeneous user groups and present such techniques developed and applied in the context of a cooperation project with a hospital. These techniques visualize cooperation in joint tasks and help identifying different interests by means of representations directly understandable to users.

## Keywords

Heterogeneous user groups, joint tasks, integrated system design, hospital information systems, cooperation pictures, point-of-view pictures

## INTRODUCTION

To support complex cooperation contexts in organizations integrated computer systems instead of stand-alone systems are necessary. Complex cooperation contexts are characterized by tasks in an organization consisting of a large number of individual tasks and responsibilities. They are performed by employees from different departments and professions in close cooperation. The necessary coordination of the individual tasks takes place through explicit or implicit arrangements and has to provide the space for situative adaptation. For this kind of tasks we introduced the notion of joint tasks [9].

Designing an integrated system for a particular organization requires attention of the following facts. The domain for which a computer system is sought, is divided in different sub-domains each being represented by different

user groups. Each user group has its own profession and its own perspectives. Due to the differences in responsibility and tasks these groups compete or are to a varying degree able to assert themselves against others. Each group is interested in an optimal support for its own work field whereas aspects of integration are less important. Also the factor time introduces additional pressure. Each domain wants to be autonomous and be served immediately (or first). Waiting for an integrated solution seems to be a less valuable goal. Also external factors come into play. New legal requirements need immediate system solutions or system changes in sub-domains. Consequences are often stand-alone sub-systems without any support of joint tasks.

Therefore the design of integrated computer systems requires the involvement of heterogeneous user groups and the balance of their different interests. System designers have to be aware of the following questions:

- Who is the *advocate* of an integrated solution? Is she or he *powerful* enough? What kind of *other perspectives* have to be taken into account?
- How are the *heterogeneous users organized* themselves? Do they convene meetings to analyze and organize their cooperative work?
- Why is *integration* important? What does integration mean other than data exchange across system borders? Is *cooperative work* to be supported and how? What are its characteristics?
- Are the problems, particularities and requirements for cooperation *understood* on the user's side or is the situation somewhat *inscrutable*?
- How much focus has to be placed on *existing sub-systems*. Can they be discarded for the integrated solution? How *close* are *sub-domains* related?
- What implications brings a search for an integrated solution with regard to the whole *way of proceeding*? What kind of organization of the analysis and design process of the information system is required?
- What kind of additional effort for participation - different kind of *meetings*, visualization and feed back *techniques* etc. - has to be taken esp. concerning supporting the participation of *heterogeneous user*

groups?

On the background of a cooperation project with a hospital selecting/ designing an integrated system (with an emphasis on the clinical section) we want to address these questions. After some project experience (mainly during requirements analysis) we have to point out that integrated solutions with the involvement of heterogeneous users have special impacts on the way to proceed. Furthermore, they require advanced techniques for participation.

In this article we focus on new techniques we have developed and applied in our project context. These techniques were used to gain an understanding of the manifold requirements for an integrated system. They help qualified users in learning about their own organization and they support designers in elaborating together with users on knowledge about the integrative nature of the future system. Additionally they support the process of weighting the importance of existing subsystems, support of the cooperation or strategies in defining sequences of system versions.

The techniques which are presented here are founded on the tradition of evolutionary system development, in particular STEPS (Software Technology for Evolutionary Participative Systems development) ([5][6]) and the Tools&Materials approach ([2][12]). The emphasis and aims of these approaches lie in evolutionary software development, based on a cyclical process model, in the support of a participative communication and learning process for the developers and users alike, on the emphasis on the use context which means an interlacing of system design and organizational development, on a task oriented requirements analysis, oriented on the tasks of organizations instead of system functions as well as in the support perspective which is expressed in the leitmotif of software workplaces for qualified human activity and views the user as the expert ([4][7]).

