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ABSTRACT
                Computer-assisted school information systems (SISs)
are developed and used worldwide; however, the literature on
strategies for their design and development is lacking. This paper
presents the features of a fundamental approach to systems design
that proved to be successful when developing SCHOLIS, a
computer-assisted SIS for Dutch secondary schools. The SCHOLIS
strategy concentrates on the following elements of object system
modeling, data modeling, and function modeling: activity analysis,
object analysis, and function analysis. The SCHOLIS strategy involved
seven stages: (1) constructing the hypothetical reference models; (2)
testing reference models in project schools; (3) formulating
elementary draft activities; (4) verifying draft elementary
activities; (5) towards a SIS framework; (6) collecting feedback of
the final framework; and (7) defining the final framework. The
fundamental strategy described in this article proved to be
labor-intensive but successful. It helped meet the following goals:
(1) development of a future school information system which can give
all possible and meaningful support to school staff and that probably
will have a long life-cycle; (2) integration of all subsystems in one
school information system which enables single entry and multiple use
of data as well as investigating relations between all database
elements; and (3) design and development of a system with a high
acceptation probability. Five figures are included. Contains 18
references. (LMI)

A FUNDAMENTAL METHODOLOGY FOR DESIGNING MANAGEMENT INFORMATION SYSTEMS FOR SCHOOLS

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Abstract

Computer-assisted school information system (SIS's) are developed and used worldwide but literature on strategies for their design and development is lacking. This situation should change since IS-quality and acceptance is to a high degree dependent on how the system is designed. Many of the strategies used proved to result in sub-optimal IS's. For that reason this article presents the features of a fundamental approach to systems design that proved to be successful when developing a SIS for secondary schools. Moreover, the analysis and design results are discussed and the merits and demerits of the strategy are evaluated. [Keywords: administrative applications, system design strategies, effectiveness]

Advantages of computer-assisted school information systems (SIS's) are recognized in many countries and as a result these systems are developed worldwide (see e.g. Visscher, Spuck and Bozeman, 1991). However, remarkable little has been published on strategies for the design and development of such systems. Literature only contains very global descriptions of the way in which SIS's have been developed in a number of countries (e.g. Bird, 1991; Dale & Habib, 1991; Fung, 1991; Telem, 1991). Self-trained teachers prove (Visscher and Spuck, 1991) to have developed the first school administrative computer applications, however without possessing the required professional knowledge and skills for this activity. Their approach was application-directed: the possibility of one valuable computer application (e.g. pupil registration) was observed, which resulted in system analysis and development concerning that specific activity area. When this application had been developed, after some time a new possibility for computer support was observed which again led to system analysis and development. This procedure was repeated every time the possibility of a new application was observed. When developing tailor-made systems for their own school the power of these teacher-developers in system development was considerable. In the 1970s software vendors entered the market, attempting to develop systems that can be used in as many schools as possible (Visscher and Spuck, 1991). Their system analysis and design activities often remained limited to one or a few schools, after which the system was adapted on the

basis of the experience of other schools using it. In the development strategy of software vendors some consideration was given to relationships among computer applications. However, complete integration of applications was a distant goal and not to be achieved until much later. Just like pioneer teachers software vendors played an expert role and user participation in system design was limited.

The third group of information system designers started to operate in many countries in the mid 1980s (Visscher and Spuck, 1991), and is formed by those who initiated a project aimed at the production of a new generation of systems by developing all possible forms of computer support in a systemic way on the basis of a so-called fundamental design strategy (Fung, 1988). This strategy implies that the information household characteristics of the entire school are first determined and the architecture of the entire computer-assisted system (the so-called information system framework) is defined on that basis. Subsequently the 'paper-modules' from the framework are transformed into software in a stepwise manner. The fact that the system is planned to be used in as many schools as possible implies that a standard system is produced. However, the importance of user participation in system development is also recognized and realized, and where possible flexibility is built into these systems, which enables system adaptations to a certain degree. Although the fundamental approach to system design can be observed in some countries, this level of system development is not yet widespread. On the contrary it is exceptional. Nevertheless, experience has shown that if a country wants to develop school administrative computer systems, it should choose with the fundamental, participative approach (see Dale and Habib, 1991; Fung, 1991; Telem, 1991; Visscher, 1991) because that strategy will quickly return the cost and effort invested. So, information on and evaluation of fundamental strategies for information system design is essential. For that reason the characteristics of a fundamental strategy that proved to be successful when developing SCHOLIS (a computer-assisted SIS for Dutch secondary schools) are portrayed in this article.

The added value of the SCHOLIS-strategy in comparison with others concerns the fact that the SCHOLIS information analists did not try to depict the existing information household of schools (who registers, processes and uses which information in which way?) but focused on finding the core of a secondary school in terms of its organizational activity subsystems, their mutual relations, input and output, elementary activities, entity types needed to represent the essential school objects and their attributes (= features of entities), as a basis for designing the information system architecture. So, user information needs that more or less accidentally exist at the time an information system is designed were not the starting point. The goal was to depict the essence of a secondary school and then to design the database in such a way that many varying kinds of information needs can be satisfied. As a result of the fundamental analysis the model of the object system pointed to many more valuable computer functions and forms of computer-output than already existing school information systems provided. So, in the case of the SCHOLIS-strategy, in

contrast with an evolving strategy, the strategy goes from developing *an object system* model, to designing the *database contents*, to determining *computer functions* that produce certain computer output and finally to *computer displays* that can be used by information system users (see Figure 1).

insert Figure 1 here

Moreover, SCHOLIS design activities were not only directed to pointing to possible computer functions, but also paid attention to manual activities in connection with computer functions. In fact, a completely new clerical and management organization has been designed for a situation in which the possibilities of modern information technology can be utilized.

