# Electronic Document Management Systems Structure for University Research and Education

[1]Mikhail Nikolaevich Krasnyanskiy, [5]Andrey Vladimirovich Ostroukh,
[2]Sergey Viktorovich Karpushkin, [1]Artyom Dmitrievich Obukhov,
[3]Nataliya Vyacheslavovna Molotkova and [4]Irina Vladimirovna Galygina
[1]Department of Research and Innovation,
[2]Department of Computer-Aided Design of Processing Equipment,
[3]Department of Continuous Education,
[4]Department of Economics,
Tambov State, Technical University (TSTU), Tambov, Russia
[5]Department of Automated Control Systems,
State Technical University-MADI, Moscow, Russia

**Abstract:** The study discusses the issues of increased paperwork and document flow due to a variety of factors, including the need to track and store research results, ensure the quality of educational services delivered by the educational institution, etc. Modern systems of automated tracking and storing of information seem to solve most of the above problems. In the study, the researchers discuss the issues of the University EDMS with regards to its features. The model of computer network, ensuring the required level of storage reliability and access differentiation is proposed. The EDMS structure for R&D is described by the example of chemical product and PPE catalogue. The design of universal advanced project solutions remains a relevant problem for research and education institutions and meets the needs of today's market of IT.

**Key words:** Electronic document management, research and education institution, higher education institution, electronic catalogues, automated system

## INTRODUCTION

Document automation in scientific and educational institutions, as well as the need to improve the reliability of tracking and storing documents in the extensive document database requires a systematic approach given the specifics of business processes occurring in higher education institutions (Novikov and Sukhanov, 2005). Staff members of scientific and technical departments, researchers, university lecturers have to create, store, handle and transmit large amounts of various documents. When creating Electronic Document Management Systems (EDMS) one should consider both the internal structure of the scientific and educational institutions and specific features of document creation and flow (Pechnikova and Pechnikova, 1999).

## THE GENERAL STRUCTURE OF ELECTRONIC DOCUMENT MANAGEMENT SYSTEMS

First, consider the common features of the developed automated systems and their design. The most common method of arranging electronic document management systems is using client-server architecture: A central computer with a plurality of LAN terminals connected to it via the internet. To ensure the reliability of storing documents and access differentiation on the physical level researchers have developed a modified model of computer network shown in Fig. 1.

Computer network model includes, central server is located on an independent platform, such as cloud storage or remote hosting (internet server). This object ensures full functionality of the system, it stores actual databases and archives.

Local servers are located by their functionality (department, division and sector). Their power is determined by the number of users and network load in this segment. Thus, there is a physical separation system that ensures data security of each department (division, sector) independent of all other parts of an organization. Furthermore, such a structure accelerates access to information, as application of a single server can lead to a significant reduction in performance. For convenience,

**Corresponding Author:** Mikhail Nikolaevich Krasnyanskiy, Department of Research and Innovation,
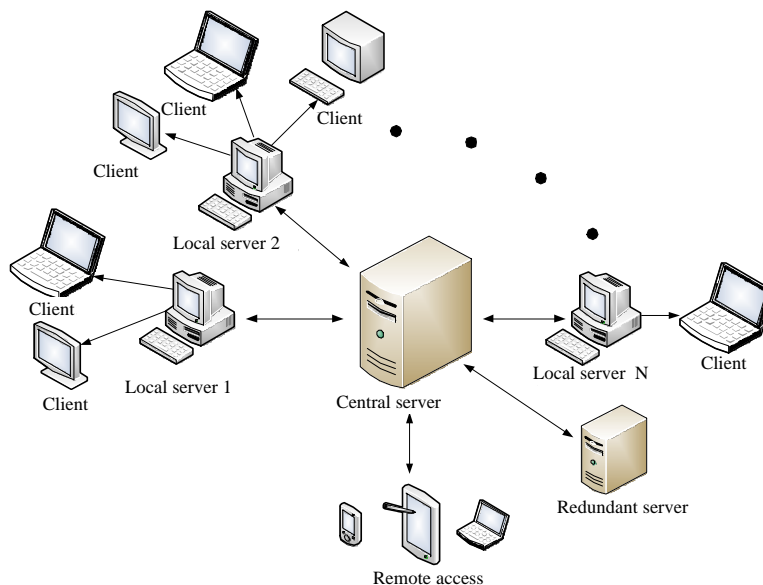Tambov State Technical University (TSTU), Tambov, Russia

Fig. 1: Diagram of EDMS computer network

let the concept information area denote the set of assigned to the local server clients. Local servers ensure the functionality of the information system; keep all the necessary databases and documents of its information area. At the same time, data is synchronized into the central server and can be retrieved for other business processes.

