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## INFORMATION TECHNOLOGIES IN UNIVERSITY EDUCATION ACTIVITIES

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**Abstract.** University institutions realize studying process through organizing of studies, realization of education processes and providing students with help in learning and passing exams. Organizing of studies includes defining curriculum, admission and studying conditions as well as defining conditions for enforcing lectures and exercises. Realization of education processes includes enforcing curriculum, qualification tests and exams. In a matter of successful surmounting of curriculum, students are provided with help in learning and testing of their knowledge. Methodology of resolving of these problems and its realization in intranet environment are presented in this paper. Student services system and enforcing of traditional educational process support are emphasized.

### 1. INTRODUCTION

The world of computers and information technologies is developing rapidly. The Internet lies in the center of this amazing development. Nowadays, the Internet represents distributed developing environment, which is able to offer information and services to millions of people around the world.

Originally, as a network of local networks, Internet was implemented in University environment. Its first services were created by students and teaching staff. In the

meantime, Internet became dominating communication media. Therefore systematic involving of Universities with this global network is natural and necessary.

Information technologies have reached satisfying development stage for enabling realization most of business and education activities in Internet environment. Intranet concept, as most important technology concept for those purposes, provides secure connection with Internet and includes advantages of Internet services, such as:

1. Promoting mechanism of data exchange, which are collected at one place (or more) and are available to all users (employees, students)
2. Reducing hierarchical organization structure to an interdisciplinary structure, that promotes coordinated work
3. Data bases access, exchange of documents and information, employee cooperation, graphic user interface
4. Better communication between the education institution and students, whose studying process has been made more effective, by offering ability of getting all necessary information about studies (administrative and related to specific exams)

Core of all Faculty activities is student service subsystem. All other subsystems relay on it. Therefore, the second and the third sections of this paper present implementation of Intranet, where student services subsystem is emphasized. The fourth and the fifth sections are related to using of Internet technologies in education process. This kind of use spreads implementation of Intranet to the education activities and makes the system complete, i.e. suitable for all purposes. The example of using Intranet in realization of activities of Faculty of science in Kragujevac is given in subsections 3.1 and 5.1.

## 2. INTRANET AS THE CONDITION FOR SECURE CONNECTING TO INTERNET

Many institutions and companies implement Internet technologies in their organizations. Almost all institutions and companies base their activities on already existing information systems in local networks. Problem is how to make secure connecting of those systems to Internet, i.e. how to be protected from "breaking in". In order to solve this problem, concept of Intranet has been brought.

The Internet is separated from private networks by a security system. Intranet uses the Internet technologies such as: Web servers, Web browsers, TCP/IP protocols, E-mail, FTP, News, IRC and developing tools like HTML, ActiveX controls, client script languages (VBScript, Jscript, JavaScript), API and CGI programming. Intranet connects different systems and platforms, such as mainframes, Novell networks, minicomputers, different databases etc. These internal networks enable organizations to:

1. centralize information
2. organize information
3. reduce costs and increase efficiency
4. promote sharing of information
5. accelerate the development and distribution of applications
6. organize presentation using Web sites

Universities were among the first organizations that applied Intranet technologies. Institutions of this kind have considerable information resources, which are very useful for employees in administration, student services, for teachers and students. The first step in designing Intranet is the choice of hardware and software, considering the server as well as the clients. One should keep in mind the initial quantity of information and the number of users, as well as scalability and robustness.

Connecting databases to Intranet is the most important decision, which is brought in order to promote and enlarge functionality of the internal network. Most of information is found in databases. These databases can be situated at one place, but most commonly they are scattered across the whole Intranet. In designing, the attention must be paid to education institution needs, and according to them proper tools must be chosen. High-end databases like Oracle, Informix and Sybase offer great opportunities, but often middle packages like MS Access and Paradox meet the needs of Intranet.

Distribution and replication are not primary questions for little and middle Intranet networks, but with the spreading of the Intranet, especially if it connects remote Universities, these technologies may considerably accelerate the communication between clients and databases.