Already existing school information systems had been based on an evolving design strategy (see Figure 2): from observing an user *information need* (= output desired by users, e.g. a specific report), to designing a *computer function,* and a *database contents.* When the information need had been satisfied, users after some time discovered another information need which again resulted in new computer functions and database contents This procedure was repeated again and again.

insert Figure 2 here

As a result of fulfilling each new information need the software had to be adapted repeatedly. The resulting software is ill-structured and hard to maintain (spaghetti-structures) because it has been developed gradually without having a picture of the whole system to be developed. Moreover, an evolving strategy leads to partial automation, because software development is not based on a structural analysis of all possible forms of computer support.

Before the more detailed features of the SCHOLIS-strategy are presented the importance of system development methods is explained first. Subsequently the results of using the strategy for system analysis and design are discussed as well as its merits and limitations.

THE IMPORTANCE OF INFORMATION SYSTEM DEVELOPMENT METHODOLOGIES

Developing computer-supported information systems (IS's) concerns a complex activity threatened by many problems. Essink and Romkema (1989) mention some of them:
- lack of adequate project planning;
- realized information systems do not meet user expectations;
- communication and knowledge transfer between project staff raise problems;

- responsibilities of project staff have not been defined clearly;
- project complexity is too great.

Information system development methodologies (ISDM's) contain warnings and guidelines to prevent certain mistakes when developing information systems and provide designers with a careful approach. These methodologies for instance enable the division of a big project into project stages and thereby specialisation of staff. Using ISDM's also makes project realization less dependent on personal characteristics. They help to cope with questions like "How should information systems be designed and constructed?" and "How can IS-development projects be managed effectively?". So, methodologies as well give assistance concerning the determination of the required IS-contents as concerning project planning and control.

Support concerning project planning and control is provided by so-called project management methodologies whereas system design methodologies assist determining the desired IS-contents. In this article the use of ISDM's is in the centre of attention, methods for project planning and control are not discussed here.

ISDM's help to answer the following questions:
- Which knowledge is required to take a design decision carefully?;
- How can the process of knowledge acquisition take place?;
- How can adequate structures of the IS to be build be derived from available knowledge?;
- How can IS-structure alternatives be described compact, unambiguously and communicatable?;
- How can a well-considered choice be made from available IS-structure alternatives?

In general, information system development projects start with a pilot study to determine if automation is advisable given the problems of an organization. The next stage generally concerns information needs assessment and a definition of IS-characteristics which involves analyzing the essential organizational activities and objects (object system modelling), determining the required computer functions (function modelling) and data analysis (data modelling). When the function model and data model are available the structure of the software (process structure modelling) and database (database modelling) have to be determined. The final project stage concerns constructing, maintaining and adapting the database and software.

THE SCHOLIS STRATEGY

The description of the SCHOLIS strategy as an example of a fundamental strategy for developing school management information systems concentrates on the following elements of object system modelling, data modelling and function modelling:
- determining the relevant organizational activity subsystems, their constituting activities and

mutual relations (activity analysis);
- analyzing relevant organizational objects (object analysis);
- function analysis (which activities can be automated, their required input, data processing and output).

So, purely technical activities like designing computer software (process structure modelling) and the database (database modelling) are out of the scope of this article.

Some general features of the SCHOLIS design strategy.

SCHOLIS design activities were directed at defining those organizational activities related to information collection and processing that were expected to improve school functioning. The formal and prescribable (sequences of activities, procedures) were the focal point instead of the human relations aspect of school organizations.

Moreover, a static design approach towards school organizations predominated. The goal was to improve the quality of how schools operate, by constructing a computer-assisted school information system. Although it was attempted to solve undesired effects of information system implementation in schools that participated in the SCHOLIS·project as much as possible, SCHOLIS was also developed to be sold, after the SCHOLIS-project to non-project schools. In the case of non·project schools developers of course could not pay attention to possible future problems arising in these schools as a result of information system use.

Knowledge used for designing and developing SCHOLIS came from the disciplines of educational administration, computer science and educational innovation. The nature and complexity of the task to be fulfilled, that is designing a professional and sophisticated school information system made that SCHOLIS designers operated in a manner that in many ways resembled the so-called design· approach of Ganzevoort (1985). The design approach is characterized by a linear and top down strategy: an expert diagnoses the problem and presents a solution without being involved in implementation of the solution. Nevertheless, school staff were offered the opportunity to comment on design proposals which frequently led to modifications of initial proposals.

