Internal Systems development for a sector in change

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1. EXECUTIVE SUMMARY

In this article focus is on:

- How did we succeed in building this organization?
- How did we succeed in building solid information systems?
- Solid methodology for systems development, including strong focus on specifications and data modeling
- Knowledge of the area of student administration, research administration and admission administration
- Experience with, and knowledge of project management

1.1. Background

The IT-department at the University of Oslo is a vendor of administrative systems for all Norwegian universities and university colleges. Our department is more or less the only vendor of these systems.

Our department consists of about 40 employees, and we have the following systems in production:

- FS - Student information system
- SO - admission system, for applicants to higher education
- Frida - system for registration of scientific activities (publications, etc.)
- Data-warehouse, now entering its second phase of development

1.2. Conclusions

A significant characteristic of systems development is uncertainty about what is needed. It is only natural therefore that requirements will change over time (Moving Target). With our methodology we have systems that:

- Are up to date and meeting requirements
- Are rooted in the academic environments
- Has resulted in developers increasing their competence in the field of higher education
- Does not have local adjustments
- Builds on best practices at the institutions
- Have several common descriptions of practice
- Makes it possible for institutions to educate each other
- Makes it more natural for institutions to establish increased contact between them.
- Have contributed to the development of a high degree of trust between developers and users.

2. Internal systems development for a sector in change

During the last 18 years, the IT-department at the University of Oslo (USIT), has built an organization that develops administrative systems for the sector of higher education.

My section consists of about 40 employees, and we have the following systems in production:

- FS – Student administration system
- SO – Admission system for applicants to higher education in Norway
- Frida – System for registration of scientific activities (publication etc.)
- Data-warehouse, now entering its second stage of development

In this presentation my focus will be on essential factors contributing to where we are today. Our method of systems development is focused on two factors: Close cooperation between users and developers, and data-modeling. A solid data-model is the very foundation of our systems.

Our staff is relatively small, and the cost of using our systems is low compared to other systems used in the sector (mainly systems for wages, personal administration and economics). Today the number of man-hours used on the 4 systems is.

FS:	12 (plus 5 in user support)
SO:	9
Frida:	4
Data-warehouse:	5

2.1. A process of cooperation in the sector

Early in the 1990's, cooperation on acquiring or developing administrative systems, started within the sector. SO and FS were the first projects started.

SO was initiated by the Ministry of Education in 1991. At the time, every institution within the sector ran their own process of admission without any cooperation between them. No one knew the total number of applicants to higher education or the total number within programs.

Because of this, gathering of data and compiling statistics were the first activities in the SO project. After a while the next step was taken by implementing common admission. Applicants can apply to several institutions and to several programs of study but the receive only one offer.

We now work on an activity of being able to do the entire admission process paperless. In addition, we are adapting the system to a new reform in Upper Secondary Schools (Knowledge Promotion Reform).

The development of FS began in 1993 as a collaborate project between what was then the four universities in Norway; The Norwegian University of Science and Technology (NTNU), the University of Bergen (UiB), the University of Oslo (UiO) and the University of Tromsø (UiT)

A formal specification of requirements was compiled in the spring of 1994 and the data-model was ready in the fall of 1994.

Development relied on seminaries, meetings in the project group and the steering group and close dialogs between all parties involved.

Technical development started in the spring of 1995 and the system went into production in the summer of 1996.

During this period we had 3 developers and one person producing user documentation. The number of institutions using FS has grown considerably since 1996. During 2009 – 2010 every state owned institution in the sector is going to be using FS. The number of developers has grown to approximately 12 man-years each year. Today the system mainly meets the required functionality expected by the owners. Focus now is on communication with other systems, common use of the system and standardization etc.