The reasons for which a University should implement databases into the Intranet are:

1. The ability to browse great collection of data easily in order to find relevant information. Student services employees may receive information on students, payments, statute etc., since important features e.g. key words or table fields may be easily included in the Web or Intranet search engines.
2. The possibility of changing, adding or updating databases from more than one location. By using databases and appropriate gateway, employees may update important data, receive and send different information from their working places or from places far away from them, thus providing an insight into current situation.
3. Giving on-time and dynamic data in an easy, quick and modern way to all users.

There are many ways to access databases from the Intranet. The most popular way is CGI (Common Gateway Interface). Web server forwards HTML query to CGI script, which converts it and sends it to the database server. The result is again forwarded to CGI script and sent to Web server in HTML format.

Relation databases represent the standard for keeping business information. Relation databases are flexible. They provide integrity of data and access to them, as well as concurrent work.

Structured Query Language (SQL) is a language that provides user interface for working with relation databases (RDBMS). It is based on client/server technology.

HTML pages give the opportunity of insight to every user who owns a search engine. Text editors and HTML editors can be used for creating HTML pages, or translation from some other format into HTML format if it is required. HTML documents may contain multi-medial elements (texts, images, audio and video elements etc.). Web pages show different information, provide browsing and entering data, discussions, taking over the files etc.

FTP protocol provides quick transfer of files from the server to the user computer. Telnet is a service, that provides access to remote computers and use of programs and services available on these computers.

Electronic mail provides an exchange of messages in a quick and easy way. Intranet also offers the possibility of real-time conversations in programs like IRC or ICQ.

Every institution, including a University, in order to work, requires certain time adjustments for employees. Applications like InTandem, WebShare and Crew, provide online calendar, hyperlinks, automatic mail sending etc.

Message boards represent another means of communication between users. In addition to asking questions and giving answers, one can ask FAQ, give suggestions, browse etc. These services are important for the information like test schedules, timetables etc. With the increased popularity of the Internet, a serious problem related to the security of networks arose. Firewall is a combination of hardware and software that provides Intranet users with an access to the Internet, but prevents an unauthorized break in from the Internet.

An additional protection may be provided by routers, proxy servers, bastion servers etc.

Viruses are also a serious danger for the network. That is why it is advisable to use anti-virus software especially designed for the Internet, which controls input

and output packages. Encryption is another efficient way of protection. Encryption is used to protect stored data, as well as the communication between two Intranets through VSPN (Very Secure Private Networks meet).

To transfer data securely using HTTP protocol, the following protocols are used: SSL (Secure Sockets Layer) and SHTTP (Secure HTTP). SSL provides encryption authentication and integrity of data. SHTTP provides the same as SSL, but it can be used with HTTP protocol.

From all stated above, it is clear that Intranet TCP/IP networks have many advantages over classical client/server applications, like open standards and protocols, restricted access to the information, profitability, unique user interface, independent platforms, independent databases, powerful developing tools and rich multi-medial environment.

### 3. PROCESS ANALYSIS

Globally, a University includes the following information subsystems:

1. Information subsystem for scientific research
2. Business information subsystem (student services)
3. Information subsystem for education process
4. Library information subsystem
5. Information subsystem for financial, accounting and administrative activities

Although all subsystems represent separate complete units, there is more or less overlapping between them. Information systems in education process are shown in connection with business information system of Faculty. Business information system of Faculty includes the following processes:

1. Entering test

2. Lectures and exercises organization
3. Term admission
4. Term verification
5. Applying for the tests
6. Taking tests
7. Graduation
8. Issue of certificates
9. Statistical analysis and reports
10. Postgraduate studies

Data flow diagram of business information system of Faculty is shown on fig. 1.

Figure 1. Data Flow diagram

### **Admission test**

This process begins with announcing a competition, which actually means defining documents required for applying for the studies at the Faculty, defining the admission conditions and deadlines for all activities. In the process of admission, the following is to be determined:

1. Completeness of the documents
2. Taking tests organization
3. Listing and publishing the results

Candidates who passed the admission test fulfill the conditions for enrollment to the Faculty, or to the first term.

### **Lectures and exercises organization**

Lectures and exercises organization means making groups, appointing teachers and assistants as well as making lectures and exercise timetable.