It was the role of other project staff (non-designers!) to implement SCHOLIS in project schools, a difficult task that required considerable attention. Therefore, a lot of time and energy were dedicated to providing user support and training by a special implementation team. As such the SCHOLIS strategy also possesses some characteristics of the so-called developmental·approach of Ganzevoort (1985) which pays attention to realizing change by supporting users.

Van Strien (1975) distinguishes a predictive cycle from a regulative cycle. The first concerns the general scientific approach which is directed to predictive testing (falsification). Reality is studied as it is and if interventions are carried out this is done to observe their consequences for reality. The regulative cycle according to Van Strien applies in the case of problem-oriented thinking like clinical

diagnostics and counselling/guidance activities. The cycle especially is a matter of designing (instead of predicting and testing); the subject of investigation is something that changes and is changed, instead of something to be explained only. Within the regulative cycle the future is anticipated for in a realizable way; an attempt is made to accomplish a desired situation. Problem-oriented thinking is guided by a rule or goal and observation is directed by criteria, standards and goals (e.g. a social ideal, a health criterion or an organizational model). Client behaviour, organizational behaviour and the like are compared to those standards and it is determined where the behaviour observed deviates from the standard. If interventions are carried out, this is done to have the client, the organization etc. deviate less from the standard.

In the case of guidance/counselling activities the standard is designed <u>as a design</u> in cooperation with the organization or patient, and the client is supported in the realization of the goal(s) set. Following Schein (1969) Van Strien distinguishes between two subcycles of the regulative cycle:

1.   thinking: diagnosing the entrance situation, developing proposals for a solution, forecasting effects of interventions, evaluating them, and

2.   action planning: looking for excuses/barriers for change, executing the action planned, evaluating the actions.

Summarizing both subcycles, the regulative cycle goes from problem definition, via diagnosis, drawing up a plan and intervention to evaluation.

The strategy used within the SCHOLIS-project has many features of this regulative cycle. The SCHOLIS-project started with a definition and diagnosis of the problem, when the pilot study was executed, to determine the state of the art concerning computer-assisted school administration in the Netherlands as well as to take stock of existing problems in that area and to investigate factors causing those problems.

Diagnosing the existing situation implied that information collected on the state of the art of school administrative computing was compared to what was possible in that field, taking into account essential school activities as well as possibilities of modern information technology.

Moreover, if the situation observed deviated from the standards set the factors causing the difference between the existing and desired situation were investigated. The desired situation comprised a situation in which schools benefit from the advantages modern information technology offers and as a consequence operate efficiently and effectively.

The third step in the regulative cycle (drawing up a plan) in the case of the SCHOLIS-project consisted of defining SCHOLIS-project goals, including a project strategy that was meant to accomplish the desired situation.

SCHOLIS-project activities like designing the School Information System Framework (SISF), developing SCHOLIS software and introducing software into project schools, in terms of the

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regulative cycle of Van Strien must be regarded as elements of the intervention stage.

In trying to construct the computer-assisted school information system, first the organizational SISF was designed. This was done by taking stock of school organizational activities (including their interrelations and the information required for their execution) carried out in project schools. Similar to the problem definition and diagnosis stages, when the general SISF was designed the information collected in project schools was compared to a standard, the standard of a school benefiting from the advantages of computer use and possessing a sound administrative organization. If working methods observed in schools could in the opinion of designers be improved by means of computer usage, or where a schools' administrative organization could be improved, this was translated into the SISF-design.

When the SISF was available and software had been developed, intervention really started. Schools were taught how to work with SCHOLIS software (first prototypes, later end systems) and several school procedures were changed because of the expected positive effects of introducing and using SCHOLIS subsystems.

Finally, effects of interventions were evaluated (the final stage of Van Strien's cycle), when the impact of implementing one SCHOLIS subsystem, the Absentee Registration subsystem, was determined.

The SCHOLIS strategy stages

More detailed characteristics of the information system development strategy used for designing SCHOLIS are presented now.

A pilot study (Visscher & Vloon, 1986a, b) on computer-assisted school administration and school management showed that a thorough analysis of essential organizational activities of secondary schools, including an analysis of the information required for their execution and the school's interaction with the environment was lacking. Such an analysis was regarded a prerequisite for developing a detailed school information system framework (SISF). A SISF comprises all school organizational activity subsystems (e.g. financial registration or educational planning) and shows their input, output and mutual relations in terms of information and/or material flows between them. Moreover, in each school organizational activity subsystem its constituting activities are described as well as the role the computer can play in their execution. Figure 3 shows the seven project stages for the design of the SISF for SCHOLIS.

insert Figure 3 here

Stage 1: constructing hypothetical reference models

The first activity concerned the design of so-called reference models that provide temporary

7   8

hypothetical diagrams of information dependencies (information flows) between school organizational processes which were used as a basis for analyzing the information household of schools. An important reason for the use of reference models was the goal of controlling information analysis (without them the danger exists of loosing overview as a result of an overload of information). The diagrams were made by means of the so-called ISAC method (Lundeberg, Goldkuhl & Nilsson, 1987).

What information analists needed were descriptions of what happens in schools, from the moment a student applies for a school, till he/she leaves the school. Reference models were not only constructed for student-related affairs but also for areas like personnel, finance, timetabling and resources, both at clerical and management levels. Literature research showed how little detailed information was available on the contents of activities involved in running a school (e.g. constructing timetables, student registration, planning finance, personnel and other resources). Therefore, what is known about similar processes in companies has been used to form an image of the way in which these processes take place in schools.