The paper is structured as follows. Section 2 describes the context of and the proceeding in the hospital project. Section 3 elaborates on the specifics of the integrative nature of the desired system. It focusses on the cooperation required in the special work context, introduces the notion and characteristics of joint tasks and gives a concrete project-specific example. Section 4 introduces the analysis technique of Cooperation Pictures for visualizing highly cooperative work settings with joint tasks. From the background of the project it is described to what extent this technique is as useful for an increased understanding of the developers as it is for the feedback with heterogeneous user groups. Section 5 introduces Point-of-View Pictures which visualize different user interests for given topics. This technique initiates interchange of perspectives or desires concerning future system support based on criticism on current cooperation practice. Section 6 summarizes the results.

## THE PROJECT SCENARIO

### The Project's Environment

The subject of our cooperation project is to support the decision finding process of a hospital regarding the

development and/or selection respectively of an integrated Hospital Information System (HIS) in the clinical sections and planning the configuration and use of this HIS in the light of changing demands. The cooperation partner is a small acute care hospital with 230 beds and 560 employees. The assignment of the project is embedded in the organizational development in the hospital which is taking place with the participation of all groups of employees from the different departments: internal medicine, surgery, anesthesiology, nursing staff, administration, maintenance/technical support. These will be the future users of the system. The involvement of the users in the development and/or selection of the system is presumed and supported methodically.

The situation in the hospital at the beginning of the project in September 1995 was characterized by the existence of stand-alone systems in some parts of the hospital. The administrative department has been provided with a closed software system for some years already. Some computers exist at the different functional workplaces of the internal medicine department like in the X-ray department, the ECG unit etc. They have no access to the patient data of the administrative system, though. In the surgery department it was just begun to introduce a software system which is likewise not connectable.

The project was triggered by a new health care law in Germany which was passed in 1993 and discharged the financing of the actual expenditures of the hospitals for a recompensation of the performed deeds. This brought along a strong intertwining of clinical and administrative data. In view of that, the focus of the project lies on finding an integrated software system with an open interface that allows the access and use of data in different departments. Thus, a continuous registration of case dependent performances becomes possible. This integrated solution aims at supporting the cooperative work in the clinical departments as well.

### The Hospital Project

The course of the project was planned in four partly parallel activities, each of them concluded by a workshop:

- the *task oriented analysis* of the work practice by means of interviews and group discussions on the basis of scenarios and glossaries;
- the *requirements specification* based on system visions with consideration to the required organizational development and the existing hard- and software systems;
- the *market analysis* of the available software systems with regards to adaptability, extendibility, usability and data security. In the context of this activity pilot systems are to be used and evaluated;
- the *decision process* whether a cooperation with potential software producers is wanted and if so in what frame. The cooperation may either consist of the adaptation and integration of package software or of a customized solution for the hospital.

A period of nine months was estimated for the project.

Since gaining an understanding of the tasks and of how they are accomplished in the users' world is of paramount importance for an integrated system, we will describe the act of analyzing the current work practice and the experiences resulting from it. We shall justify the need for additional techniques for the involvement of heterogeneous user groups.

### **The Course of the Work Practice Analysis**

At the beginning of the project we took stock at the site of the hospital in order to get an impression of the existing situation and to hold preliminary talks. Next was the establishment of the project which defined the frame of the cooperation with the users and the kind of feedback of results. The list of planned interviews was passed. We also presented the planned project at a meeting for all employees in the hospital which was organized by the local members of the trade union. Subsequently interview guides were developed for each planned interview which were to be held with representatives of each of the different departments. In these interview guides the topics and questions to be discussed were collected.

Altogether 20 qualitative interviews with people from the hospital were held at the corresponding workplaces. The interview partners were chosen following the concept of the functional role [11]. A functional role is classified by a collection of tasks for which a person or a group of persons is responsible. From these interviews scenarios were extracted which describe the present way of accomplishing work tasks with the means and objects of work in the professional language of the users. In addition a glossary of the technical terms was produced. Scenarios and glossary were fed back to the interview partners and revised. For the feedback of joint tasks in the course of the work practice analysis, two workshops were carried out with the participation of the interview partners as well as members of the installed project group of the hospital.

