To be published in: Proc. of Hawai'i International Conference on System Sciences, HICCS-34, Maui, January 2001.

Information Systems Development with Anticipation of Change Focussing on Professional Bureaucracies

Ingrid Wetzel
Hamburg University
Computer Science Department
Vogt-Koelln-Str. 30
22527 Hamburg, Germany
wetzel@informatik.uni-hamburg.de

Abstract

The problems associated with the development of hospital information systems and their implementation in organizations have been the subject of much literary debate. The perspectives taken in regards to this phenomenon are often similar to the debate in IS design in general, in that the overseen social and organizational factors of IS implementation are mainly addressed.

However, from our experiences in applied research projects we claim that the specific organizational structure of hospitals as professional bureaucracies requires specialized development methods.

This is the subject of this article. First, we will establish that hospitals represent a special organizational type. We will then draw conclusions regarding the requirements for specialized IS development approaches. Third, we will discuss limitations of existing approaches and introduce the Anchor method. Anchor supports the intertwining of anticipation of IS induced organizational change and IS development by the provision of participatory techniques, processes and tasks suitable for professional bureaucracies.

1. Introduction

Despite the perceived potential of Hospital Information Systems (HIS) to enhance the performance of healthcare organizations, several articles describe the low acceptance and slow diffusion of HIS in hospitals or the failure and discontinuations of HIS projects. Observers and analysts attribute this to various causes related to different perspectives.

First, HISs obstruct and alter traditional practices, patterns and routines. They affect the cooperation within the professional relationships between individuals and groups. Second, frequent difficulties in HIS projects such as the lack of system integration or frequent interruptions and delay in the implementation processes overshadows its discernible improvements and benefits. Third, the implementation process itself is an extensive source of difficulties since it depends heavily on the integration of the system into complex, organizational settings as Anderson relates [1]. "Past experience suggests that efforts to introduce clinical information systems into practice settings will result in failures and unanticipated consequences if their technical aspects are emphasized and their social and organizational factors are overlooked"(pp. 89). Similarly, in [11] Heek et. al use a model of conception-reality gaps and argue "that the greater the change gap between current realities and the design conceptions (i.e. requirements and assumptions) of a new healthcare information system, the greater the risk of failure"(pp. 96).

All this does not seem to be specific to HIS. In general IS design literature emphasize that the critical issues involved in organizational changes induced by IS are social and organizational in nature and not solely technical. Recent socio-technical approaches appoint towards new efforts to overcome the dichotomy between the "hard and soft" [17]. The conflicting theories – technological determinism and theories on the social construction of technology – seem to be still unrelated. Impacts of this are all over visible and experienced in practice.

However, presently there is a greater awareness, disturbance and movement in this direction. Recent literature on approaches to increase organizational productivity which are rooted in deterministic methods using business process reengineering and workflow, emphasize the importance of involving stakeholders and marketing projects throughout an organization [18]. The appreciation of the particular aspects of white color work (like flexibility) in comparison to mass production [19] or simply the importance of understanding that IS projects change social interactions, communication, cooperation and decision making are addressed. A critical analysis of the failures and shortcomings of implementation of IS shows that these approaches are "...creating a rational organization far away from any kind of possible natural organization" [24](S. 33) .

None the less there are difficulties remaining. The discussion concerning situated activity in organizational processes and the benefits resulting from flexible human responsiveness began as early as 1987 [26]. Still, the challenge lies in the attempt to represent work reality as well as organizational reality and to decide which of these aspects are relevant to design [23][15].

Furthermore, over time integrated ISs has been called upon to support various aspects of work, like cooperation or team work. From its conception, the related research field of CSCW has been interdisciplinary, bringing social psychologist, anthropologists, economist, organizational theorist, educators and computer scientists in order to understand and support group activities. Again, it became apparent that many of the problems in the development, marketing and application of groupware is not due to technical failures [10].

Due to the increased awareness of these different facets of IS support and change management in organizations, demands of research communities for comprehensive solutions focussing on aspects, like the organizational, group and technological facet as claimed in [5] have been risen.

The above evaluations, interpretations and postulations have proven valuable and indisputable. However, it is questionable if these analyses and implications are sufficient. There are other important aspects that need to be related and addressed. First, research fields and methods often fail to provide their underlying assumptions or domains [16]. Taking BPR and CSCW as examples, both address the reactions of organizations in respond to external pressures such as globalization and the rapid fluctuations of the market but deal with different perspectives and organizational structures or cultures. Briefly, BPR are designed to overcome functional division and mainly addresses machine bureaucracies with standardization of processes used as coordination mechanism [21] based on top-down-approaches. CSCW instead focuses on virtual group support addressing innovative organizations with mutual adjustment as a coordination mechanism [21] while emphasizing social aspects of collaborative work. Obviously, both areas use very different methods, and of course their products also provide functionality of disparate nature.

Therefore, our primary question is: to what extent is the specific organizational structure of hospitals characterized as professional bureaucracies, needing both, specialized methods and different types of system support at least in comparison to those addressing machine bureaucracies and innovative organizations? Where is this well-known and well-investigated difference in structure, strategy formation and work covered, kept, left during design and implementation? This question corresponds with [4] Butler's observation. "Previous research in this area (enterprise transformation) has tended to focus on the organizational effects of IT-enabled change; however, researchers have pointed out that the manner in which IT affects and is affected by an organization's structure and process has not been the subject of systematic investigation. The role that an organization's function has to play in this process has also been largely ignored".