The school has been divided into six organizational activity subsystems (planning, resources, pupil administration, the teaching-learning process, financial registration, personnel administration) and their contents has been unravelled by building reference models for each of them. The input and output of each subsystem have been determined, just as their interrelations in terms of the information and material flows between them. In subsequent diagrams each activity subsystem after that has been elaborated upon. The organizational activity subsystem "Pupil administration" has for instance been elaborated into nine essential component activities (= groups of interrelated activities): 1. enrollment, 2. grouping pupils into classes, 3. administration of principal pupil data, 4. absentee registration, 5. pupil guidance and counselling, 6. test scores registration, 7. internal examination/national written examination, 8. deletion of pupil names out of the school register, 9. producing pupil reports.

These component activities after that have been elaborated on more detailed levels. 'Enrollment', the first component activity of "Pupil Administration" consists for instance of four other component activities (recruiting pupils, handling applications, admittance and composing pupil files) with many information and material flows between them. Finally, the elementary activities that comprise a component activity have been formulated for each component activity. Elementary activities cannot be divided further into subactivities. The person carrying out the activity possesses all required information and is independent on the results of other activities (s)he does not control.

Moreover, various concepts (e.g. root class, lesson group, profile improvement) had to be defined to clarify school organizational life and to prevent communication within the project team and between analists and school staff becoming confused.

Stage 2: testing reference models in project schools

To verify the constructed reference models three schools for general secondary and/or pre-university education have been analyzed by means of 85 interviews (that have been based on reference models) with school staff intensively involved in certain school organizational activities (student counsellors, (deputee) principals, clerical staff, the timetabler, heads of department and the caretaker).

Examples of organizational activity areas that have been analyzed are: absentee registration, personnel administration, planning the next academic year, resources supply, devising timetables and test scores registration.

Interview questionnaires have been developed on the basis of reference models to enable the execution of a specific analysis and to discover errors in the reference models. In addition to the interviews all school documents used for a specific school organizational activity have been collected and analyzed, because they show which data are registered and processed and how this is done.

Stage 3 + 4: formulating and verifying draft elementary activities

On the basis of the data collected in the previous stage a chronological description has been made of the elementary activities comprising each school organizational activity subsystem.
Descriptions of each project school in terms of elementary activities have been presented to interviewed staff members for verification and, when necessary, adapted as a result of that. At the time all school organizational activity subsystems of each project school had been described correctly, the next important step could be taken: designing a general model of the information housekeeping of secondary schools.

Stage 5: towards a school information system framework

It was attempted to construct a general model (the school information system framework) of a Dutch school for secondary education that did justice to all project schools analyzed. When it was not possible to design an information system framework that integrated everything that had been observed in all schools analyzed, choices had to be made on what could be honoured and what not. Moreover, when the framework was designed, not only the situation was depicted as it already existed at the time computers were not in use. It has also been determined how modern information technology could be used for administering schools. As a result new elementary activities, possible as a result of the availability of the computer have been included in the general model as well.
An important goal of defining new computer-assisted activities concerned realizing availability of

reliable information for internal and external purposes. This goal especially lead to defining elementary activities intended to provide school management with all kinds of valuable management reports.

The general goal guiding design activities concerned realizing a sound administrative organization. This means that a situation was strived for in which it at any desired moment is possible to present an accurate view of the existing organizational situation speedily and in which available information makes it possible to carry out organizational activities in a coordinated way. Moreover, for reasons of efficiency an attempt was made to prevent double registration of data. It was also considered important to determine which staff members were competent to take decisions and which procedures should be followed in case of important decisions. Finally, it was attempted to avuid informal procedures, if they were considered to be ineffective.

Designing an information system framework concerns a creative activity; design principles are always latent; every now and then designers get an idea about how school procedures can be improved by making use of the design principles.

The role of the design principles

The way the design principles played a role in designing the Enrollment subsystem are now explained as an example.

As already mentioned, a sound administrative organization was aimed for. Therefore a distinction was made between direct, indirect, incidental and interim student applications, and elementary activities necessary for handling each type of application were designed. A direct application is an application that comes directly from parents (by telephone or letter). On receipt of such an application the school sends an application form to parents to complete. An indirect application comes from delivering schools that are regularly approached by a staff member of a receiving school. Incidental applications are direct applications at the start of a school year for grades that normally do not have many applicants (like the second, third and sixth grade), nor a formal admission committee. The applying student in these cases is often only approved by one person (e.g. the deputy head). An interim application is an application submitted during the school year and as such is always a direct application. In cases of interim applications for a school type grade, the application is always treated very informally (no admission committee).