Clients are multiple staff computers of the organization (university and research institution) to access the information system, create, edit and add documents. Access is restricted to the local server of their information area.

Remote access is availability to retrieve data from an electronic archive of a remote computer or mobile device (tablet/mobile phone) by accessing the central server located on hosting. It allows uploading and retrieving data from the system after successful user authentication.

Redundant server is an auxiliary computer that stores all electronic archive of servers and database at specified intervals. Such security measure eliminates the complete loss of data in case of failure of any of the local servers. Redundant server is located separately from the general location of the local servers and must be isolated from normal users to prevent the possibility of distortion or damage to the backup data.

Such arrangement of the information system will secure its application in any scientific and educational institution providing the possibility of scaling, changing the number of servers, their capacity, etc. and given the specificity of the subject area, the number of departments and personnel, the prevalence of territorial institutions (Kartashow, 2005).

Electronic document management systems existing in the Russian market can be divided into 2 segments: The first one is powerful and expensive solutions (foreign Alfresco, EMC Documentum, domestic 1C: Workflow, WSS Docs, Motif) while the second one is free (low cost) products with weak support and functionality (Banker and Kauffman, 2004; EMC, 2012).

The comparison of popular systems shows that many of the products are not integrated into the external subsystems, they lack in remote access through the phone/tablet or have poorly developed management of business processes and contracts. Unlike their foreign counterparts, domestic developments are still focused on the specific automation tasks and do not solve the complex problem of electronic document management throughout the organization.

The analysis of existing solutions, showed the need to develop an information system of electronic document management with regard to the specific business processes of research and educational institutions, as well as supporting the integration of existing modules of the automated control system of the organization. When creating EDMS for complex object-level university it is necessary to determine the structure of business processes occurring in the organization and make a list of major subsystems and modules.

## THE STRUCTURE OF ELECTRONIC DOCUMENT MANAGEMENT SYSTEM OF SCIENTIFIC AND EDUCATIONAL INSTITUTION

University document management is primarily associated with the automation of the traditional system
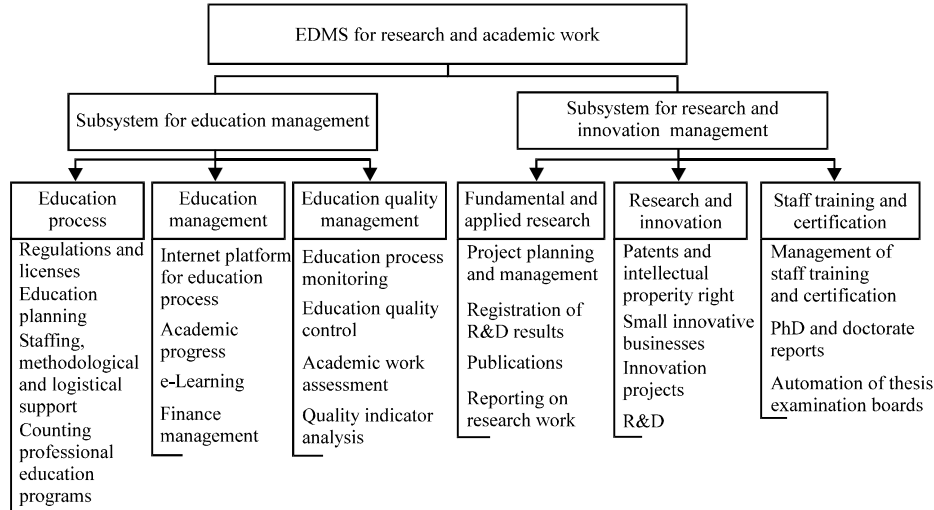
Fig. 2: Technical University EDMS structure

of education and research, the widespread use of information resources to improve the academic performance of students, simplify the control over the learning process, analysis of scientometric indices of scientists and subdivisions, arranging contracts and agreements, accounting the results of intellectual activities, etc. (Ghani *et al.*, 2012; Wokocha and Adebayo, 2012; Staley and Malenfant, 2010). Document management features in this subject area include:

- Allocating the 3 big categories of EDMS users, including academic staff, students, office and management personnel; all this requires differentiation of access rights and providing each group of users with certain functions for working with documents
- Ensuring document control, both internal (throughout the scientific and educational institution) and external (regulatory authorities, public organizations, shareholders and boards of trustees, etc.)
- Providing mandatory remote access to the system, including training opportunities for users with disabilities
- Offering opportunity to integrate with other information systems (automated system of university management, e-Learning, report system for the different activities, etc.), adding new forms and modules, using web-based applications
- Providing details on activities of students, academic staff, the learning process, the implementation of contracts and agreements

- Providing remote access to information resources (reference materials, scientific, technical and educational literature, state standards and patents, scientific and technical reports, etc.)
- Ensuring possibility of organizing and conducting online conferences, seminars, webinars, remote consultations with the instructor and supervisor of studies

The structure of technical university EDMS, the composition of its major subsystems and modules, as well as business processes modeled in the framework of research and educational activities are presented in Fig. 2 consider this structure in more detail.