The Quality Reform is a far reaching and ambitious Norwegian reform within the field of higher education implemented during the years 2003 to 2007. The Bologna process that happened at the same time influences many solutions in the Quality Reform. The Quality Reform is far more extensive and the intention was for the reform to result in better quality in higher education and research. The Quality Reform was a:

- Structural reform (new structure for degrees, new grade system, structured studies and individual education plans)
- Content reform (Follow-up and feedback, evaluation during studies, varied ways of work and evaluation)
- Financial reform (for institutions)
- Financial reform (for students)
- Reform of environment of studies
- Privilege reform
- Quality assurance reform
- Managing reform

The reform brought about changes to FS. The implementation of individual education plans and varied ways of evaluation involved the largest changes. The module for exams was totally rewritten. Implementation of the module for evaluation was the last activity done in FS to implement the reform.

The development of **Frida** began in 2002 as a collaborate project between NTNU, UiB, UiO and UiT. These 4 universities own Frida.

The good experiences obtained from SO and FS was the main reason the project development of Frida landed at USIT.

Because of the large interests shown by many other institutions for using Frida, the Ministry of Education currently consider whether to use Frida as the basis for a system common to all government supported research in Norway. A decision will be reached during 2009.

In principle Frida has one database for each institution, however using VPD technology has enabled us to keep all logical databases in one physical database, and to have some tables common to every institution. Many scientists are employed by more than one institution and many scientists from different institutions collaborate in research and publications. We have changed the data-model to ensure that a publication is registered only once and at the same time individual institutions still have responsibility for quality assurance for their data. Even though the restructuring of the data-model was done quickly, it was done only after many discussions and assessments.

The steering committees of both projects in the start-up phase consisted of one person from each institution. The project groups were likewise organized with one person from each institution, and with the project manager and secretary from USIT (UiO).

The data-warehouse project started closely connected to FS in 2002. Since technology for developing and using data-warehouses is different from development of source systems in many ways, some time was spent before we had sufficient expertise of the technology. For some years only data from FS was used. Analysis of throughput and production of study points were made. The head user of these analyses has been the Ministry of Education but interest from institutions is increasing.

The version we are now working on incorporates data from other systems as well; Frida, a system for economical data (OF) and some from the personnel managing system.

The four phases in our methodology for systems development:

2.2. Phase 1: Specification of requirements

The specification of requirements is compiled both at the start-up of development of a system, and when planning large modifications. In this process the collaboration with users happens through seminaries, project and reference groups, and through close contact with key users.

The original specification of requirements for FS was compiled in the spring of 1994, for Frida in 2003. The secretariats from USIT had previous experiences from development of systems for administration of studies and research information at the University of Oslo. The secretariats used their expertise to formulate first drafts of the specification of requirements. They in their turn were used in seminaries with the users. For instance when FS was going through initial specification, three seminaries of three days were arranged, with about 30 users participating in each seminary,

At first, needs and wishes from different institutions may appear to diverge. This has not been a problem in our cases so far; on the contrary we welcome the opportunity to get views from many perspectives on the subject matter. Which in turn, opens up possibilities for producing more general, flexible and robust solutions, especially in regard of future changes.

One example: The module of assessment is modeled in such a way that all examination, portfolio assessment and compulsory assignments are generalized into one concept.

Because the data-model in FS is highly generalized, new functionality is easy to implement. The changes to FS due to the quality reform were implemented by a minimum of resources.

In time, both developers and users gain experience leading to more optimal solutions. In this connection the new national solution within Frida may be mentioned.

Especially in this phase users feel that their everyday work and problems are taken seriously, and the foundation for confidence between developer and user is being laid.

2.3. Phase 2. Data-modeling

During this phase, some users were given education in the method for structuring information called NIAM. We worked through the data-model in project groups, working groups, and in seminaries.

2.4. Phase 3: Development period.

In this phase, the functionality of the system and components being developed is demonstrated to users several times, leading to important feedback allowing us to adjust functionality. And so on.

2.5. Phase 4: Testing

As has been previously stated, we firmly believe in the value of good data-models and their essential role in developing good systems. Experiences show that a good data-model results in fewer errors in the system. During the development period in FS, testing by users was only occasionally done. Despite few user tests, few direct errors were found when FS went into production.

New requirements and wishes continue to arise after a system is in use. We believe in the importance of users having faith in the belief of an ongoing process of improvement.