A distinction was also made between applications for the transition grade and applications for higher grades. It was proposed to use different application forms for both grades because different data are important for the application decision in both situations (e.g. subjects a student would like to choose are only important for the entrance decision concerning applications for higher grades). Other examples of attempts to realize a sound administrative organization within the Enrollment subsystem are as follows:
-       It was proposed to send a confirmation letter to parents/students when an application is

received and when the final entrance decision has been taken, in order to inform them about the progress of their application;

- Steps were taken to ensure missing data on forms and missing forms are timely noticed, and to take action in cases of missing data/forms;
- It was proposed to give each application form received a number according to the order in which it is received as well as the total number of applications at a given moment;
- When application forms have been received data relevant for the entrance decision have to be registered first. Other data on the application forms are only registered after a student has been admitted. This is done for reasons of efficiency, since all other received data of students who will not be admitted does not then have to be registered;
- An important characteristic of the designed subsystem concerns the already mentioned cross list which contains data relevant to the entrance decision. The list is meant to be used by the admissions committee and always provides an up-to-date overview of the number of applied students and the state of each application. As such the cross list has an important coordinating function. The 'wait-condition' terms were proposed to be able to distinguish between different states of application;
- If parents do not agree with the rejection of their application these are dealt with as follows: parents have to submit a request for a review. if approved the admissions committee (as the competent body) changes the state of an application from 'Rejects' into 'Admits Definitively.' By defining this procedure it is attempted to avoid informal procedures;
- Schools delivering students are informed about their students' enrollment. They receive a report including which of their students applied for the school and the final entrance decision concerning these students.

Next to striving for a sound administrative organization, defining new valuable (computer) activities was mentioned as a goal/design principle. Several new elementary computer activities were proposed when the Enrollment subsystem was designed. The role the computer can play in executing each elementary activity has been evaluated as follows: (a) none, an activity which cannot be formalized, b) one that can be formalized, but which should be executed by a person, c) a supporting role (a man-machine activity carried out partly by a person and partly by the computer), or d) complete executing role (the computer carries out a machine activity). Figure 4 depicts the various possible organizational activities.

insert Figure 4 here

Legend:
- *in scope*: the activity is part of the information system framework;

- *out of scope*: the activity is not part of the framework, so no attention is paid to it;
- *formalizable*: the activity can be described within strict rules;
- *non-formalizable* (code 1): the activity cannot be described within strict rules;
- *manual* (code 2): the activity cannot be automatized (e.g. judging if a student can have a day's leave of absence or not);
- *machine tasks* (code 3a): for instance the computer produces lists;
- *man-machine tasks* (code 3b): e.g. entering data into the computer.

Some of the new defined activities are meant to retrieve valuable information. School management can for instance investigate:
- the relation between the number of students applying and the number of students that have been admitted;
- trends in the number of students received from each of the delivering schools;
- the relation between the school of origin, or the school advice of the principal of the delivering school on the one hand, and student achievement on the other.

Other new elementary activities have been designed to draw the attention of users if a certain action has to be carried out (e.g. to obtain missing data), again others are executed to register new relevant information in order to produce new forms/lists, or to process data.
Since data are supposed to be registered in a database that can be approached from various points (terminals within a computer network) within the school, double registration of data is avoided.

Stage 6 + 7: collecting feedback and defining the final SISF

To prevent a framework being designed that does not fit the practical situation of schools, it was decided to have the organizational activity subsystems and the elementary activities judged by a selection of school staff from project schools. Feedback was obtained by arranging several meetings with school staff, during which SCHOLIS project staff presented their proposals concerning each activity subsystem (proposed elementary activities, their sequence and where the computer was planned to be used for their execution). Each project school was represented by a cross section of staff. During the feedback meetings the essence of each activity subsystem was discussed in groups (with regard to their feasibility and (dis)advantages). As a result of the feedback from school staff the SISF was modified until an information system framework had become available that as well did justice to the potential of modern information technology as to the needs of schools that would work with the system. The SISF formed the basis for designing computer functions (Essink & Romkema, 1989) and for developing the SCHOLIS-software.

ANALYSIS AND DESIGN RESULTS

The complete results of the analysis and design activities have been published in Essink & Visscher (1989a, b). In this article, these results can only be described very briefly.

The first type of output of the analysis and design activities outlines the interaction of a Dutch secondary school with its environment. The external persons/bodies with which the school exchanges information, goods and the like are presented as well as *what* goes from the school to these persons/bodies (output) and comes from them (input). A more sizeable kind of result concerns the school organizational activity subsystems comprising a secondary school, their desired input and output and the organizational activities by which input is transformed into output. The portrayal of a school in terms of its organizational activity subsystems is hierarchical. It starts with the school as a whole and on that level typifies six important school organizational activity subsystems (planning, resources, student administration, the teaching-learning process, financial registration and personnel administration), their mutual relations and input and output. Subsequently the elements of the school diagram have been elaborated upon in other diagrams whereby each organizational activity subsystem has been portrayed more in detail: component activities which later on have been elaborated into elementary activities.

When this organizational subsystem structure was available, the structure of the computer-assisted information system SCHOLIS was determined by deciding on the subsystems SCHOLIS was planned to consist of. In some cases this meant that parts of the organizational activity subsystems were planned to be separate computer-assisted SCHOLIS subsystems. The structure of SCHOLIS that is portrayed in Figure 5 and which shows seven registrational and four management subsystems is discussed briefly now.

insert Figure 5 here

Figure 5 shows the 'Student Registration' subsystem to be a central one, since eight student registration subsystems are reserved for registering student data. A student's school progress is depicted by registration elements ranging from 'Enrollment' (subsystem I.1) to 'Deletion'(I.8). Just like in other organizations a Personnel (II), Financial (III), Text (VI) and Resources registration (VII) subsystem have been identified. Two other subsystems have been classified as registrational subsystems as well: 'General school registration' (V), which includes registration and mutation of general school characteristics like the school structure, student promotion standards and subjects to be taught and 'Timetable registration' (IV) in which the timetable and daily timetable modifications are recorded.