**Subsystem for education management:** The subsystem is responsible for management, organization, planning and control of education process. It includes all of the core business processes of university educational work and aims to increase their effectiveness. The subsystem includes the following modules, databases and business processes.

**Module education process**
**Legal regulation of educational activities:** It involves developing and placing the database of local regulations governing educational activities. It allows generating reports on educational activities in compliance with the form approved by the founder and executive authorities.

**Licensing of educational activities:** It enables to analyze the need for the introduction of new educational programs, examine educational programs for their compliance with the licensing requirements of educational

standards form a set of documents for licensing, control the compliance of educational activities with licensing requirements, support both planned and unplanned inspection of the university by the supervisory authorities.

**Education process planning:** It includes training curricula database for all types of educational programs and forms of education, department work plans and lecturers work plans and the registry of disciplines. It allows for control of training curricula to meet the requirements of educational standards, calculating teaching load of university departments for the academic year, academic planning and development of the education process schedule.

**Education process staffing:** It enables to create staffing table for the university departments, certify teaching staff and assess the teaching staff compliance with the skills and basic education requirements of educational programs.

**Methodical support of educational activities:** It allows forming a thematic plan of a single library fund of the university, filling and maintenance of electronic library of the university, supervising the execution of planned purchase of literature, as well as the compliance with the requirements of methodological support of educational standards.

**Logistical support of educational activities:** It includes inventory of buildings and facilities of the university, the university classroom fund, laboratory equipment and furniture for educational purposes. It allows for the analysis of efficiency and availability of classrooms and laboratory equipment, control over the compliance with the logistical requirements of educational standards.

**Continuing professional education programs:** It includes a database of Continuing Professional Education (CPE). It allows analyzing the effectiveness of implementation of the SPE system at the university.

**Organization and support of networking in educational activities:** It includes joint educational programs, integrated multi-level programs. It permits the organization of the education process in a network form.

**Module education process management**
**Analytical internet platform for educational activities:** It includes the details of the management structure of educational activities, ongoing educational programs, the schedule of the learning process and examinations, educational standards, educational and methodical documentation, etc.

**Academic progress rating system:** It includes a database of inspection activities for each academic discipline of all major educational programs and scores obtained by each learner. It enables to generate reports on the results of the monitoring of educational activities, monitor the learning process and exercise self-control on the part of the learner.

**e-Learning and distance education technologies:** It includes a database of electronic educational resources with regard to their demand and intensity of use.

**Finance management:** It enables to form cost estimates and standard forms of contracts for educational activities, as well as accounting of issue and turn-in transactions.

**Module education quality management**
**Monitoring of education process:** It allows controlling the execution of the educational process schedule and timetables, work plans of the department and teachers work plans, state tasks. It ensures computer-based testing technology, generating reports on the prescribed forms, checking final qualifying works for plagiarism (Anti-plagiarism system).

**Education quality control:** It includes a database of assessment tools to assess the level of reached competences with the possibility of generating reporting forms and ensuring quality control of the core educational programs.

**Academic staff assessment:** It includes a database of full-text materials for core educational programs (educational and methodical set of documents, including tutorials, etc.).

**Quality indicator analysis and report preparation:** It enables to analyze the enrollment figures and assess the target indicators, status and composition of students, student flow (monthly and quarterly), provide the university self-assessment resulting in the required reports, generate analytical reports on self-assessment and program module on the university performance indicators, organize state and public accreditation of the educational programs and monitor the key areas of educational activities.

**Subsystem for research and innovation management:** This subsystem can be used not only in higher education institutions but also in research institutes, high-tech industrial enterprises engaged in research, development activities and implementation of innovative solutions in

production. As part of the university EDMS, this subsystem solves problems of creating, processing and publication of scientific results, monitoring science and innovation, arranging verification and certification of research and academic staff. The subsystem includes the following modules, databases and business processes:

**Module fundamental and applied research**
**Project planning and management:** It includes training, tracking and storing information about applications and tender documentation for Research and Development (R&D), standard forms of contracts, thematic plan of Research and Development (R&D), registration cards of scientific and technical activities, project objectives and its separate stages. It provides possibility of joint work of several project participants, importing and exporting data in various formats. It enables allocating the Results of Intellectual Activity (RIA) to individuals, projects and structural divisions of the university.