### **Experiences with the Work Practice Analysis**

The techniques used in the course of the work practice analysis, i.e. interviewing, orientation on functional roles, production of scenarios and glossaries, and feedback were helpful to gain an understanding of the tasks of the application domain. At the same time, through the use of these techniques a process of learning and communication among the people involved was furthered. Thus, the problem setting in the singular departments for which a software support is sought could be worked out together with the employees concerned.

Nevertheless, in the course of the project it became apparent that it is necessary to look at tasks that expand to more than an individual workplace or to the inter-

locking of a few workplaces. From the many single interviews we gained an increasing understanding of the joint tasks in the hospital. We recognized that joint tasks require an integrated information system. At the same time we noticed that we were lacking techniques to feedback joint tasks to the different user groups concerned.

### **COMPLEX COOPERATION AND JOINT TASKS**

To illustrate the necessity of cooperation support in integrated software systems in the medical domain, we will give an example of a joint task. Figure 1 describes in a largely simplified manner a patient admission to an internal nursing unit. It requires the cooperation of the organizational units admission office, nursing unit, functional departments, laboratory, archive, kitchen, gate, secretary of chief physician, administration and senior physician on duty.

An extended characterization of joint tasks follows. As an aside we want to remark that these characterizations are identified in the area of clinical care. Nevertheless, these characterizations match situations which are found in other application domains like servicing airline passengers or hotel guests.

- Joint tasks require the cooperation of a multitude of people from different occupational groups often with a variety of fields of activity, e.g. administrative employees, nursing staff, radiology technician, surgeon, internist, anesthetist, and so on.
- Joint tasks require a high degree of flexibility since their accomplishment is dependent on external factors like the patient's condition.
- Within joint tasks a multitude of singular activities are performed solely for coordination purposes, e.g. passing objects, especially documents, processing knowledge for information sharing, coordinating appointments, allocating resources or marking urgent changes.
- Joint tasks are characterized by group workplaces, e.g. wards or functional departments. Group workplaces imply that a set of single steps belonging to a joint task and performed by a functional role are not necessarily carried out by the same person. Therefore, this emphasizes once again activities for information sharing and synchronization.
- Joint tasks need actors who have a clear understanding of the flexibly required activities to be performed ([1]). Indications for starting activities are for example the location and status of a document (e.g. a partly filled out X-ray form for signing in the mail-basket) or stipulated signals (e.g. a rider on the patient record which signals a change).

The admission of a patient to the hospital is usually initiated by a call of a general practitioner or the central hospital bed registrar. The calls are received either by the admission office or the senior physician on duty. Each morning the admission office provides a list with all available beds. The senior physician makes himself knowledgeable about it. The allocation of beds is made by the senior physician and the admission office in close cooperation.

When a patient arrives at the hospital he usually brings with him an admission sheet from the general practitioner on which the diagnosis is stated. The patient signs an admission contract and is being questioned regarding his personal data. He receives his admission contract and stickers on which are printed his personal data and walks to the nursing unit. The admission of patients usually occurs in the morning.

On the unit he is questioned further by a nurse. She fills in a sheet about his physical condition and starts the patient's record. She enters his name on several tables for overviews of bed usage, telephone numbers, diagnosis and treatments. She passes on a menu card of the patient to the kitchen.

The responsible resident physician examines the patient and fills in a physician's order sheet. The nurse copies all the doctor's orders into the patient's sheet. For the (routine) examinations ordered in the course of admission she fills in the order entry forms, hands them to the physician for his signature and delivers them to the corresponding department e.g. X-ray department. She labels the blood tubes for the blood tests and also fills in order sheets. If the patient was previously admitted to the hospital she calls the archive and orders the old patient record.

When the arrangement with the functional departments have been accomplished the patient goes or is brought to the corresponding department e.g. X-ray department. The radiology technician orders the old X-ray bag from the archive if the patient was admitted before. The result of the examination is dictated on a recorder by the radiologist and typed directly on the order entry sheet by the secretary of the chief physician. Some time in the afternoon the nurse picks up the sheet from the X-ray department, hands it to the resident physician to read and sign, and after that files it into the patient record.