Trygve Lauritzen at NTNU wrote his master thesis on how users at the four universities experienced the introduction and subsequent use of a common student system. Responses were mainly positive, and clearly showed users belief in FS becoming a good system. This attitude was clearly connected to the fact that users expected the system to be further developed, and to their expectation of being part of this process in the future as well.

2.6. External contact networks

An extensive network is another result of developing FS and Frida. We believe in the importance of good relations with the Ministry of Education, NSD, SSB, research communities etc. These relations contribute to developers gaining competence in the business area.

2.7. What have we achieved?

Developing FS and Frida has resulted in developers enjoying a higher level of competence of the entire sector of higher education. Which means that we are able to partake in solving problems different from merely technical problems, and that our opinions are valued for instance by the Ministry of Education. We have got systems that:

- Are up to date and meeting requirements
- Are rooted in the academic environments
- Has resulted in developers increasing their competence in the field of higher education
- Does not have local adjustments
- Builds on best practices at the institutions
- Have several common descriptions of practice
- Makes it possible for institutions to educate each other
- Makes it more natural for institutions to establish increased contact between them.
- Have contributed to the development of a high degree of trust between developers and users.

2.8. Gartner Group

Peter Hidas is a consultant with Gartner Group. In March 2009 he wrote an article in Computerworld wherein he points to the necessity for changes and iteration in systems development.

Excerpt from the article:

"We think about development projects as if they were construction projects. We know exactly what to build, which materials to use and how to do it. We have done it many times before. In construction projects plans laid are often followed unless something unexpected turns up. But it is a lame comparison to systems development.

Systems development is not a technical construction process; it is about gathering and systemizing knowledge and opinions. It is all about learning. Designers struggle to understand the needs of users and managers, who have some ideas, but they change all the time. Designers try to 'freeze' requirements: 'From now on no more requirements are accepted, now we build!' – This never happens. One has to consider new and relevant requirements – otherwise the process fails.

Systems development is a journey, not a place to arrive at. Nick Jones at Gartner puts it like this: 'to develop new systems is more akin to exploring a new continent than driving the highway to visit grandmother.' Data systems are innovative and complex."

And:

"Systems development is quite as much a social process as a technical process. In a given development team, there will always be different targets and opinions. Fights for prestige. Interaction with users, who will be judging the system, can be good or bad. When users tells us that the new system is entirely hopeless, they do not tell the truth, but give their perception of both the process and the result. And of their willingness or unwillingness to receive changes.

If all this is true, we deceive ourselves (and our principals) over and over again when we expect a data system with no errors, delivered as promised and solving the problems it was intended to solve. It just wont happen."

A significant characteristic of systems development is uncertainty about what is needed. It is only natural therefore that requirements will change over time. To use this fact as an excuse when projects fail shows an unprofessional attitude. Large projects must be managed in such a way that changes are taken care of.

See appendix A for more information on: *Systems development at USIT*

Appendix A:

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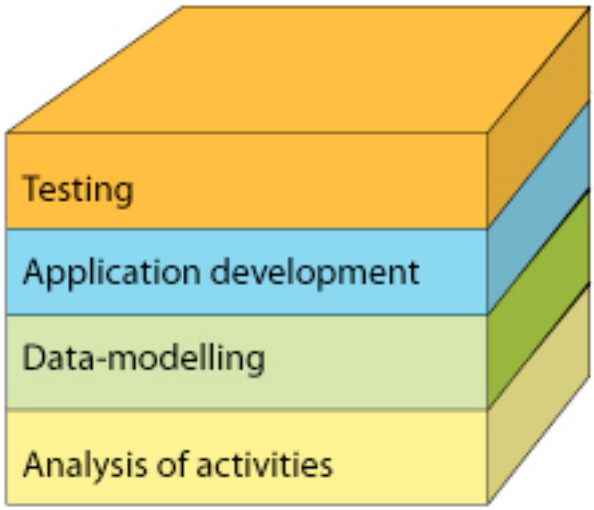
1. Systems development at USIT

Systems development in USIT has User-participation and data modelling as two fundamental elements. The development of the data-model is based on a structured specification of requirements developed in collaboration with the customer. The data-model is the foundation for our systems.