This leads to the second topic, the initial steps towards developing comprehensive and holistic development methods to intergrate social interpretations, organizational processes, and contexts [4]. As long as conceptions in IS research do not influence and extend generally to applied system development methods - i.e. by providing user-oriented representations supporting cooperative design tasks or by explicitly defining application models for cooperation included in the system's functionality – future design effort will fail to bring about significant changes in regards to the situation of system implementation as already described. Thus, if we are able to provide specialized (as indicated i.e. in [28]) and at the same time holistic development methods, then IS designs will certainly be enriched in general.

The previous two questions provide to the structure for the following outline. In section 2 we will establish that hospitals are representations of professional bureaucracies and we will describe their characteristics. Section 3 draws implications for specialized IS development approaches. Section 4 introduces the rational of Anchor (ANticipation of CHange in ORganizations) as a development method developed in applied research projects in professional bureaucracies. Section 5 describes tasks to proceed and gives examples of Anchor techniques in more details. Section 6 summarizes the results and discusses future research directions.

2 Hospitals as Professional Bureaucracies Cooperatively Working „on Humans"

In his book "The structuring of organizations", [21] Mintzberg classifies five (later six [22]) different organizational types. One of these organizational types is the professional bureaucracy. Hospitals and universities are classic examples of this type. The following text, briefly present Mintzberg's organizational characteristics.

The work of professional bureaucracies is primarily organized around *experts*. They work relatively independently of their colleagues and closely with the clients, whom they serve. Through the application of sets of (more or less) stable and sophisticated skills under constant or stable conditions, they produce *standardized services* or products offered by the organization. In this regard, the work of professionals can be broken down into two steps; the diagnosis of which standard program should be applied being a fundamental task and the execution of the chosen program. This type of "pigeonholing" simplifies the work process as well as enabling autonomous work.

By comparison, the *work processes* themselves, like diagnosing are usually very complex and hence too sophisticated for standardization (experts are required for this very reason). The outputs are also very difficult to measure and standardize. Other usually applied coordination and control mechanisms, such as direct supervision and

mutual adjustment are less useful as they reduce autonomy and the discretion required to serve the individual needs of the client.

The result is a specific *organizational structure* with a large operational core, a small middle line, a very small technostructure for planning and standardizing organizational performance and a considerable support area to relieve the highly paid professionals from as much routine work as possible. The structure is what distinguishes professional bureaucracies from both machine bureaucracies and innovative organizations. While, machine bureaucracies have a single-purpose structure and when presented with a stimulus a standard sequence of programs will be executed. The highly standardized processes require a large technostructure for planning, evaluating and standard setting. On the other hand, innovative organizations depend upon fully open-ended diagnosis, which are applied in the search for a creative solution to a unique problem. Standard programs are useless for this purpose.

Furthermore, the dominance of expert work affects the *administrative structure* in such organizations. The administration lacks a good deal of power in comparison to machine or entrepreneurial organizations and is decentralized providing professionals with more control over their own work as well as collective control over administrative decisions. The administrative task is often to spent in handling disruptions and negotiations. Furthermore, administrative structures serve a key role in creating the boundary of the organization. It is often through these roles that they gain indirect and subtle power.

A small technostructure and a weak administration lead to a very different *strategy process*. The conventional way, in which central administrators develop detailed and integrated plans seldom works. Instead, many strategic issues are controlled by individual professionals or require the participation of a variety of members in a complex collective process. The resulting fragmentation of activity discourages initiatives. This is one reason for the remarkable degree of stability in these types of organizations.

So far, we have summarized the perspectives of organizational theory . In contrast, the book “Social Organization of Medical Work” [25] emphasizes intentionally on “the *primacy of work* over the division of labor itself”. The insights given in the healthcare field complement the results of organizational theory in the understanding of the operational specifics of hospitals.

Strauss et. al analyze in [25] the complexity of healthcare work and identify and describe different kinds of work as machine work, safety work, comfort work, sentimental work, articulation work. Each area of work has its specialties and is affected by the changes hospitals undergo due to the explosion of medical specialization.

The careful analysis is based on the conviction that “work with and on human beings has characteristics not present when the material worked on is inanimate”. Human material reacts, is able to participate, influences the results, is part of the divisions of labor and increases especially in case of illness significantly the contingencies of work.

As a major concept for understanding health work they introduce the term trajectory which means the organization of work done over a course of illness. Similar to the pigeonholing process described by Mintzberg Strauss et. al characterize two stages, the diagnosis related to a trajectory scheme and the following treatment as a plan of therapeutic action. Therapeutic action involves control of developments in the disease course, sequencing and coordination of actions of many different types of personnel and resources from different hospital departments. Organizing therapeutic actions is complex because of problematic illness courses and the host of involved tasks.

This leads to a further characteristic of health work which lies in the network of coordination and cooperation and the kind of group work being required. “The articulation of medical work in hospitals may or may not be more complex than industrial, engineering, legal, military, or other kinds of work, but that articulation certainly looks different when examined closely” [25]. Due to rationalization efforts and division of work trajectories lead to small repeated actions of different responsibility and skill. Contingency factors cause constantly revision of trajectories requiring situated cooperation of increased amount. Furthermore, teams have to cope with many patients each of which are in a different stage of trajectory. And besides medical work they cooperatively have to accomplish tasks regarding legal aspects, purchasing, supply for each single patient. For coping with this complexity hospitals have elaborated an established set of awareness signals, regulations and conventions to be learned.