As far as management subsystems are concerned three planning activities, (Capacity, Educational and Financial planning) have been identified as well as School year evaluation. 'Capacity planning'

(VIII) concerns planning the required (teaching and non-teaching) manpower, technical infrastructure, school buildings and grounds. Under manpower planning one can think of planning the number of lesson periods to spend and planning the number of lesson groups (the latter has consequences for the manpower required). Capacity planning in particular involves a lot of computational work and therefore concerns an area in which computers can be very valuable. Another planning activity concerns Educational planning (IX) which includes teacher recruitment and determining which teacher will teach which subject, to which lesson group and when. 'Financial planning' (X) covers all kinds of budgetary activities including drawing up the draft school estimate and determining the final estimate, department estimates, and investment plans. 'School year evaluation' (subsystem XI) covers wide-ranging management processes like evaluating the resources and organizational structures the school has used, the way in which financial resources have been used and evaluating social matters and student achievement.

HOW THE DESIGN RESULTS HAVE BEEN USED

A prototyping team produced prototypes on the basis of the organizational information system framework by concentrating on the framework component to be automated. The so-called prototyping strategy concerns an approach for information system development that was introduced in the eighties. Witsenboer (1985) on the basis of an evaluation of several definitions, defines prototyping as follows: "Prototyping in all stages of information system development concerns an iterative modelling process; an executable model of part of the information system is built quickly and in interaction with the user to reduce specific uncertainties, in order to make the development process more effective and to realize better accepted and more effective results". Witsenboer (1985) mentions some reasons for prototyping as well.
The prototype is built and shown to the user who then can evaluate to what degree this 'proposal' corresponds to his desires. By providing feedback on the proposal the user participates in the design process. (S)he sees the results of the first design activities very clearly (in former days written or oral system descriptions were presented) and can influence system characteristics by submitting proposals for change. The user has the possibility to formulate his desires and can do this more carefully since (s)he can react to a visual prototype and as such indicate where it corresponds to his/her wishes. For developers this form of user participation offers the advantage that user desires and demands concerning the system to be developed can be determined better. One may suppose that this strategy results in information systems that agree more with the ideas of users, and as a consequence increase the probability of the innovation being accepted.

MERITS AND LIMITATIONS OF THE STRATEGY

The SCHOLIS strategy proved to be very labour-intensive which among others resulted from the fact that the thorough analysis of the information housekeeping of schools could not be based on earlier scientific work concerning school administrative life. A positive effect of the large amount of time invested is that detailed images of school administrative processes are available now.

The use of reference models made an efficient and effective analysis of schools possible and enabled the processing of the flood of information the analysis produced. The models helped to put specific questions that were used to test the 'hypotheses' and to distinguish between major and minor affairs in respondents' answers to interview questions. Moreover, they proved to be an excellent tool for bridging the communication gap between analists and users. Analists were not completely dependent on respondents' 'brainwaves'. Formulating and verifying elementary activities offered the advantage that the information collection and processing features of schools had to be stated on a more detailed level than the reference models. Defining those activities and presenting them for verification to those interviewed led to modifications of the descriptions. Incorrectnesses in draft descriptions were probably caused by a number of factors:

- descriptions of the elementary activities may have been incomplete due to the interviewer not asking all the relevant questions, or the interviewee not giving all the essential details of an activity;

- communication between interviewer and interviewee is often imperfect since both form an image of what the other says and means; these images may not fit completely with what the other person meant to say.

Sometimes it proved difficult explaining the information needs of designers to school staff and to let them describe an activity in full detail. Many operations carried out by school staff are so self-evident to them that they only described them after persistent questioning. So, verifying descriptions by presenting them to interviewed staff served two purposes: 1. checking if the image of the information received was correct and complete and 2. investigating if designers' ideas were correct on those activities where information proved to be incomplete.

Since the feasibility of the proposed elementary activities was crucial (to prevent that proposals would not fit with school features) school staff have been asked to give feedback on these proposals. As a result valuable additional information was obtained on the basis of which the draft design proposals could be improved. Since it was difficult for users to judge these complex proposals on paper, they also have been presented with information system prototypes and have been asked to react on them. This strategy offered users the opportunity to influence prototype characteristics as a result of which prototypes could be adapted relatively easily.