The systems development process is mainly split into 4 phases:

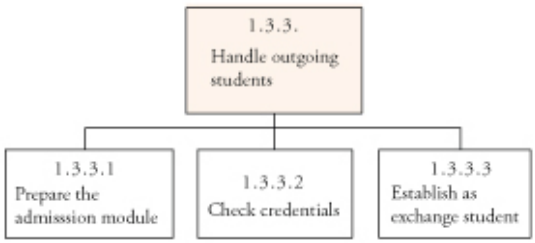


Analysis of activities is the first phase, resulting in the "specification of requirements". The process is carried out in close dialog with users. Users will collectively have to go through their work-related tasks, describing the contents with special focus on the purposes thereof. The systems developers task is to determine the requirements and arrange them systematically in the specification of requirements documents. All tasks are arranged in a tree structure (root at the top) and broken down to a level where each bottom node consists of how to do the task (by producing a report from the system for instance), in what organisational level the task belongs, whether the task is to be done manually, or whether to do it manually now but aim for later automation.

It is important in our model to have participation from users at different institutions as well as from different organisational units and levels within an organisation.

At the beginning of a systems development process, users often have different ways of solving similar tasks. By a systematic review of users routines, a best practice is collectively arrived at. In this phase, to listen to users, to ask them questions and structure information is the role of systems developers.

Analysis of activities produces a work breakdown structure and a description of activities. Each node in the diagram has a corresponding textual description, an example of which looks like this:



1.3.3. Handle outgoing students
1.3.3.1 Prepare the admisssion module
This will be implemented in the application
1.3.3.2 Check Credentials (more)
1.3.3.3 Establish as exchange student (more)
1.3.4 Further examples

In our opinion this manner of developing the specification of requirements is also useful when the process is aimed at purchasing a readymade system, by allowing the customer a very good background for an evaluation of what the system covers and consequences arising from what it does not cover.

Systems developers then start data modelling, putting the results to the group of users. As users are not normally able to evaluate whether a data-model is correct or not, we need to present them with the consequences of the model, often a challenging task. Some developers may cheat and simplify the model the better to explain it to users. This may swiftly lead development astray. The systems developer has a clear duty to present the model in such a manner that users recognises their reality in the model. When users do establish their recognition of the model and its relation to the work breakdown structure, we consider this a victory, and know that the solid foundation of the system is in place.

The application development phase comes next. The contact between users and developers is typically less in this phase. Developers take the requirements as their starting point when they produce suggestions for application windows and reports. When developers face choices in layout or functions, for instance, users are again consulted. The amount of contact between users and developers is dependent upon the system being developed.

Users and developers are together in close dialog again in the test phase.

When development of a system is "finished", the system is put into production. If the new system replaces an old system, an activity of transferral of data from old to new, is necessary. Users with knowledge of the old system, and developers with knowledge of the structures of the new system will carry out the activity.

1.1. Systems development for systems in production.

Most large systems must meet requirements in an ever-changing reality. "The moving target" is an expression in systems development highly relevant to our systems in the sector of higher education. Rules are being changed and new proposals for a system to cover greater areas and enhance functionality are requested. Changes in IT-technology will produce new possibilities and set new demands, and so on.