3 Implications for IS Design

In this section we will outline the requirements for design addressing the above described organizational and healthcare characteristics.

Collective participation in IS planning and implementation

Most obviously, whoever is involved in IS development in hospitals (in-house staff, consultants or vendors) has certainly to face and nurture *collective participation* and a great deal of negotiation within the whole process.

As we have seen, decisions can not be made solely by a centralized administration, nor can they usually be based upon detailed in-house knowledge provided by a large technostructure, since both instances posses neither the required power, work resources nor available knowledge of organizational processes. The low motivation among professionals to participate in collective efforts may also aggravate the situation. IS improvements are often perceived not to be in the interest of the professional or in

some cases the benefits that IS implementation may bring the entire organization may hinder or even block resources for their own units. As a consequence - intentional or not - IS development projects might become entangled in shaping entire IS strategies for the organization and permanently selling the project to the different units. The support and engagement of each unit is even more essential during the implementation phase of the IS system into the organization.

In summary, it appears that building an IS and implementing it into hospital organizations requires more involvement with the organizational structure and its autonomous parts. Here the recognition of subtle power plays and existing alliances between various hospital units assumes a greater role, in comparison to other organizations where IS development has more stable and responsible teams in charge.

Collective design decisions

User involvement is not only a prerequisite for political decisions concerning the prioritizing of requirements and the allocation of resources, it is also required for decisions concerning design. The complexity of the diagnosis process; the design and documentation of trajectories; the network of existing coordination and the handling of contingencies all require careful consideration. The change in one single item, affects the whole network of tasks. To complicate matters, interdepartmental cooperation takes place between teams with sophisticated internal coordination with the result, that the consequences of changes might be overlooked easily. The acceptance of changes is required from all participants, because even small changes might affect the autonomy of teams and units.

Embedding of computer work and integration issues

As emphasized above, health care as a highly specialized and coordinated work on human beings incorporates a high degree of various types of work and needs closer consideration. Health care is not desktop work. IS development has to set priorities concerning which part or aspect of the medical treatment should receive primary support and how these decision effects or influences other types of activities. Simple issues concerning how computers or mobile units could be employed without disturbing sensitive conversations, or how to integrate such devices into surgical procedures, or how teams will share computers, all these aspect are deserving of careful consideration and are part of the design effort.

Broadening the perspective, if the use of HIS is not primarily directed by administrative purposes, HIS development will result in the selection and integration of a variety of specialized systems supporting distinct medical disciplines.

Specific cooperation support

Interdepartmental cooperation as well as team work is critical in hospitals and they constitute a major portion of work. As pointed out above, this type of cooperation is subject to multiple and strict regulations, due to the specific work division within multi-professional teams caring for many patients simultaneously and according to different responsibilities. It is highly regulated and at the same time situated and requires specific methods supporting the understanding of the cooperation complexity as well as the development of appropriate system support.

Standardization

Hospitals are comprised of several units or teams with nearly identical functionality, most obviously are the wards, but also different operating theatres or X-ray rooms are good examples. Interdepartmental cooperation also needs standardization. The process of standardization is nearly mandatory for the design and introduction of systems. Design approaches have to provide ways to proceed and again representations to further these processes.

Service Processes

Trajectories are at the center of clinical reasoning processes pertaining to diagnosis and the organization of cooperative procedures. Furthermore, evaluation of trajectories against standards is at the hub of administrational interest, particularly in regards to performance and reimbursement. Today, much of this is held in the patient's record which offer less potential for exchange and evaluation, but serves more as support for the experts in their usual work patterns. The challenge of meeting such divers perspectives and the demand to explore new potential may be one the reason why successful digitized counterparts designs are not easy to produce. The exploration of new internet technologies trajectories should be the focus of specialized research to incorporate the patient's perspective as well and to lead to concepts like individualized service processes based on standard pattern.

Each of the above listed requirements are directly related to professional bureaucracies. To some degree they are valid in projects for other organizational types as well. Although certain aspects of implementation of computer work and specifics for cooperation and service require specific methods and solutions.

4 The Rational of Anchor

After a brief overview of the background of the Anchor method, we will highlight the specifics of this method particularly in relationship to the previously stated requirements. We thereby discuss to what extend specialized approaches are necessary to meet these requirements or conversely what seems to be missing from other system design approaches.

