Flexible Enrollment Information System ERES 2: A Tool for Managing Teaching Activities*

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Introduction

The increasing need for smooth management of all academic and administrative activities, and requirements for more efficient utilization of limited academic resources (academic staff, space, laboratory equipment and financial resources) imply increased needs for more cost-effective organization and better resource management in universities.

The managerial and organizational issues are more complex for those universities which have introduced the modular system of studies, or so called *Flexible Individual Enrollment System* (*FIES*) for students. The Faculty of Electronics and Information Technology is the first academic institution in Poland to have introduced *FIES*, in 1990.

FIES allows all students to study individually. It gives substantial flexibility of studies, where students can select their own menu of lectures, as well as the individual workloads and timetables. They also may select some variants of similar or equivalent lectures. Credit points are attached to courses, and students individually select courses and collect the required credits by the end of each phase of study.

The introduction of *FIES* creates many managerial problems at the university. An appropriate information system for computer-assisted enrollment and computer-aided management of academic activities is not only an important help, but is a *must* in order to achieve performance and proper organization of all university activities.

A crucial feature of many universities is that they have to operate at a relatively low budget. It is hence important to develop and implement an information system that will provide proper organization, flexible management of university activities and efficient utilization of all university resources at low cost.

In this paper we present our experience with the development of a second generation of a novel, cost-effective information system ERES 2 for flexible individual enrollment and computer-aided administration and management of a faculty. Special care is devoted to the design and organizational issues.

Organization of the modular system

In a flexible studying system substantial freedom must be given to students to allow them to select lectures, and to provide individual enrollment and timetabling. In each semester students select their own individual sets of lectures from those offered, assuring only that appropriate prerequisites are followed. Students may also select variants of similar or equivalent lectures offered by different academic staff from various departments. Thus, students may design individual timetables in each semester.

An enhancement of flexibility of the curriculum means that programme leading to a particular degree, offered to students, allow the students many options within their areas of interest. A course offer must

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be large and diversified. It is convenient for all lectures that are offered to be structured and grouped into *subject* classes. Each subject class contains all modules (lectures) from the same subject area, such as mathematics, computer programming, etc. Inone subject group there may be lectures offered by different departments. Some credit points are attached toeach lecture and students collect the required credits.

The requirements of each individual curriculum are defined as a composite requirement for selection of obligatory and optional modules from the subject classes offered.

For each curriculum there is a set of obligatory modules. For optional modules, the requirements may be formulated as appropriate logical expressions, such as "select a required number of credits from the sum of two subject classes S_1 and S_2." The precedence relations between modules of a curriculum may be represented on a *curriculum graph,* where nodes represent modules, and edges represent the prerequisite requirements.

There are many differences in the environment and in external conditions between Polish and western universities — one of the most important differences is in the attitude and motivation of Polish students. Since Polish students do not have to pay tuition fees (studying is cost-free for all students), a majority of students has insufficient motivation for timely and cost-efficient completion of study. Therefore, the individual enrollment must be accompanied by rules for controlling the progress of students, so that a satisfactory average grade level can be maintained and the duration of study can be preserved within certain limits.

Progress in satisfying the curricula requirements is verified throughout the whole duration of study.

Curriculum requirements should be formulated for each area of concentration. To obtain a degree, a student should have to satisfy the requirements for at least one area of concentration – this ensures "in-depth" education in some sub-area of the curriculum.

The coverage of fundamentals and necessary breadth of education can be guaranteed by including in the curriculum requirements a sufficiently large set of the subject classes.

Administrative Tasks Making the curriculum more flexible and providing the students with extra opportunities potentially increases the costs of running the institution. To optimize performance, an efficient management is required, including efficient resource utilization (efficient scheduling of academic activities and resources) and an appropriate fund allocation policy which would discourage inefficient utilization of human and physical resources that occurs, for example, when undergraduate courses are taught for a very low number of students.