In the afternoon the admission officer assembles a physician portfolio and a patient portfolio. The physician portfolio contains the discharge form and further patient stickers and is sorted into the patient record. The a patient portfolio remains in the admission office and contains documents for billing purposes. Also data is sent to the hospital controlling department.

Figure 1: Admission of a patient to the hospital

- Joint tasks have to be performed within narrow time limits or up to a certain qualifying date, e.g. examinations which need to be performed at the admission day or before an operation.

The characterization of joint tasks demonstrates that integrated systems are required which have a strong focus on the support of cooperation between the different user groups. Providing standard interfaces for sub-systems of singular departments and reliable network architectures form self-evident technical requirements. On their basis specialized support for cooperative work is required.

Understanding the nature of these specialized requirements on integrated systems in detail analysis, feedback and prototyping for single user work places does not suffice. Instead, we need techniques which support the elaboration on and feedback of cooperation within joint tasks with heterogeneous user groups. Additionally, different perspectives of cooperative work need to be worked out.

## **COOPERATION PICTURES AS MEANS FOR UNDERSTANDING JOINT TASKS WITH HETEROGENEOUS USER GROUPS**

### **Cooperation Pictures**

For the acquisition of an understanding and for the feedback of joint tasks we developed so called Cooperation Pictures for the purpose of graphical visualization which were influenced by Rich Pictures (see [3][10]). Because of the characteristics of joint tasks the emphasis of Cooperation Pictures is — in contrast to Rich Pictures which serve for the description of differing views of different user groups on an integrated system — on the description of kinds of cooperation. For that purpose the passing-on

of information and objects of work are to be visualized. This implies the representation of „places“ between which information and objects are exchanged and the kind of exchange in the shape of annotated arrows between places which illustrate who passes on what entity or by what medium information is passed on.

A distinction of „places“ is made between rooms for organizational units, distinguished functional roles that have no fixed room and places or functional roles from outside of the hospital; discernible symbols are introduced for each of them. An explanation of the symbols that are used in the Cooperation Pictures is given in Figure 2. The arrows which are annotated with icons represent different kinds of transmission: objects are being passed on by humans or by a medium. We differentiate patient and staff in combination with different objects like the patient record, the X-ray bag, lists, order entry forms, cards, lab tubes, tapes. We differentiate telephone and computer as mediums.

The Cooperation Pictures illustrate which errands have to be made by the hospital staff and how the patient makes his or her way to the different units of the hospital. Also it is being shown where data are exchanged via computer and in which areas the telephone is used for coordination. In objectifying the ways of cooperation through „places“ and annotated arrows we see the largest differences to other means of representation (e.g. Petri Nets, Activity Nets [8]) in which merely abstract information passing is described. This abstract passing of information is an insufficient means to further a common understanding of the joint task at hand among all parties involved. The employment of icons as they are frequently used as signboards in public places leads to an immediate understand-







nursing unit	senior physician	general practitioner	Symbols for organizational units, functional roles, units/functional roles outside of the hospital and information transmission
			Icons for employee, patient, phone, computer
			Icons for employee with documents, tape, patient record, X-ray bag

Figure 2: Selected Symbols and Icons for Cooperation Pictures

ing of the meaning by the users and enables them to handle them promptly.

### Employment in the Project Context

The utilization of the Cooperation Pictures took place in the course of the work practice analysis after the first series of interviews. The aim was the development and feedback of our preconceived understanding of two separate joint tasks together with the involved user groups: the admission of a patient to an internal nursing unit and the planning and performance of an operation. The frame was set by a whole-day workshop with two hour sessions in small groups for each joint task where the participants were the interview partners for the corresponding task and members of the installed project group of the hospital. The Cooperation Pictures were implemented as wall paintings. We prepared labeled and unlabeled „place“ symbols and a large selection of different icons. In a preliminary run we had produced the pictures for ourselves to get an overview of it beforehand.