The Anchor approach was developed in different projects within hospitals. Our main project was devoted to support the decision finding process of a hospital regarding the development and/or selection respectively of an integrated HIS in the clinical sections and planning the

configuration, introduction and use of this HIS in the light of changing demands. The cooperation partner was a small acute care hospital with 230 beds and 560 employees. The assignment of the project was integrated into the organizational development of the hospital which took place with the participation of all groups of employees from the various departments: internal medicine, surgery, anesthesiology, nursing staff, administration, and maintenance/technical support. It started in fall of 1995. A team of three computer scientists (one of us being also a nurse) - made a requirements analysis on the basis of workplace studies and participatory techniques for understanding the interdepartmental processes in the hospital. Out of this and in close cooperation with representatives of the hospital we worked out criteria for the future system and carried out a marked analysis for HIS in Germany. We proposed a system and after a decision process (summer 1996) in the hospital the system was bought. For two and a half years we worked as consultant on the implementation of the system and its customization process. By that time the system run in the patient administration and at the wards for the physicians and nurses. Other projects addressed requirements analysis and design for customizable nursing systems and consultant work within a software house building an HIS. During these projects we build prototypes for exploring design ideas for team cooperation on wards and for interdepartmental coordination. Furthermore, we investigated to what extent available technology (groupware and workflow systems) are applicable to implement the elaborated cooperation requirements or if object-oriented framework technology with componentware is a more appropriate solution.

The Anchor method presented here was founded upon the tradition of evolutionary system development, in particular STEPS (Software Technology for Evolutionary Participative Systems development)[4] and the Tools & Materials approach [3]. The emphasis and aims of these approaches lie in *evolutionary software development*, based on a cyclical process model; in support of *participative communication* and *learning process* for developers and users alike; on the emphasis on the *use context*, which results in 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 [8][9].

In the course of the project we extended the existing approaches (STEPS and Tools&Material) according to the following three main directives.

4.1. Switch between Three Perspectives

In order to cope with the complexities of the entire design task – cooperatively shaping an HIS strategy, elucidating requirements, making design decisions, building a system or selecting a package system, and implementing a HIS into a hospital – we use a comprehensive approach by utilizing three different perspectives: a workplace or workgroup perspective, a interdepartmental perspective and a business perspective. During a project we constantly and intentionally switch between these perspectives which improves the understanding and design within each of the single areas as well as the understanding of their interdependencies. Additionally, we define as guidelines different design tasks in each of the perspectives. Furthermore, switching between perspectives allows us to involve different kind of user groups in various ways, through interviews, workshops, management meetings, market analysis.

Comparing this feature of Anchor with existing methods we observe the following distinctions. BPR approaches are usually lacking in a workplace perspective. The strong focus on processes and their relationship to business strategies overlooks the need for work place design. But this deficiency becomes crucial in the context of healthcare. CSCW approaches give valuable hints for analyzing cooperation on work places. Still such investigations alone lack the perspective of and connection to the business context. Because of legal regulations and the different responsibilities of a heterogeneous teams, we realize the need for specific analysis and apply results from coordination theory. Similarly, OO design approaches contribute to the design of work places but do not address cooperation support on a non-technical level, at least in the past.

Thus, in the hospital field we feel the strong need for a comprehensive approach which can alternate perspectives and simultaneously involve the various social actors and structuring of the design tasks. At the same time, for each of the perspective we gather appropriate research results from different research areas for meeting the specifics of the field.

4.2. Anticipation of Change

Overcoming barriers in HIS acceptance is still an open issue. Factors increasing the acceptance of HIS systems should emphasize the involvement of social actors in anticipating the effects and use on different levels during system design, selection and implementation. In [1] Anderson states that "..it is essential to consider in advance how the system being introduced will affect routine practice patterns and professional relations.. Health care organizations must be prepared to anticipate and mange a host of behavioral and organizational changes caused by the introduction of an integrated clinical information system."

Building systems should improve the existing ways of work while exploiting new technological possibilities. Due to the network of interdependencies in hospital work the anticipation (foresight) of organizational change caused by the realization of new design ideas and alternatives needs to be assessed, evaluated and improved during the design process by those whose work will be affected by the system's future use. It is crucial not to overlook interdependencies and the parties involved.

In order to assure that the approach works, each person involved must know which contribution he or she should make. Especially developers need to understand at what point their design ideas extend beyond their own decision making competence, where they need to ask what type of questions. Of course, all of this needs to be based on a detailed analysis and techniques. These techniques should be investigated to insure that the design is obtained from analysis data in a systematic manner.

4.3. Representations of Work

If design teams do not have counterpart teams provided by the user organization (as is usually the case in projects with more hierarchically structured organizations), the project's survival respective success is dependent on which strategies the designers use to compensate for this lack. It is not just a matter of creating new committees but in motivating participation and setting rules for cooperation. Here the issue of how to gather information and represent gathered information as a basis for cooperative design decisions is crucial.

One of the most fundamental requirements for representations is the ease of comprehension. No one will make an effort to learn modeling techniques if the participation in a design group is involuntary or additive work. Furthermore, there must be support for initiating communication between the representatives of different profession. One helpful suggestion is to distinguish between representations of work and of system design [15] and transform internally (among the developers) between the two.

Briefly considering the existing methods, modeling approaches from BPR are usually too complex to be utilized in this context, there are only very few CSCW modeling approaches available, none of which we find suitable, but participatory design approaches like [2] offer a good deal of ideas. New extended OO modeling approaches like [6] incorporate a much broader spectrum of content than some years ago. Some representations should be tested, while others seem to lack user-orientation.

During the course of the project we invented several representations, some of which are presented in section 5. In different contexts, we extended them according our needs. Tool support and the distribution of linked representations on a project intranet can improve today's project communication significantly.

5. Project Experience with Anchor in Hospital Projects

In the following we illustrate selected techniques elaborated and used in our hospital projects while outlining the overall process. For further detail we refer to [12] [13] [14].