An enhancement of flexibility and adaptability poses many organizational problems in the area of administration. Relaxation of restrictions on the design of individual programs of study implies significant changes in the courses offered and taught in each semester. Also, the change in the number of students enrolled in each of the courses from one semester to another is significant. The process of updating the course schedule and classroom assignment is much more difficult than in the case of the traditional curriculum. Also, the registration procedure is more complicated and might require the provision of simultaneous access of a large number of users to the database.

Therefore, adequate computer facilities should be installed and an appropriate information system for computer-assisted enrollment is required to achieve proper organization and high performance.

University information system

A university *information system* should provide procedures to record, process and make available information, concerning all teaching, administrative and research activities at the university, and to assist functional and management activities in order to improve efficiency and effectiveness.

The functional university activities include teaching activities and activities related to processing of the administrative and organizational information, including enrollment. Management activities plan and control the university functional activities.

The main objective of introducing a university information system is to improve *efficiency* and the effectiveness of the university. Efficiency is related to internal organization factors. The aim is to process all university activities so that the teaching and research activities use less resources, i.e., they can be performed more efficiently, and therefore productivity and efficiency may be improved. Effectiveness is related to external factors such as improved flexibility and adaptability to the needs of students, and improving academic quality standards.

Traditionally, most benefits have come from efficiency and productivity advantages gained from automating functional activities. However, recent trends are towards assistance in and improvement of the decision making process in management activities. Improvements in effectiveness are more subjective than improvements in efficiency, and cost/benefit estimates for systems are therefore harder to justify [1,2].

In academic practice, many interrelated information systems usually exist at the university. The interrelated systems share data and processing. The reality is that the university information system must consist of many information systems that are tightly linked and mutually dependent. Important modules of the whole university information system are the *faculty information systems.*

A faculty information system must be a compatible part of a wider university information system, therefore it should satisfy high design standards. It should be *transparent,* i.e., any available part, or function of the information system, should be accessed easily. Using of the IS must be sufficiently simple and self-explanatory.

Phases of Project

Our experience with the development of an information system for academic management and administrative tasks shows that it can be most efficiently developed in several phases. Our system was developed in two basic phases.

In the first phase, during 1990-1994, the system ERES 1 for registration, enrollment and financing was developed and implemented [4]. A proper, new organization of flexible studies was also required [5,3] to successfully complete the project.

The total cost of organizing and implementing the cost-effective enrollment information system ERES 1 was relatively low. Its cost was considerably less than one percent of the budget of the Faculty. On the other hand, the benefits obtained from the increase of efficiency and flexibility of studies substantially outperformed these costs.

Important efficiency improvements follow from better timetabling, reduction of costs and/or increased intake of students. These savings allowed us to finance the second phase of the project, the development of ERES 2, in which the additional new management information system modules are designed at the faculty level. In the future, ERES 2 will be integrated with other modules at the university level (modules for finance, personnel, research, alumni, etc.).

Design of ERES 2

Information system ERES 2 is designed for flexible individual enrollment (with registration of students) and computer-aided basic administrative tasks in the Registrar's office.

The design of the new project is based on structural database design methods with use of Oracle CASE and Rapid Application Development methodologies.

The ERES 2 system is integrated with a new faculty information system SIWEK, which creates a convenient environment for massive communication within the university and also provides frameworks for cooperative work between members of various groups of students and academics.

Main assumptions

The following design features characterize ERES 2:

- Modular structure: New system is developed as a set of subsystems. Each subsystem has its own data, application modules and interface. Subsystems can be modified or replaced without impact on the whole system performance. Several versions of a particular subsystem can be used simultaneously (eg. supporting two coexisting systems of studies).

- Wide access to data: ERES 2 is designed as an open system: it can easily be extended and authorized users can easily access data using prepared views, intended for various groups of users (eg. faculty and university authorities, staff, students) and for public usage.