For the development of each picture only a few start symbols were given, for instance for the task „admission-of-a-patient“ the rooms „admission office“ and „nursing unit“. The picture evolved through the discussion of the group members. The arrows were drawn freehand directly on the paper and the corresponding icons and symbols were attached. The role of the developers was reduced to moderation of the discussion and fixing the results of the discussion on the wall painting. The Cooperation Picture for the task „admission of a patient to an internal nursing unit“ is shown in Figure 3.

### Evaluation

With our project experience in mind we can state that Cooperation Pictures are helpful for users as well as software developers in describing the existing status of joint tasks. For *users* it means:

- With Cooperation Pictures users can actively acquire knowledge about their own work contexts. This is due to the non-formal techniques of representation which Cooperation Pictures provide in contrast to other techniques. Users were able to immediately recognize themselves and their part on the joint task through the used symbols and icons. The given “exercise“ - visualizing a joint task - was clear. Without much time for explanation the different users were able to actively participate in elaborating, discussing and introducing their activities, reasons for a particular task performance and necessary cooperation links to other departments. This was gathered and visualized on the wall painting easily and in quite a short amount of time.

- Cooperation Pictures provide the heterogeneous users with an illustration of the complexity of their work. They supply an appropriate subject of discussion which put users directly into the position to reflect together about their own organization. In our project context it was surprising for all workshop participants that within a regular admission of one patient in the morning up to 17 phone calls are made and a series of errands are performed. Immediately a discussion arose which of the phone calls or errands are avoidable, i.e. for what purposes they are made, and which ones will be unnecessary in case of future system support. Furthermore, for many users the wall painting manifested for the first time that their work does not consist in attending to a patient only but that a significant portion includes tasks for cooperation and documentation purposes.
- Cooperation Pictures contribute to an acquisition of joint understanding of the different user groups. While producing the wall painting some of the participants recognized for the first time which of the remaining activities in a joint task are performed by other departments and how and why they proceed. This supported a better mutual understanding among the group of actors in a joint task.

Cooperation Pictures also provide software *developers* with a useful means for gaining understanding of complex and highly cooperative application domains with heterogeneous user groups. They also yield hints for the design of the future system.

- Cooperatively produced Cooperation Pictures equip developers with a feedback technique for heterogeneous users. They support clarifying whether the understanding of a joint task elaborated by the developers from a bunch of scenarios align with the user’s point of view. Lack of clarity can quickly be eliminated.