5.1 Elicitation of Current Work Practice

As introduced above Anchor incorporates the switch between perspectives. In projects, after usual contract negotiations which evolve the teams already on the business perspective we usually start with the workplace perspective.

The Workplace/group Perspective

A major development task is to analyze, understand and model the work as seen from the various workplaces involved. Here, the Anchor method uses well-proven techniques like qualitative interviews together with *scenarios*, a *glossary* and *system visions* (cf. [3]). Scenarios, for us, identify the work tasks at a certain workplace and describe the present way of accomplishing these tasks with different means and objects of work. Glossary entries define the terms and concepts used in the application domain.

The Interdepartmental Perspective

Scenarios capture the perspective of the individual workplaces with their respective views of cooperative work. These individual perspectives frequently lack insight into the nature of cooperative processes. After a suitable series of interviews a special analysis is necessary in order to understand interdependencies between single tasks at different work places and to identify and describe cross-departmental tasks [12]. This analysis task is usually performed by a requirements analysis team. The results and potentials for change need to be discussed in workshops with representatives of the different units (wards, physicians, X-ray, kitchen, administration etc.) supporting the overall strategy or innovation process in professional bureaucracies.

For this reason Cooperation Pictures are used (cf. [12] and Figure 1) which were invented in our hospital project. They provide a graphical visualization of concrete cooperation in order to accomplish a joint task. Accordingly, they represent the involved (work) places or roles and the cooperation between them. Places and roles are visualized by symbols with names. In the hospital project, we distinguished between places outside and inside the hospital and certain roles like a chief physician which could not be related to a stable location. Cooperation is represented by annotated arrows. In the hospital context we distinguish the delivery of documents by the hospital staff, phone calls, data exchange via computer and the patient making his/her way to the different units of the hospital. The arrows are annotated by pictograms indicating these differ-

ent kinds of cooperation. It is possible to refine or coarsen these cooperation picture. A more detailed picture i.e. could focus on the process of an X-ray examination, were numbers are added to the arrows in order to indicate work sequences for a typical case or in case of existing system we mark each place with the system or systems being in use to visualize the status of integration.

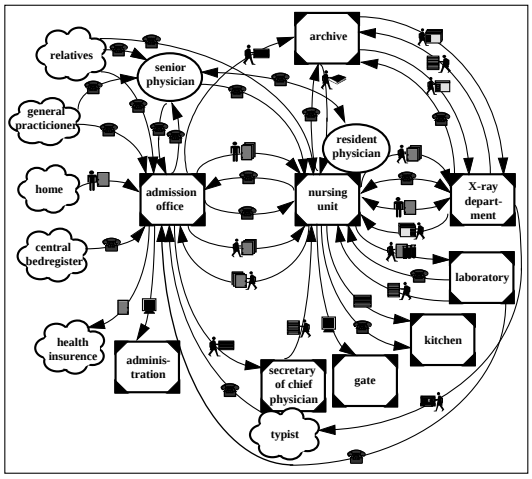

Figure 1: Cooperation Picture "Admission of a patient" in the Hospital domain

In many workshop sessions, Cooperation Pictures were proven very useful in initiating active participation of the heterogeneous customer groups in elaborating, discussing and sharing their activities, reasoning about particular task performance and necessary cooperation lings. This means: Cooperation Pictures supply an appropriate subject of discussion which put users directly into the position to reflect together about their own organization.

Focussing on cooperation needs a next task is to identify, represent and characterize specific pattern of coordination.

As seen in section 2, the standardization of skill as coordination mechanism is some sort of loose. On the other hand, the work of different professionals needs coordination and the working together of highly skilled and other less skilled personnel incorporates legal regulations concerning responsibilities resulting in rules and conventions for cooperation. As a result we found a necessity for different ways to coordinate instead of using a single generic way as in workflow system support. Therefore, after identifying and representing different cross-departmental tasks we introduce an analysis task for identifying pattern of cooperation. In the hospital domain we found i.e. the scheduling and performing of investigations (for sharing resources), signaling changes (due to the repetitive nature of tasks for lots of patients), coordination with plans and the sending of documents.

As a basis for outlining future system support and anticipating the resulting changes in regard to existing ways of cooperation we analyzed each of the found cooperation forms in more detail. The focus in this analysis lies on the purpose of cooperation, since this is the more stable factor compared to the how of cooperation which might change.

Single	Purpose/Implication
Physician writes the order on the physicians order form.	It is documented who ordered the test at what (forensic, quality assurance).To kick on the implementation of the test.
Physician puts the order entry sheet in the nurse's mail basket.	Nurse is alerted that she has to act. She knows what is planned with her patient.
Nurse enters patient's name, other relevant data and the type of test on the order entry sheet.	Nurse prepares the order entry sheet in order to relieve the physician of such burdens.
Nurse enters the test with pencil on the patient's flowsheet.	It is documented for every member of the care team and physicians when the examination was ordered and to which further examinations he is scheduled.
Nurse puts the order entry sheet in the physician's mail basket.	Physician knows that he has to validate the order.
Physician sees the order entry sheet in his basket, enters the relevant clinical information, signs it and puts it in the nurse's mail basket.	The physician that carries out the test knows what to do and that the ordering physician is responsible for the test.
Nurse carries the order entry sheet to the X-ray department.	The X-ray departement can schedule the test and the performing physician can check the order.
Radiology technician chooses a date for the test and conveys it by phone to the unit.	The tests are coordinated within the X-ray department. The nurses know when to take the patient to the X-ray Department..