### **Term admission**

For term admission an application form is needed. If a student wants to be admitted to a certain term, he must meet some conditions required by the Faculty statute. For entering fall terms, which means entering a year, certain conditions must be fulfilled:

1. Passing a required number of exams from a current year as well as from the previous ones
2. Checking if the financial obligations are fulfilled by scholarship-paying students
3. Checking other special and specific conditions for entering a term or year
4. Checking if the previous term is verified



### **Term verification**

For verifying a term, a student gives a term form and student's booklet. It must also be checked whether a student was admitted to the term that is being verified.

### **Applying for tests**

A document called test application form is needed for applying for a test, and its contents must be transferred to a database. Before a test application form becomes valid, conditions for taking a test must be checked. This check includes the control of the following conditions:

1. Whether a student attended the lectures
2. Whether the last term that includes the subject is verified
3. Whether the obligatory subjects are passed
4. How many times the student took a test
5. Special specific checks

### **Taking the tests**

Results of taking the tests are entered into the test list. For the test that is passed, all test application forms are deleted and the mark received is updated into the database.

### **Graduation**

A student can graduate when he/she

1. passes the graduation exam, or
2. passes the last exam.

The names of graduated students are put in special tables, and their data are deleted from the tables where the names of undergraduate students are.

### **Postgraduate studies**

Postgraduate studies are divided into several areas and have the same concepts applied to the undergraduate studies. Postgraduate studies mean: admission to postgraduate studies, term enrollment and verifying, applying for and taking tests, issue of certificates and statistics.

#### **Issue of certificates**

Issue of certificates is done on a student's demand, and every certificate is issued for special purposes: a student's status and a year or term enrollment certificate, the number of passed exams and average mark certificate, graduation certificate, etc.

#### **Statistical analysis and reports**

Statistical analysis and reports are very common at universities. Some of them may be considered standard, and others are ad hoc queries. The database conception allows queries for various demands.

## 4. INTERNET AS AN EDUCATIONAL MEDIUM

If we speak about the quality of Internet as an educational media, it would basically refer to the advantages of technical features. Since it is based on network and information technologies, it provides:

1. that location and time of acceptance of knowledge are independent from course materials
2. simultaneous serving of the great number of users
3. realization of information/program archive by using distributed information systems

The success of the use of Internet in education can be explained, mostly, by the fact that it supports interactive multimedia, which is based on the concepts of

artificial intelligence. More than thirty years of studies determined that interactive audio-visual technologies speed up the learning process, because:

1. individual acceptance of instructions enables more effective learning
2. audio-visual notions are easily adopted
3. immediate interaction and response enlarge the users general impression with the users
4. personalized instruction provides different learning styles

Research has proved that this kind of learning gives good results and provides the students with better communication.

Internet can be used as basic or additional means in the realization of the studies, meaning that there are two concepts of its application:

1. distance learning concept , which is basically developed inside the University, called "Virtual University", and it includes the realization of all administration and educational activities of an educational institution in the Internet environment
2. support to the traditional educational process, where services are used only to help, instead of being the basic work and education environment

In addition to all stated above, it is important to stress that education support system should not be viewed separately from the already described working concept of Intranet. It is just a part of overall direction of the University activities toward the work in Internet environment. From the aspect of technical realization, it should be placed on one of the Internet servers, which is part of Intranet network.

In the next two sections of this paper, theoretical consideration of the use of Internet technologies as support to education process is given, as well as the example of its realization.

#### 4.1 INTERNET AS SUPPORT FOR TRADITIONAL EDUCATION PROCESSES

Internet, as a global computer network, provides different forms of communication between the students among themselves, between the students and the teacher, and their access to the source of information all over the world. Its services provide:

1. the contact between the teacher and students by e-mail

E-mail is extremely popular because of its simple use and its advantages in communication. The students need the contact with the teachers, in order to get information related to the course. It is important that e-mail system should be widely used and become the way in which communication between teacher and student is carried.

2. the exchange of materials using FTP

This service gives the opportunity to transfer the test materials (literature, papers, software), regardless of their size. This opportunity exists in e-mail services as well, but the size of the files, which can be sent, is limited.