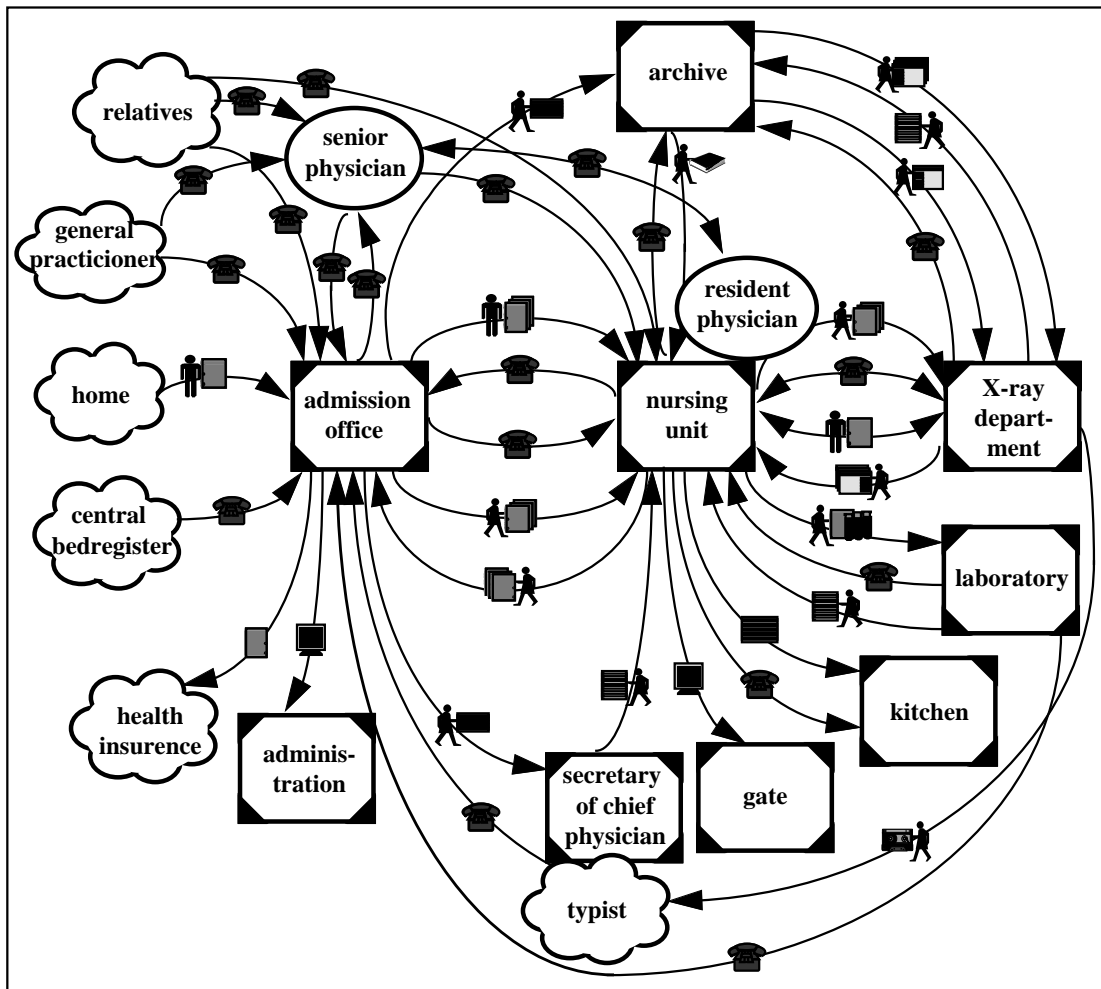


Figure 3: Cooperation Picture for the joint task „admission of a patient“

- In the discussion developers are able to recognize unknown interrelations. Developers find „blind spots“ in their analysis and they receive indications about further involved functional roles needing to be interviewed. E.g. in producing the Cooperation Picture for the joint task „performance of an operation“ we recognized that we had to interview the nurse in the ambulance to reach a comprehensive understanding of the task.
- Indications towards a future system support can be derived from the weak point discussion on the basis of and following the construction of the wall painting.
- By visualizing cooperative interrelations for joint tasks we can recognize the density of the information flow. This supports and triggers a weighting which type of the cooperative activities could be supported by a future system.

## POINT-OF-VIEW PICTURES FOR POLITICS OF PARTICIPATION

### Point-of-View Pictures

As pointed out above, providing an integrated system in the context of work settings with complex cooperation requires the understanding of the cooperative work taking

place in joint tasks. Cooperation Pictures allow us to collect and visualize information about cooperative work gathered from interviews in singular work places.

Besides that, the task is to identify the interests of the heterogeneous user groups which are to be served by a future integrated solution. Additionally, in case of competing user requirements we have to understand whose interests will be successful. Different questions arise. How important is system support for cooperation compared with specific system support for singular departments? Which department is more important/which department needs immediate support because of changed legal requirements and should be served first? Which sub-systems will therefore depend on others?

Since these different interests form sensible information it is difficult to accomplish open discussions in meetings with different user groups. We therefore used Point-of-View Pictures (similar to Rich Pictures as in [3][10]) for initiating or accompanying such interchange.