Although the time required for analyzing schools in depth meant that the number of analyzed

schools could not be large, the results of the analysis proved to be a good basis for designing the school information system framework. The limited number of schools was not a big problem because the framework was also tested by developing prototypes and by implementing and testing those in a larger group of schools. Project staff also varied the schools to be analyzed concerning those characteristics that were expected to have important implications for information collection and processing features of schools (type of governing body, types of education the project schools provide and their pupil selection procedure). It was reassuring the analysis showed that differences between the schools analyzed were not dramatic. Designing information systems for a large number of organizations means that complexity of reality has to be reduced because all existing differences between schools can not be honoured. However, some standardization can be good for schools that operate in sub-optimal ways. An important prerequisite for successfully developing one information system for a large group of schools is a well-thought-out design. Schools that have to change their procedures as a result of system usage will then eventually judge the change as an improvement.

Moreover, prototyping produced satisfying results and did not lead to radical changes in the designed information system framework.

Finally, the information system was designed in such a way that it to a certain degree offers schools the opportunity to adapt the system to their specific features and needs.

The probability that the life cycle of the SCHOLIS system will be long is high since considerable time has been paid to determining all possible computer support. So, the chance that the system has to be changed completely because of new discovered areas for computer-support is very small. Besides, if system adaptation is necessary the flexible basis of SCHOLIS (a fourth generation programming language and a relational database) enables a relatively easy adaptation and expansion of the system.

Research on the degree to which elements of the information system suit the desires and characteristics of schools using it showed that about 100 schools were very positive about its features (Visscher, 1992). Implementation of prototypes and end-systems in non-project schools, did not create substantial problems. In other words, subsystem designs were general enough to enable non-project schools to benefit from the systems.

When the SCHOLIS-project was started project initiators realized their plans were ambitious but they did not know that designing and building an information system would be that difficult and demand so many resources. Information analysis resulted in an enormous quantity of data on the information housekeeping of schools. Cooperation with and the input from many schools was intense, and developing SCHOLIS required the input from many people with different academic backgrounds. The fact that such a large group of people was needed to realize project plans meant that executing the SCHOLIS-project required frequent coordination between internal staff involved as well as between SCHOLIS-staff and external bodies. As a consequence project management

became an important but very difficult task.

CONCLUSION

The fundamental strategy that has been described in this article proved to be labour-intensive but successful. It helped to meet the following goals:

- development of a future school information system which can give all possible and meaningful support to school staff and that probably will have a long life-cycle;
- integration of all subsystems in one school information system which enables single entry and multiple use of data as well as investigating relations between all database elements;
- design and development of a system with a high acceptation probability.

By focusing on an analysis of the core of a secondary school from an information processing point of view designers became less dependent of user needs, as formulated more or less accidentally at a certain moment. The latter is important since user needs are a weak basis for system design. Users have an imperfect picture of all possible forms of computer-support and their needs in many cases will expand as a result of growing experience with information system use. When the analysis of a school had resulted in a fundamental object system model it became possible to satisfy user needs at moment X but it also did not cause problems to satisfy new information needs at moment Y or Z. The analysis and design activities have resulted in an information system with a system potential in terms of the support it can provide that is much bigger than the forms of computer-support schools need now. Besides, the thorough analysis and modular system design have resulted in a system that can be maintained very well. So, when schools grow in their role of information system users this will not create serious problems with regard to providing the desired computer-support.

Contributor

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| Modelling a school's core (object system model) | → | Design of database contents | → | Design of computer functions | → | Design of computer displays |
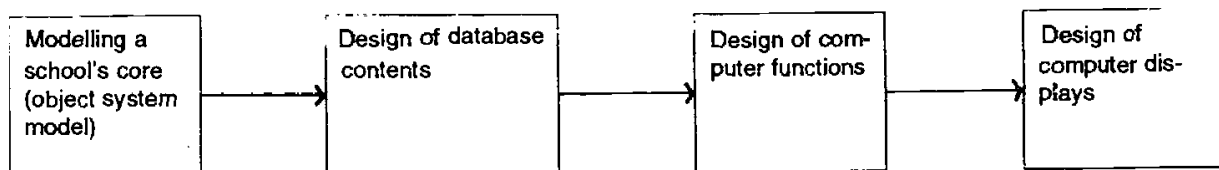
Figure 1: From object system model to computer displays

| Observation of information need | → | Design of computer function | → | Design of database contents |
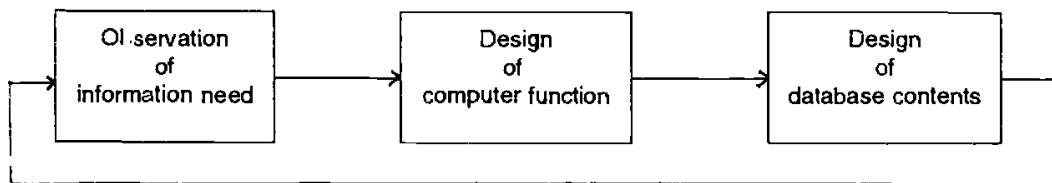
Figure 2: From information need to database contents

1. constructing hypothetical reference models

↓

2. testing reference models in project schools

↓

3. draft description of each project school in terms of the elementary activities comprising each activity subsystem

↓

4. verification and adaption of the elementary activities of each project school

↓

5. designing the general School Information System Framework draft

↓

6. collecting feedback on the School Information System Framework draft

↓

7. defining the final School Information System Framework

Figure 3: Stages for designing the school information system framework for SCHOLIS