3. searching the databases using Gopher or some other specialized search engine

4. on-line communication using IRC

Using IRC, the student can talk to the teacher in real time, and, by this, get answers to the questions that he needs immediately

5. conferencing on different topics inside the News groups

News service provides an off-line of message exchange between the greater number of participants. Students can join the groups with different subjects, ask questions and give answers to all group members.

6. creating course Web site, including lectures, materials and the tests

The course means the central part of the learning support system. The presentation offers the most important data and information related to the course or

the subject, and it is available to the students at any moment. The students use the site to achieve new knowledge. It should provide active learning, learning time reduction and it should improve motivation.

Creating the presentation is important and complex task, which demands involving the great number of participants. Creation of the site depends on the needs of users. It is important that it should fulfill all their needs in the knowledge-acquiring area.

During the creation of the site, which will be used as support to traditional education process, the following should be considered:

1. the work on the creation of the site should be divided, and the students should be engaged and liable for the part they work on
2. the teachers should be encouraged to transfer the experience and knowledge they have and which is related to the education process, to the web, with the additions and services offered by internet
3. all necessary material, literature, software, examples should be placed on the site, and the use of FTP service should be provided
4. data search through site should be easy
5. the contact between the teachers and students should be provided by using mail service
6. the information related to the subject and the test should be up-dated
7. place FAQ in order to provide the students with the quick answers related to the course
8. the link numbers toward the other institutions or sites with the similar contents should be limited, and only those which can be useful to the students should be chosen
9. the presentation should be up-dated regularly

A good site should provide an easy navigation, which means: that the path through the course materials is clearly and precisely marked; that the easy moving through the presentation is provided, which will satisfy the needs of those that attend the course; that the searching should be encouraged and that the student should be able to return to the place where he working before.

An overview of the sites all over the world shows that they are successfully used as a support to the traditional education.

## 5. AN EXAMPLE OF IMPLEMENTATION

In this section of the paper, the example of implementing Intranet technologies in realizing a part of activities of the Faculty of Science in Kragujevac, is given.

### 5.1 STUDENT SERVICES AND INTRANET CONCEPT

This section shows an example of an Intranet network at a University. Server software in use is Microsoft Internet Information Server (IIS) 5.0. IIS is supported by Windows NT security system. Designing applications for IIS is possible through two interfaces: MS Internet Server Application Programming Interface (ISAPI), or Common Gateway Interface (CGI). ISAPI allows designing dynamic library program (DLL), which is loaded when the server is started. ODBC interface is the main power of IIS and through it IIS communicates with other databases. An integral part of IIS is Index Server, which is used for data indexing and browsing.

Microsoft Access 2000, an integral part of Office 2000 Professional package, is used for working with databases.

Unicode is supported by Access. In order to save the space, there is a certain internal base compression, too. Access provides an insight into linked data, without making a special form, as well as change of form features interactively. Data block can be exported from Access to Excel. As early as Access 97 it was possible to export

reports from the database to a special file like .SNP, to provide the users who do not have Access with an insight into reports, using Report Snapshot program. This tool is valuable for reducing the traffic in large networks. It also provides direct saving in the previous version format, which is important in the period of migration (moving) of information system. Access 2000 comes in the two kernels: Jet Database Engine and MS Data Engine (MSDE), intended for front-end uses.

Jet DBE 4.0 is a new version that provides higher quality work with a database. The most important novelty is the possibility of locking a separate record on concurrent work. It is also possible that two users update the same record, changing different fields. Autonumber fields supports algorithms that make database replication easier, a new OLEDB Provider functions in OSI tier, SQL query syntax is compatible with ANSI standard.

Access can represent a front-end tier in exploiting large DB systems, such as SQL Server, Oracle, Sybase, etc. Data structures (tables, standard procedures, validity error rules) are found on the network server, while forms and reports are found in client's computer. MSDE provides this function: it is completely compatible with SQL Server 7.0. It also provides scalability, so the system is easily transferred to a higher level exploitation.