Figure 2: Purpose Table of the registration for an X-ray examination

Here, we apply Purpose Tables as a representation technique. In purpose tables, we describe the cooperative task divided into Who - does What - with What or Whom - for what Purpose. The focus of this table is to identify the different purposes or implications of each individual task. Figure 2 shows the registration of a patient for an X-ray examination. A first look might only show the registration of a patient for an X-ray examination. Only by looking at the purposes, it becomes clear that a lot of cooperation and coordination is involved: the nurse is informed about the examination and thus about the treatment of „her" patient. In addition, the entry in the patient's flow sheet makes the registration visible to other physicians and nurses with subsequent medical or nursing consequences.

Usually, in the cross-departmental perspective also the standardization task is seated. For this we invented generalized scenarios where we marked differences in performance of tasks according to categories like work organization, time, place, role, etc. In workshops we used task pictures (similar to figure 5) which were highly useful in initiating the standardization discussion among representatives of different units [14].

The Business Perspective

Briefly, the business perspective in development projects in general has to nurture the understanding of a whole domain. This knowledge forms the basis to plan and control the whole project activities and to select appropriate methods. Sources for understanding are the gathering of information about contingency factors and their continuous monitoring, the evaluation of strategy formation (in competitor or the project partner organizations), knowledge of organizational and work specifics as described to some extent in this paper. As an example of its importance. The legally enforced change in reimbursement of services from health insurance companies was the of our project. In the course of the project the importance of the

strong interconnection of the administrational and clinical sections got clear and caused some severe trouble as it lead to a redefinition of our work and the extension of the intended system support. Understanding of factors from organizational theory and work specifics directed efforts in analysis and design.

5.2 Requirements Construction/Design

In this section we restrict ourselves to present results only from the cross-departmental perspective. Here main tasks on the macro level are to negotiate and determine requirements concerning the extent of the future kernel system together with system stages for anticipating sequences of either system development or implementation into the organization. On a more detailed level we have to make decisions about design alternatives for future cooperation support for the identified cooperation forms.

System Kernel and Stages

For determining the future integrated architecture and extent of system support we introduce the term application kernel. It dissects a seemingly monolithic system, like The HOS, into a minimal kernel and specialized systems. The kernel is to be determined by the following criteria: it needs to be operative and has to satisfy urgent needs of the organization (business perspective). Additionally, it should support tasks of key units or departments (workgroup perspective) which show a high cooperation profile (cross-departmental perspective). And it needs to supply basic cooperation and coordination means (cooperation pattern). Therefore, identifying the kernel and determining extensions of an application system for cooperative work is by no means a trivial task. Usually, kernel extensions differ for different kinds of hospitals (according i.e. to size). Furthermore, it requires agreement among competing customer requirements. While we have stressed the priority of domain-related features, technical kernel facilities like openness, extensibility and appropriate database interfaces for integration together with demands on vendor companies like the ability and willingness and experience of vendors in supporting integration work systematically have to be considered as well.

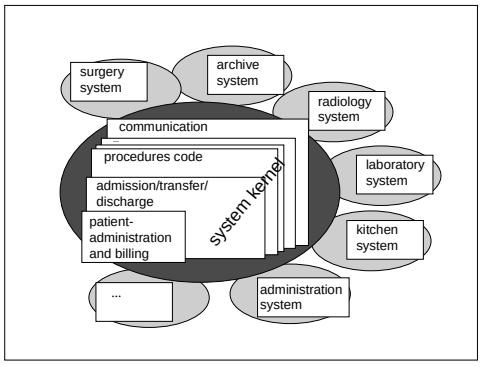

Figure 3: The application kernel (with extensions) and subsystems

As an example, Figure 3 shows a sketch of the application kernel system with specialized systems of the hospital project.

A still large application kernel has to be further divided into system stages determining the sequence of development or implementation into the organization. Basis for forming stages are logical dependencies between tasks. Using representations of system stages, as shown in figure 4, domain experts can enter a discussion about which extensions will support which task; what are the interrelations between the cooperative tasks and extensions; what are the priorities for realizing these extensions. In our hospital projects, users and user management pretty soon grasped the idea of the application kernel with system stages and used numbers to name the various stages, which they could relate to familiar cooperative tasks. Even in discussions outside the software project they kept talking about „application kernel“ or „extension 2“.

Summarizing, introducing the notion of system kernel and stages helps making the development and introduction process transparent throughout the whole organization.

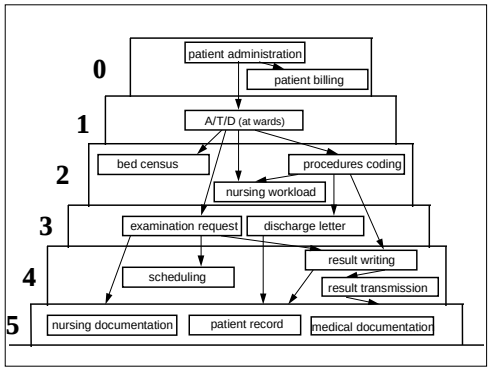

Figure 4: The application kernel with its extensions

Design Alternatives for Cooperation Pattern

For each of the identified cooperation pattern it is necessary and worthwhile to find an optimal design solution. As emphasized above, this requires joint efforts for exploiting technological potentials in defining new ways of cooperation while concurrently anticipating future organizational change and practical feasibility as a consequence thereof.