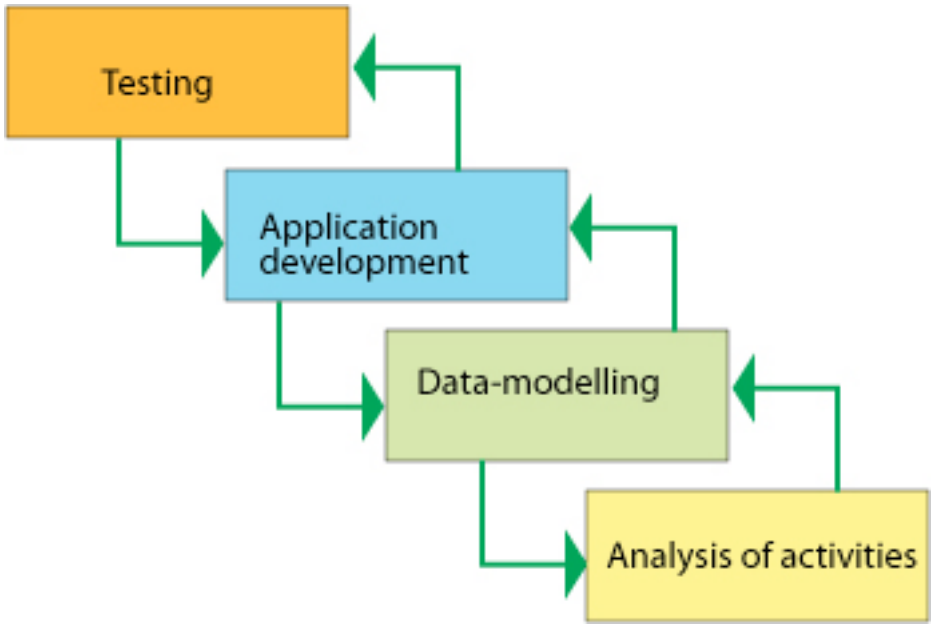
When users of a system in production gets to see what sort of tasks can be effected with the system in a more concrete manner, new wishes and requirements usually arises.

Wishes and requirements must be noticed, reacted upon and prioritised. Even though not every wish will be implemented, it is important to discuss the prioritisation with users and make sure they understand the reasons why. An example of a wish being rejected could be that the required functionality is to be implemented in another system.

As to the development of large systems, one must accept that the original specification of requirements hardly ever will carry all the functionality wanted for it. This is why it is of importance to ensure users that the system is being developed further even after being put into production. A system will be redeveloped through its lifecycle, and knowledge of this is also a component in strengthening the amount of trust between user and developer.

That users wish "everything" to be solved by the system without thinking about cost/benefit is common. Usually a vendor will want to comply with users wishes. With systems developed in-house, developers motive will be to make users satisfied. This can also be the case with an external vendor, in addition to them having a commercial point of view.

Until now the users has been addressed as the end-user of the system. That is as the person who will use the system to solve tasks in her occupation everyday. There exist many other persons and institutions who have interest of and demands for the systems. The Department of Knowledge is an example in our sector having diverse use for data to proposals to the Norwegian parliament, to meetings with institutions and as input to the model of financing for the sector. Data must be exchanged between systems. For instance FS delivers data to economic and personal systems, Norwegian Universities and Colleges Admission Service and a host of other systems. In systems development there must exist a person (project manager, executive manager etc) who evaluates wishes and demands against each other and produces a proposal of priorities to the person or level of decision who decide what to develop further, in a way that enables good decisions to be made. For this reason it is clearly necessary for the project manager/ daily manager to have extensive knowledge of both systems development and the fields in which the system is to operate (administration of studies, administration of research and so on)



Systems development is an iterative process.

Changes to the system decided for implementation after production, can be of a simple or complex nature. Wishes for new functionality that does not demand changes to the data structure are often relatively easy to implement. The case in hand can be as easy as a change to a leading text, or a new application window or a new report. If however the change demands one or more new fields not contained in the data model, the model must be changed too.

Depending upon the type of change, the developers will take a number of steps backwards in the systems development method. The introduction of a new field hardly ever cause developers to step all the way back to the analysis of activities. If however a large portion of the system is to be re-developed, the process starts with a new analysis of activities.

Close interaction between customer and vendor may contribute to improvements to the system being implemented without involving bureaucracy. Developers know both the users and their needs well enough to make decisions at a lower level.

Close interaction between customer and vendor bring about numerous meetings and discussions. When users from many institutions get together this also results in users having the opportunity for internal discussions and exchanging experiences. The systems development method in USIT encourages such cooperation. More and more often we observe that users sees the value in using systems in a common manner. The requirements are common, except in some smaller institutions where some functionality may not be necessary. Priorities may be different, but with an awareness of this, in common we will be able to prioritise.