Access 2000 includes visual tools based on Da Vinci technology, that allows the access to SQL Server structures. If there is a "local" application based on Jet database and which is to be transferred to a client/ server environment, MS Access Upsizing Wizard is available. Upsizing Wizard then connects database with a new front-end instance by MSDE. MSDE contains many more advanced technologies, e.g. on-line replication in both directions, dynamic maintenance of database, making queries using a spoken language instead of SQL commands, etc.

When it comes to the placing of data on Intranet, Access offers an interesting solution. Data Access Pages, a new element, is introduced. It is a HTML document which is created directly in Access and which is dynamically connected to the database contents in the way of forms and reports. The users who do not have Access may review data by using Web browsers. It is also possible to send Access Data pages

by e-mail, and the users of Outlook 2000 will be able to see the contents immediately. Access can open any HTML page and the user can connect his data to it. It supports object model for programming in VBScript and JavaScript. Office 2000 Web components provide the possibility that browser data analysis can be added to the dynamic pages in Access. Writing a code part is avoided by linking forms and reports through hyperlinks. The examples of pages are shown on Fig. 2, 3, 4.

Figure 2. Statute

Office server extensions are installed on the server, and their integral part is Microsoft Data Access Components (MDAC) 2.1. For those pages that use data from Access database (.mdb), Jet Database Engine 4.0 is used.

The clients must have Internet Explorer 5 (or later) and Office Web components. All files are placed on the Web server. Pages for data access as well as the server have the configuration to support three-tier data access.

For presenting HTML pages, Microsoft Front Page 2000 is used, and it supports HTTP, FTP and SHTTP protocols.



Figure 3. Faculty curriculum

Figure 4. Passed exams

Security is regulated with the following steps:

1. Network authentication. When logging, users enter username and password. These data define authority level and are used as the evidence for accessing certain resources and can be forwarded to other systems.
2. Security of Internet Explorer. IE warns the users when it finds "bad" ActiveX scripts.
3. Microsoft IIS has the security system to control the opening of Web sites.
4. Databases security system uses Microsoft Office Data Source Control (MSODSC), which accesses database by asking user identification. MSODSC can use two modes for data access: two-tier and three-tier modes.

Working with documents and their reviewing is an important process in the interaction of the employees in student services, lecturers (teachers) and students. Several problems may arise in sending documents and taking them over. Documents can be lost or switched, and the sender does not have an insight into the process of reviewing. Designing Web based data flow and tracking solutions are done by Microsoft Access Workflow Designer. Documents, i.e. their hyperlinks are placed in the library. Document library offers more pages with the lists according to the owner, category or status. The document owner chooses the persons to review the document, appoints the date and specifies information to be reviewed.

By using Web Folders, the users who are authorized to access may create folders, copy them or save the files on Web server. Microsoft Front Page 2000 offers the interface for creating HTML pages easily. Discussion boards can be easily designed by Wizard. Automatic registration of index server folder is possible to do by Front Page, as well as creating files needed for making queries.

Certain Web pages can also be protected by a password.

Real-time presentations using NetShow program are possible in Microsoft Power Point.

Microsoft Outlook 2000 offers many advantages for working in Intranet environment. Sending e-mail is quick and simple. HTML documents can be sent and received. There is also a possibility to send encrypted messages with a digital signature, as well as many other useful options. Outlook calendar may be saved in HTML format to be available to other employees and students. For example, the calendar may contain lectures timetable and the information for students, tasks and activity plans for student services employees, etc. There is also a reminder for informing employees on time. Intranet users may get an insight into task and activity schedules of others, and according to them appoint meetings, determine tasks, etc. It is possible to collaborate online on Office documents, or simply chat, by a single click on the mouse and starting NetMeeting program. Journal option keeps track of working on some Office documents. Outlook may be also used for sending faxes, keeping address books, reading News messages, etc.

Intranet network is secured by a firewall, called Conseal. Microsoft Proxy Server is also used. Command Software Antivirus Ver.4.58.3. is installed as antivirus software.