For organizing this process Anchor applies results from coordination theory [20]. Briefly, the direction of this research is based on the understanding that coordination is the process of managing dependencies between activities. The underlying idea is to provide a characterization of different kinds of dependencies, to build up a set of coordination mechanism and to identify which coordination mechanism can be used to manage certain dependencies. Based on such a groundwork processes can be analyzed in

a deeper way and new ideas for coordination can be derived in a systematical manner.

Malone et.al distinguish three main interdependencies between tasks calling them flow, sharing and fit.

- In a flow dependency one activity produces a resource that is used by another activity.
- A sharing dependency arise whenever multiple activities make use of the same resource.
- A fit dependency occurs whenever multiple activities collectively produce a single resource.

Further analysis classifies resources as sharable or non-sharable and consumable or reusable. So far coordination theory. For applying it for design we have to consider that while transforming resources into digital representations they might change these properties – i.e. a non sharable resource might become sharable which alone provides new potentials for future cooperation – while other resources like certain material or machines won't change these properties. A careful consideration of the whole network of dependencies within processes including the characterization of resources and the identification which of them to digitize in future indicates design potentials and consequences. Consequently, this approach – grounded in a deep analysis – makes designers more aware about each of the design decisions and is a contribution to the process of "drawing data from design" as required in [2]. It sharpens the awareness of consequences and requires the will and conviction of developers to address these problems with customers. They should not too easily count on users for finding the difficulties as often enough there is a severe time problem and everybody prefers to go on or get along with quick results.

In the following, we want to exemplify the general proceeding with an example, the coordination pattern scheduling and performing an (X-ray) investigation. Simplified, it incorporates the following coordination tasks.

- Making reservations of resources
- Sending documents (back and forth)
- Sending a possibly prepared patient (back and forth)
- Sending the patient record (back and forth)

In our example, the patient and the X-ray room/team are non-sharable, reusable resources which won't change their properties while using a computer system. It follows, that the way to synchronize and schedule them remains. However since calendars used in scheduling, in principle, become sharable while using computers, system developers and customers have to discuss new scenarios of making reservations. Questions are, who is able to see whose calendar with what kind of information. Who is allowed to make reservations (cross departments or not), is the ward allowed to make an appointment right away into the x-ray calendar or, the other way round, is the x-ray department allowed to write into the patient's calendar at the ward.

Using extended task pictures, s. figure 5, for capturing the different design alternatives, discussions among developers and customers from different departments about future system use and anticipation of changes in cooperation are supported. The two examples describe two different future scenarios where in alternative 1 the ward is able to see both calendars (the patient calendar and the X-ray calendar) and is able and allowed to make reservations directly in the calendar of the X-ray team (being automatically copied to the patient's calendar) whereas in alternative 2 she sends a request to the X-ray department and the X-ray department can see into both calendars making the reservation in "her" calendar which is automatically inserted into the patient's calendar. There are many more possible alternatives and each have their advantages and disadvantages some of which are dependent on the organization's culture.

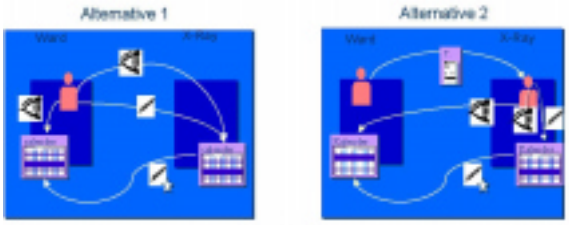

Figure 5: Design Alternatives for an X-ray investigation

6. Summary and Future Work

In the first part of the paper and based on characterizations of health care from organizational and social theory we have argued that requirements for HIS methods are on the one hand beyond the scope of existing IS methods in demanding for holistic approaches. Comprehensive methods have to address social, organizational and technical aspects. On the other hand based on the specific complexity of health work organization we have asked how HIS development methods can at the same time "capture" the specific organizational context in order to support the IS strategy finding process among representatives from different units and the understanding of the reality of situated heath care and potentials for change. Specialized methods and solutions should address specific cooperation support, trajectories and the embedding of computers into the work context.

In the second part we introduced the Anchor method. Anchor was developed in applied research projects in the area of professional bureaucracies like hospitals and universities. It introduces different perspectives (workplace/group, interdepartmental, business), uses anticipation of change as design rational and provides user-oriented representation techniques. Furthermore, Anchor determines development tasks such as the definition of an application kernels and system stages and the identifica-

tion of cooperation pattern and applies suitable techniques, e.g. results from coordination theory for analyzing and redefining complex coordination settings. Thus, Anchor is a first step in both directions. In incorporating organizational and social and technical aspects Anchor complies with the requirement of comprehensive approaches while at the same time it meets the requirement for specialized methods in decorating the process with suitable techniques from different research areas according to organizational and work specifics.

Further on, we suggest that Anchor can be used as a method framework in general. Starting with characterization tasks in the business dimension including investigation of organizational and work specifics of a domain this could systematically direct to the selection of suitable (specialized) methods and tools for the development within the interdepartmental and workgroup perspective similar to the HIS specific results presented in this article.