**Analytical internet platform for research and innovation:** It provides details of the department of science, its structure, goals, objectives and functions. It provides notification of the university divisions of competitions, conferences, seminars and other events. It disseminates news about the important science and research events in the university, region, Russia and abroad. It places internet adverts of research projects, innovative products and services of the university, as well as all the necessary information on thesis examination (abstracts and dissertations, reviews of leading organization, official opponents and foreign scientists, information about researchers, etc.).

**Publications:** It allows maintaining a database of publications by staff and students of the university (conference abstracts, papers, monographs, patents, certificates, etc.) given their citation index in web of science, scopus and RISC databases.

**Finance management:** It provides accounting for R&D contracts, credit and debit transactions under contracts and project estimates.

**Reporting on research work:** It allows generating reports on the university research activities in compliance with the form approved by the founder and executive authorities. It ensures keeping to the project schedule given the performance targets and indicators. It generates data for integration with information system of academic staff rating system and structural divisions involved in R&D (Anvari *et al.*, 2012; Ostroukh *et al.*, 2014; Kojima and Iwata, 2012).

**Module research and innovation**
**Patents and intellectual property protection:** It ensures tracking, editing and storing of information about the different types of intellectual property (patents, certificates for computer programs), including the current status of applications and patents. It enables to prepare the necessary documentation to register the results in specialized centers of scientific and technical information, patent and intellectual property protection. It ensures storage of full-text materials related to performance (documents, images, templates, etc.) registration of license agreements and agreements on the alienation of rights to Intellectual Property (IP). It contains a database of normative documents on IP (university policy for IP, IP and RIA regulations, valuation rules for IP (acts of non-exclusive right, book value), privacy and commercial confidentiality, etc.) (Albert, 2010).

**Small innovative businesses:** It contains a database of Small Innovative Businesses (SIB) established with equity participation of the university, including their annual economic and financial reporting, teaching materials and local acts on SIB foundation.

**Innovative projects of the university:** It contains a database of innovation projects of the university, its potential consumers, the list and reports on the innovation centers, information and advertising materials on research and innovation projects of the university.

**Research work of students:** It contains a database of the university students' achievements (winners of regional, national and international competitions, scholarships holders), regulatory documents of student design bureau, databank portfolio of research works of undergraduates and postgraduates.

**Module staff training and certification**
**Training and certification of highly qualified personnel:** It includes database of personal files of postgraduates, doctoral students and candidates for a degree, as well as their scientific advisers. It enables monitoring of educational and research activities of postgraduates, doctoral students and candidates for a degree, planned enrollment figures, records of entrance examination results.

**Preparation of reports on the activities of postgraduate and doctoral departments:** It enables to generate reports on the activities of postgraduate and doctoral departments of the university in compliance with the forms approved by the founder and executive bodies, including analysis of statistical information.

**Thesis examination boards:** It includes database of thesis examination boards of the university, registry of science divisions, specializations, areas of training; scientific advisers, experts, reviewers, official opponents and leading organizations. It permits generating standard reporting forms of thesis examination boards, create, store and process electronic copies of attestation cases, including the ability to attach full-text electronic versions of documents (thesis, transcript, minutes and letters, etc.), carry out an examination of the text of the thesis for plagiarism (system anti-plagiarism).

## SOFTWARE IMPLEMENTATION OF EDMS SEPARATE MODULES FOR PRODUCT CATALOGS

Technical University of Research of type is involved in the following business processes: Conducting researches, development of design documentation, experimental manufacturing of innovative products and commercialization of the results of intellectual activity. They are accompanied by creation, editing, searching of large volumes of scientific and technical documents, including technical projects and tasks, reports and orders, patents and standards, patent applications, research papers and others (Bondarenko *et al.*, 2010; Henderson, 2009; Chimes, 2009; Frohmann, 2009; Hou and Lin, 2006). In this regard, EDMS developed to the needs of research and development work should provide the following functions:

- Quick access to information; hardware and software independence of end-user information (operating system, computer, mobile devices), relevant data
- Notification of staff about the uploaded documents, control overt the performance of tasks, ensuring transparency and accountability in the document flow between departments of the university and staff
- Implementation of the electronic archive of documents, including patents, drawings, models, standards, projects, preservation and authenticity of the stored data and business search in the archive
- Creating templates, development of electronic forms to facilitate the completion of standard documents (declarations, orders and instructions, etc.)
- Integration of EDMS subsystem and product catalogs (patents, scientific papers), the links between the products and available design, technical and reference information

It should be noted that the integration of EDMS subsystem and products catalogs is essential for presentation of basic scientific results in the form of final products, inventions, patents, etc. This integration improves the efficiency of the system due to the possibility of storing product catalogs and referring to specific documents, drawings and other documents (Konishi and Ikeda, 2007; Eloranta *et al.*, 2001).