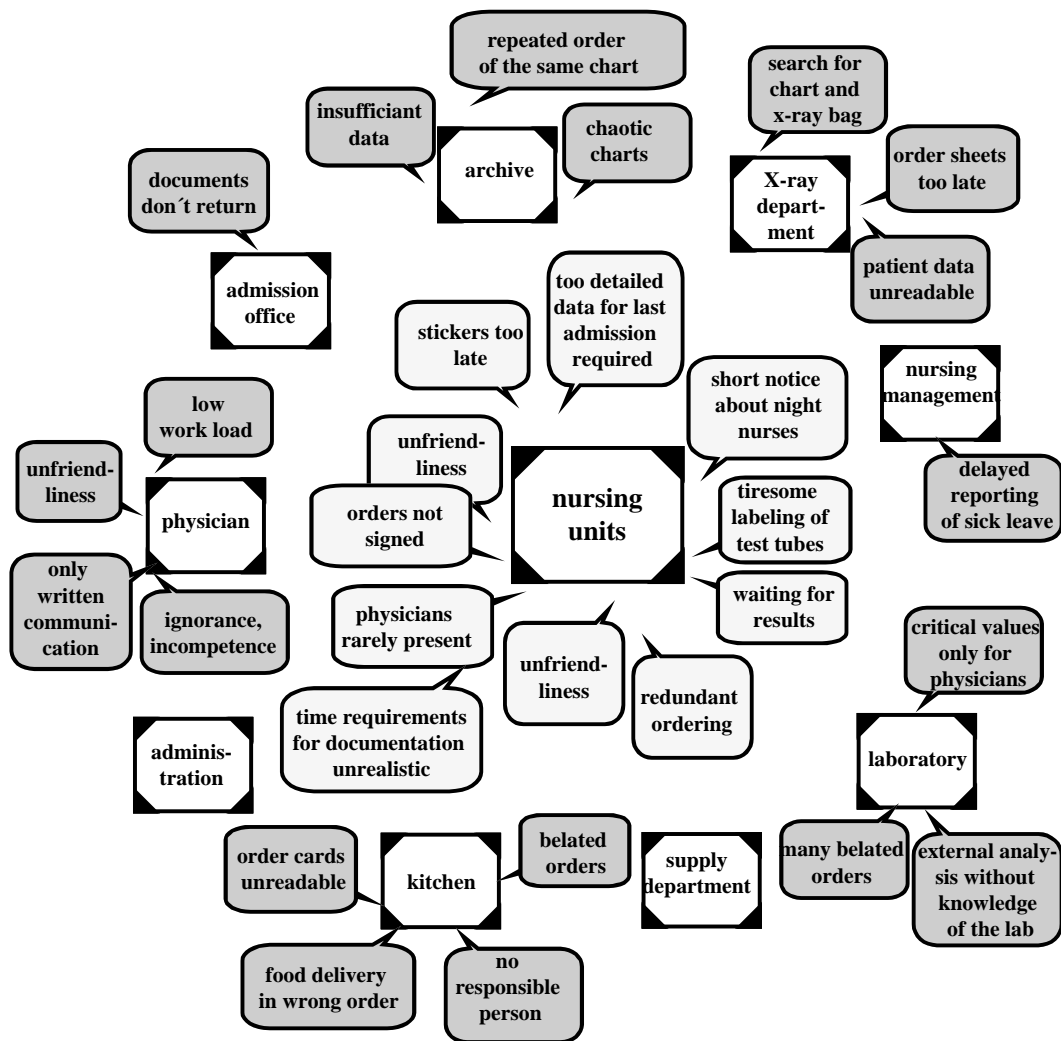


Figure 4: Point-of-View Picture about „perspectives/difficulties concerning the current cooperation with nursing units“

Point-of-View Pictures are easy to draw. They consist of symbols representing different user groups (same symbols as in Cooperation Pictures) and balloons capturing their interests or assessments. Each picture should be devoted to a specific topic which not necessarily needs to be concerned with desires about the future system. E.g. figure 4 presents a Point-of-View Picture with the topic: Perspectives/difficulties concerning the current cooperation with nursing units. Each balloon belonging to a department cooperating with nursing units describes its point of view concerning difficulties in the cooperation. The balloons around the nursing unit state its point of view whereby the location of the balloons indicate which department is concerned by the statement.