Further research is devoted to two directions. Belonging to HIS specifics, to develop system support for trajectories based on the idea of service processes. The other is devoted to the extension of Anchor towards IS development in general. We want to apply the method in different domains (start is done in the banking and insurance domain) and investigate which criteria for characterization of domains are of most value to select appropriate specialized techniques for the development process.

References

[1] J.G.Anderson, "Clearing the Way for Physicians' Use of Clinical Information Systems", *Communications of the ACM*, Vol. 40, No. 8, 1997, pp. 83-90.

[2] H. Beyer, K. Holtzblatt: *Contextual Design*, Morgan Kaufmann, 1998.

[3] U. Bürkle, Gryczan, G., Züllighoven, H. (1995). Object-Oriented System Development in a Banking Project: Methodology, Experience, and Conclusions. In*: Human-Computer Interaction*, Volume 10, Numbers 2 & 3, 1995, S. 293-336. Lawrence Erlbaum Associates Publishers Hillsdale, England.

[4] T. Butler, Enterprise Transformation and the Alignment of Business and Information Technology Strategies: Lessons from Practice, in *Proc. of the IFIP Conference on Information Systems: Current Issues and Future Changes*, Helsinki, 1998.

[5] De Michelis, G. et al.: A Three-faceted View of Information Systems, in *Communications of the ACM*, Vol. 41, No 12, 1998.

[6] H.-E. Eriksson, M. Penker: Business Modeling with UML, OMG Press 2000.

[7] Floyd, C., F.-M. Reisin, G. Schmidt: STEPS to Software Development with Users, in: C. Ghezzi, J.A. McDermid (ed): *ESEC'89*, Springer-Verlag, 1989.

[8] Floyd, C.(1987). Outline of a Paradigm Change in Software Engineering. In: G. Bjerknes, P. Ehn, M. Kyng (eds.): Computer and Democracy, Gower Publishing, Aldershot, pp. 191-210.

[9] Floyd, C., Züllighoven, H., Budde, R., & Keil-Slawik, R. (Eds.). (1992). *Software Development and Reality Construction.* Springer Verlag, Berlin.

[10] J. Grudin, Groupware and Social Dynamics: Eight Challenges for Developers, in: *Comm. of the ACM*, 37(1), 1994.

[11] R. Heeks, D. Mundy, A. Salazar, "Understanding Success and Failure of Health Care Information Systems", in A. Armoni, "Healthcare Information Systems: Challenges of the New Millennium", Idea Group Publishing, 2000, pp. 96-128.

[12] A. Krabbel, I. Wetzel, S. Ratuski, Participation of Heterogeneous User Groups: Providing an Integrated Hospital Information System, In: *Proceedings of the Participatory Design Conference* (PDC'96), Cambridge, Massachusetts, USA. 13 – 15, November 1996. pp. 241 – 250, 1996.

[13] Krabbel, I. Wetzel, H. Züllighoven: On the Inevitable Intertwining of Analysis and Design: Developing Systems for complex Cooperations, in: *Proceedings of the DIS 97*, Amsterdam, 1997.

[14] A. Krabbel, I. Wetzel: Designing Hospital Information Systems: Handling Complexity via a User-Oriented Document-Based Approach, in: A. Armoni (ed): *Healthcare Information Systems: Challenges of the New Millennium*, Idea Group Publishing, 2000.

[15] M. Kyng, Making Representations Work, *Comm. of the ACM*, Vol. 38, No. 9, 1995.

[16] L. Matthiassen: Reflective Systems Development, Volume I and II, Aalborg University, 1997

[17] T. McMaster, R. T. Vidgen, D. G. Wastell, Networks of Association and Due Process in IS Development, in *Proc. of the IFIP Conference on Information Systems: Current Issues and Future Changes*, Helsinki, 1998.

[18] B. P. Lientz, K. P. Rea: Business Process Improvement, Harcourt Brace & Company, 2000.

[19] T.M. Koulopoulos, *The Workflow Imperative*, John Wiley & Sons, 1995.

[20] T.W. Malone, K. Crowston: Towards an Interdisciplinary Theory of Coordination, in *Computing Surveys*, 26 (1), 1994.

[21] H. Mintzberg, *The Structuring of Organizations*, Prentice Hall, 1979.

[22] H. Mintzberg, J. B. Quinn, S. Ghoshal, *The Strategy Process*, Revised European Edition, Prentice Hall, 1999.

[23] P. Sachs: Transforming Work: Collaboration, Learning, and Design, Communications of the ACM, Vol. 38, No 9, 1995.

[24] T. Schael: Workflow Management Systems for Process Organisations, Springer-Verlag, 1996.

[25] A. L. Strauss, S. Fagerhaugh, B. Suczek, C. Wiener*: Social Organization of Medical Work*, Transaction Publishers, 1997.

[26] L. Suchman, *Plans and Situated Actions*, Cambridge University Press, Cambridge, 1984.

[27] R.B. Walford, *Business Process Implementation*, Artech House, 1999.

[28] C.G. Wolf, J. Karat, Capturing What is Needed in Multi-User System Design: Observations from the Design of Three Healthcare Systems, *Proc. of DIS*, Amsterdam, 1997.