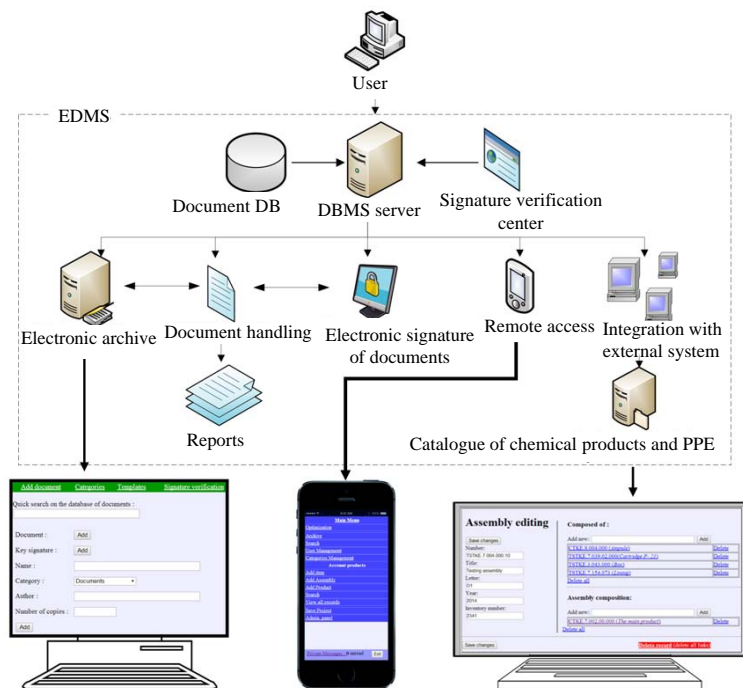EDMS Structure for R&D is shown in Fig. 3. It is illustrated by catalogue of chemical products and PPE.



Fig. 3: EDMS structure for R&D

The practical value of introducing such a combined system is as follows (Wang *et al.*, 2008):

- Reduced time spent on searching and filling out documents
- Secure storage of documents: All documents are digitized and collected on the server
- Accurate information about the author of the document and all persons working and changing it including the dates of document execution and editing
- Elimination of paper documents from internal document flow and transition to the electronic version of the archive. This reduces the costs of document flow management
- Improved accountability of departments and each employee, in particular, due to the transparency of document flow and execution of work
- Simultaneous access to product catalogues and document database (instructions, technical assignments, certificates, etc.)

All this proves the need to create and use a combined EDMS for R&D where the storage and processing of documentation are organically linked with experimental production, training and business processes of the institution. Such EDMS, ensure the reliability and security of stored information and have an impact on product quality and productivity in general (Henderson, 2005; Siersdorfer and Sizov, 2008).

The findings of the research departments, including achievements, inventions and publications require copyright compliance. Patenting department is responsible for intellectual property storage, its internal workflow must be included in the overall automated system.

## CONCLUSION

Electronic document management systems are of paramount importance in today's information world. In higher education, the EDMS is aimed primarily at improving the quality of the educational process, simplification of student learning and work of academic staff, greater control over achievers, streamlining storage and use of documents, etc. The transition from paper to electronic libraries, document repositories, scientific publications and educational literature is especially relevant.

The conducted research into business processes occurring in research and education of the technical university revealed the most relevant aspects to be

considered in design of EDMS. The proposed EDMS structure permits customizing the system to the needs of education and research of the university by modifying the existing modules and subsystems.

EDMS is absolutely necessary to handle the technical and regulatory documents of researches and increase their productivity. Electronic document management systems can effectively address, such issues as structuring of production, control and management of staff performance, safe storage of documents, optimization of creation and design of supporting documentation, etc.

To sum up, the use of electronic document management systems is the need of today's market, developing and customizing EDMS for specific tasks, as well as creating universal design solutions through advanced IT are becoming important issues in higher education.

## ACKNOWLEDGEMENTS

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