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                    ┌─────────────────────────┐
                    │ Organizational activities│
                    └────────────┬────────────┘
              ┌──────────────────┴──────────────────┐
         ┌─────────┐                          ┌──────────────┐
         │ In scope│                          │ Out of scope │
         └────┬────┘                          └──────────────┘
      ┌───────┴───────┐
  ┌────────────┐  ┌───────────────┐
  │ formalizable│  │non-formalizable│
  └──────┬──────┘  │       1       │
         │         └───────────────┘
    ┌────┴────┐
┌─────────┐ ┌──────────────┐
│ manual  │ │ automalizable│
│    2    │ │      3       │
└─────────┘ └──────┬───────┘
              ┌────┴────┐
       ┌──────────────┐ ┌──────────────────┐
       │ machine tasks│ │man-machine tasks │
       │     3a       │ │       3b         │
       └──────────────┘ └──────────────────┘
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Figure 4: A classification of organizational activities

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Registrational                                                        Management
subsystems                                                            subsystems

  I          II          III         IV          V           VI          VII        VIII        IX          X           XI
Student    Personnel   Financial   Timetable   General     Text        Resources  Capacity    Educational Financial   School year
registration registration registration registration school  registration registration planning    planning    planning    evaluation
                                              registration             (including
                                                                       book fund)

  I.1        I.2         I.3         I.4         I.5         I.6         I.7        I.8
Enrollment Grouping    Principal   Absentee    Student     Test scores Final      Deletion
registration students  student data registration guidance   registration examination registration
           into classes administration          and                    registration
                                                counselling
                                                registration

                                                                                  XI.1        XI.2        XI.3        XI.4
                                                                                  Resources   Financial   Social      Educational
                                                                                  evaluation  evaluation  evaluation  evaluation
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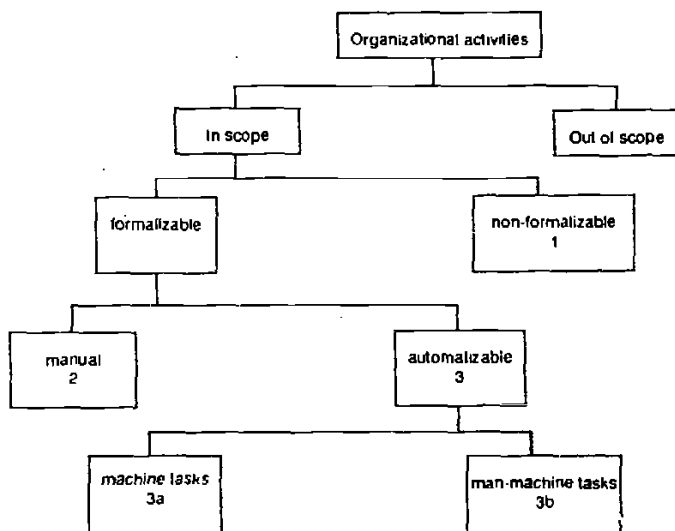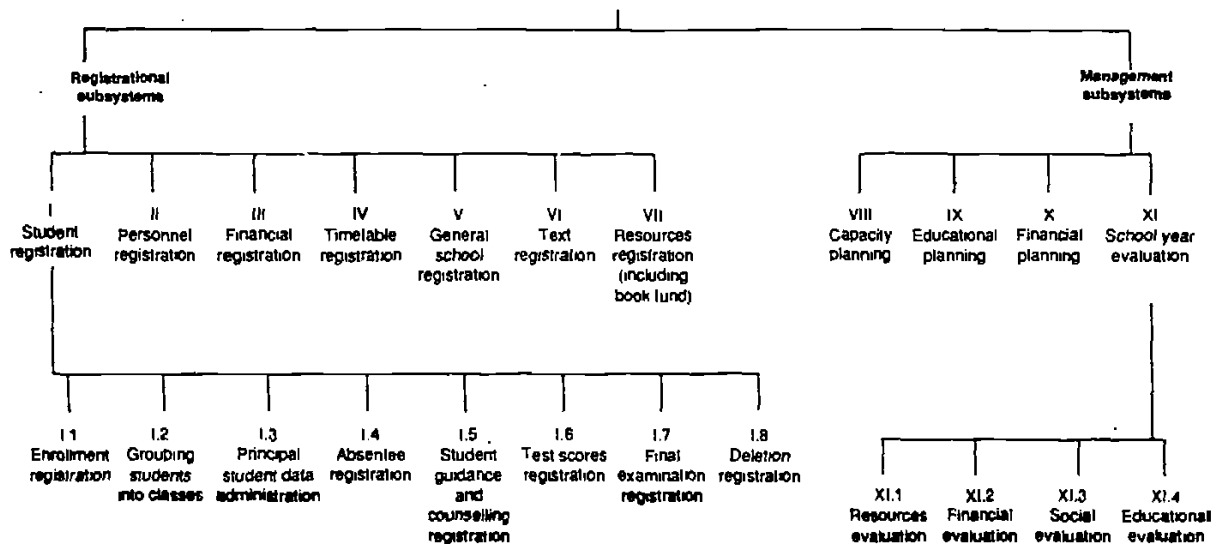
Figure 5: A computer-assisted School Information System Framework for Dutch secondary schools