- Extended information functions: The new system will be used not only by the Dean's office, but by staff, students and external users as well. ERES 2 is integrated with the faculty information system SIWEK, based on World Wide Web (WWW).

- Scalability and interoperability: Advanced software tools used in ERES 2 ensure scalability and portability of the system. Both server and client software can be ported to more powerful hardware and system platforms, and can be used in a heterogeneous environment. The system is designed for future usage in distributed university information systems. ERES data can be accessed through various software interfaces: SQL, embedded SQL, call-level interfaces, ODBC, W WW.

Software and system environment

New ERES 2 system works in a client-server environment. It is based on Oracle 7 RDBMS.

The initial configuration consists of database server working under Novell NetWare, Oracle Sql*Net networking software with SPX/IPX and TCP/IP protocols, and Oracle Developer/2000 application development and runtime software on client stations, working on Microsoft Windows. Future upsizing to a Sun Solaris system for server and Unix/Motif workstations for clients is being taken into consideration.

Data structure and main ERES 2 applications are developed using Oracle Designer/2000, with extensive usage of Forms Generator and Reports Generator.

Structure **of ERES 2**

Modularity ERES 2 consists of logical modules called subsystems. Each subsystem owns appropriate data (tables, triggers, etc.) and application modules (eg. forms, reports, procedures, menus). Data dependencies between modules are well-defined and have a tree structure (without cycles). Data' owned by each subsystem can be changed only by the subsystem itself or through an interface (procedures and views) built into the subsystem.

Integration with faculty information system **SIWEK**

ERES 2 is integrated with the new faculty information system SIWEK, which provides various utility tools to all students and faculty members, and creates a convenient environment for massive communication within the university.

SIWEK is based on World Wide Webb and consists of documents and CGI interfaces. Standard Oracle-WWW interface called WOW is used to provide information from the ERES 2 database. It receives HTML query-forms, queries the database and creates on-line HTML responses.

Public access to faculty information resources Many ERES 2 information services provide publicly accessible information, eg. list of faculty members (with telephone numbers, e-mail addresses, etc.), lecture offers and curricula requirements.

This information is rarely changed and frequently requested, so it will be pre-prepared as HTML documents by off-line module.

Other information (eg. lists of students enrolled for courses, timetables of lectures) varies frequently, so it must be provided on-line by WOW interface.

Authorized access to data CGI interface will also provide access to confidential data, using SIWEK authorization services. This information is provided for faculty members and university authorities. This kind of data includes students' personal data, grades, etc.

Distributed data acquisition WWW will be used for distributed data aquisition. HTML forms will be prepared for input of students' declarations and grades.

Each student in the faculty must choose several courses for each semester, and all those declarations must be inserted into the database. In the former ERES 1 system declarations were delivered as paper documents and had to be inserted into computer system by clerks, which was inefficient and time-consuming.

In the new ERES 2 system students will be able to insert their declarations using HTML form. WWW daemon will read filled forms, check data correctness and immediately send a receipt, or an error message.

Teachers will have two ways of supplying lists of grades: they will insert them using HTML form, as described above, or they will provide grades on special paper forms that will be read by electronic readers.

Concluding Remarks

Our experience shows that the total cost of organizing and implementing a cost-effective enrollment information system may be relatively low. It's cost may be considerably less than one percent of the budget of a School. On the other hand, the benefits obtained from the increase of flexibility of studies may outperform these costs considerably.

The operational features of system ERES 2 for flexible individual enrollment and computer-aided basic administrative tasks help the academic institutions both to develop and update new curricula, and to achieve higher standards in teaching performance.

The implementation of the new system was linked with the design and introduction of a new curriculum (a variety of the new two-stage BSC. and MSC. programmed within the areas of information technologies). The new methodology for designing ERES 2 helped the Faculty to develop and update new curricula and helped to achieve higher standards of university performance, both in quality and efficiency.

We believe that our successful experience with implementing an information system for *FIES* will encourage for other universities to implement similar modular systems of studies.

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