## 5.2 INTERNET AS A SUPPORT IN A TRADITIONAL EDUCATIONAL PROCESSES

In this section of the paper, the example of the support to the realization of the Operating systems course is given, in the Mathematics group at the Faculty of Science in Kragujevac. The presentation is prepared in a way which provides the students with the filing up all necessary information related to the subject and the test. The navigation is made easy, regarding the structure of the presentation. Communication can be achieved by using e-mail.

In the presentation the following kinds of information are available to the students:

1. faculty curriculum
2. the way of taking the exams
3. test questions

4. direction for writing the papers
5. the examples of completed papers
6. the information of the time and the place of tests and of the time and the place of oral exams
7. on-line script
8. zipped script offered for download
9. the list of links to the sites on which additional information can be found, on the topics dealt with in the test
10. necessary software for writing the papers

Figure 5. Course curriculum

Figure 6. Description of the way of taking exam

The presentation gives all the information necessary to the students in order to take the test. Creating learning systems is also planned, which will enable the students to complete and check their knowledge.

## 6. THE CONCLUSION

Internet became dominating communication media and significant part of everyone's life so involving of Universities with this global network is natural and necessary. Its activities must be directed toward the work in Internet environment. There are two basic groups of activities which realization should be considered in that matter: organizing of studies and realization of education processes. Resolving of these processes demands technologies that provides both security and efficiency in information exchange. Intranet technology concept is the answer.

Intranet gives good background for data exchange and effective communication. Providing secure access to databases from outside, e.g. Internet, with graphic user interface improves communication between the Faculty and the students, whose studying is made easier. Firstly, they are offered by the possibility to reach the information related to the studies, like the information about the studies curriculum, the passed exams, schedules of taking the tests, the test results, possibility to apply for the exams through Internet. Secondly, by the support to the education process, through giving all the necessary information related to the exam and possibility of communication with the teacher using different services, preparing and taking the exams is made easier for students.

Substantial advantage of Intranet lies in its flexibility. There is not any common pattern, meaning that every university may and should define, design and use Intranet which reflects its particularity and supports its business goals in the best way.

## References

- [1] D. Garrett, J. Ablan, E. Ashman, J. Becker : *Intranets Unleashed*, Indianapolis, Indiana, Sams.net Publishig, 1997
- [2] M. Ivković , B. Radenković : *Internet i savremeno poslovanje*, Tehnički fakultet, Zrenjanin, 1998
- [3] S. Presić : *PROLOG relacijski jezik*, Belgrade, 1996
- [4] J. H. Ellsworth, Ph.D., B. Barron, J. December, W. R. Stanek: *Internet Unleashed*, Indianapolis, Indiana, Sams.net Publishig, 1998
- [5] J. DeVaan: *Microsoft Office Resource Kit*, Microsoft Corporation, 1999
- [6] M. Cierzniak: *Running a Perfect Intranet*, Indianapolis, IN, Que Publishing, 1999

- [7] P. Gralla: *How Intranets Works*, Macmillan Computer Publishing USA, 1998
- [8] S. Zimmerman, T. Evans: *Building an Intranet with Windows NT*, Indianapolis, Indiana, Sams.net Publishig, 1999
- [9] V. Andersen: *Access 2000 Complete Reference*, Osborne, McGraw-Hill Companies, 1999
- [10] W. Chen, S. Hettihewa: *Designing and Implementing Microsoft Internet Information Server*, Indianapolis, Indiana, Sams.net Publishig, 1999
- [11] D.Korunović, S. Cvetanović: *Informacioni sistem preduzeća u intranet okruženju*, Internet i savremeno poslovanje, Beograd, 1999
- [12] D. Maulsby, I. H. Witten: *Teaching Agents to Learn: from User Study to Implementation*, Computer, Volume 30, Number 11, November 1997
- [13] G. Davies: *Teleteaching, Distance Learning, Training and education*, Preceeding of the XV IFIP World Computer Congress, Wien, Budapest, 1998
- [14] A. Kaplarević, S. Miloević, B. Radenković, V. Vujin: *Intranet tehnologije u obrazovnom procesu*, Info science 1-2, 2000.
- [15] D. Stefanović, D. Parezanovic, A. Kaplarević: *In Internet Environment Business and Educational Activities of Universities*, Management 44-51, Beograd, 2000.