### Employment in the Project Context

We used Point-of-View Pictures for two different purposes. One purpose is connected to Cooperation Pictures for joint tasks. Cooperation Pictures clarify where cooperation activities are particularly dense. Taking the example of „Admission of a Patient“ we recognized the nursing units as central points of cooperation with having the most arrows going to and from the nursing units to all other departments in the picture. In the project context, we used Point-of-View Pictures to raise discussions about

the implications of this focal point of cooperation.

Another purpose concerns gathering and illustrating the different expectations for future system support on which basis decisions towards the above raised questions can be made. A good example from the project context belongs to the required extensions in controlling. Currently, each department has to gather statistical information (by hand) and transfers it to the administration unit. In future many more advanced statistics will be required. We used Point-of-View Pictures to open up the discussion about wishes concerning system support and specific statistical analysis for each department while comparing this to the perspectives from the administration.

We used Point-of-View Pictures during the requirements analysis in a project review (with the hospital leaders and the internal project group of the hospital) and in our second workshop with interview partners after having employed Cooperation Pictures in the first workshop. For the implementation we prepared wall paintings with symbols representing departments. We recited different assessments, wrote them piece by piece on prepared balloons and attached them onto the picture. Another time each participant got a number of cards, wrote his wishes on top of it and explained them while fixing them onto the balloons in the wall painting.

## Evaluation

Our project experience in the project shows that visualization of different estimations in topic specific Point-of-View Pictures highly supports discussion and identification of interests in project meetings. For *users* it means:

- Point-of-View Pictures serve as feedback techniques. Different point of views recognized in interviews can be visualized in meetings and can be brought to a point. In the case of the given example „perspectives/ difficulties concerning the current cooperation with nursing units“ a very intense and controversial discussion arose. The scope of perspectives ranged from: the cooperation support is one of the major goals of the future systems to: there is no reason at all for cooperation support - became apparent for the first time in the project.
- Point-of-View Pictures support users to actively formulate their own expectations for future system support and in clearly explaining them in front of non-departmental colleagues.

Point-of-View Pictures support *developers* in identifying different interests and influences among heterogeneous users which form the basis for further decisions:

- Point-of-View Pictures support developers in recognizing different perspectives, tensions and influences between user groups more clearly.
- Point-of-View Pictures support developers sharing discovered reasons for difficulties in the current work practice. This helps decreasing overdrawn expectations in the sense that problems won't just vanish because of the introduction of a software system. E.g. in the context of cooperation with nursing units some reasons may lie in an unbalanced kind of required cooperation (nursing units cooperate with several different partners whereas nursing units are often the only cooperation partners of the other departments), specialties of group working places (nursing units need high cooperation amongst their staff themselves) and different levels of hierarchical organization of departments (other departments are much more independently organized so that nursing units have to serve the requirements for cooperation postulated by other departments but not the other way round).
- Developers get feedback of their intentions about which parts of the integrated system should be emphasized, e.g. support of the cooperative work with a high density (from and to nursing units), or about their planning of system versions, e.g. which departments need to be served first.

## SUMMARY

Our intention with this article is to emphasize the following aspects. Integrated systems in the context of work settings with complex cooperation challenge existing approaches to user participation. They require the participation of heterogeneous user groups.

Specific problems lie in the understanding of the current implementation of cooperation which can only be worked out in meetings with representatives of each involved department. The same is required when possible implications and changes through introducing system support need to be evaluated. Besides that, integrated solutions often include the support of specific requirements for single departments which might compete against the desires of other units. Additionally these requirements might compete with cooperation support.

Out of the concrete project context we presented in this article applied and tested techniques for actively involving heterogeneous user groups during the requirements analysis and decision processes. These techniques are directly understandable and usable by users of different professions and abilities to articulate themselves.

The introduced Cooperation Pictures help to understand and visualize cooperative work. Whereas Point-of-View Pictures illustrate different perspectives, opinions and wishes concerning current work practice and future system support.

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