Management of Competitiveness of the University on the Basis of CALS-Technologies

[1]A.S. Sizov, [2]V.P. Dobrica, [3]A.A. Golovin, [3]P.V. Sergeev, [1]A.I. Pykhtin and [1]E.A. Titenko,
[1]Department of Engineering Sciences,
[2]Department of Physical and Mathematical Sciences,
[3]Department of Economic Sciences, Southwest State University, Kursk, Russia

Abstract: The object of research is the managerial processes of the social-and-economic system a higher educational institution. The study deals with the tasks and limitations of the classical planned target university. It is shown that the higher educational institution experiences objective difficulties in ensuring the quality of education and increasing competitiveness in an unstable environment. To overcome the limitations and difficulties, the term of a higher educational institution of a new form an innovative marketable higher education institution is introduced. The study of all types of existing processes and their reengineering is the basis of the management method of this type of social-and-economic system. The goal is to increase competitiveness with the help of CALS-technology which provides a redesign of the organization's business processes to identify reserves, reduce costs and maximize the use of available resources. The subject of the research is the chains of educational programs, represented in the form of a graph. Unlike the classical higher education institution such a graph expands on entry and exit with new elements. These elements complement the basic elements, i.e., educational programs on three levels of education. In addition, the new graph has a cyclic structure. It allows the user to specify iterative sequences of specialized educational programs. As a result, it becomes possible to form a wide variety of learning paths within a single higher education institution. The constructed new graph has a structural complexity in comparison with the standard one by 17.5% more. Nevertheless, a typical graph is a subgraph of a new construction. This feature allows us to use the continuity of the chains of educational programs in the computation of competitiveness. Then the number of specialized chains of educational programs of maximum length is a measurable structural indicator of competitiveness of a higher educational institution. The number of such chains is estimated in relation to the "ideal" higher education institution. It makes possible to evaluate competitiveness for different organizations with different sets of educational programs objectively.

Key words: University, business processes, reengineering, life cycle, competitiveness, educational programs, graph

INTRODUCTION

General provisions: A higher educational institution (a university) is a social and economic system that usually has utmost public importance in any region whether in Russia or any other country. From the community point of view it is focused on training professionals for different public activity spheres including industry, economics, medicine, culture, education and other social institutes. From the system standpoint a university (Anfilatov *et al.*, 2002) is a sum-total of:

- Elements (structural units, employees, students, etc.)
- Resources (curricula, teaching staff, scientific descriptors, academic and on-job training programs, retraining and refreshing courses, etc.)

- Links and relationships between the elements and resources that ensure the education quality level that is expected by the society

Social-and-economic systems, including universities are specifically characterized by such feature as response to external environment effects that are able to change both the system as such and its functional goals. Form the point of view of the system theory a university is a part of a metasystem (a supersystem) which is understood as external environment with its educational competitive processes (Vasilev, 2000). External environment of a university is formed by numerous external objects that are able to impact the university functions on one hand and are influenced by it on the other.

Corresponding Author: A.S. Sizov, Department of Engineering Sciences, Southwest State University, Kursk, Russia

With regard to a university the most important external environment elements are school leavers, applicants, students, teaching staff, administrative and supporting personnel. Among them applicants and students as controlled members represent a meaningful en masse part of society. They traditionally predetermine the goals and objectives of a higher educational institution that have been mentioned above. In this context a university can be understood as a Targeted Direct System (TDS-Uni) in which all available resources are exceptionally spent on educational processes, so that, to meet government targets and undertake profit-making activities.

At the same time the current stage of university development has demanded taking in account new external environment side-line elements such as school teachers, parents, future employers, employees of other educational institutions and local authorities. These elements render specific environmental responses. Moreover, they form social development trends that may influence the functioning of a university. In addition to TDS-Uni activities the metasystem sends signals to the university that tell about new wants and incentives of both young people and matured professionals to get special training/retraining in a certain field and/or continue general education in order to develop culturally make career advancement or social evolution.

Thus, a general outlook on higher educational institutions has shown that a university is a diversified system that has a consolidating goal to train industry specialists and scientists and relevant obligations resulting thereof and is in relationships with other social, economic and cultural systems.

MATERIALS AND METHODS

Competitive ability as the foundation of an innovative marketable university: One of main university management challenges is to control the training life-cycle that comprises all successive educational, administrative, supporting and auxiliary processes that run in the sphere of attracting, educating, monitoring and maintaining qualification level of industry specialists and academic researchers (Sudov and Levin, 2002; Meleshko and Emel'yanov, 2010).

Structural and organizational changes in the environment (e.g., decreased budgetary funding, deteriorating demographic situation, increasing customer's demands, etc.) in which a modern higher education institution has to function give birth to new sustainable data management flows and make it necessary to give comprehensive consideration to mixed, sometimes conflicting, requirements and significant tendencies that exist in such environment. By contrast with TDS-Uni conditions, financial sustainability of an educational institution as well as the improvement of the quality of educational services and customer's satisfaction in an advanced university is connected with its better competitive ability, validity and timeliness of decisions, establishment of organizational and administrative mobility and alignment of curricula in line with external influence. In the most general case an improvement of a controlled system is reduced to cutting down the duration of the management cycle and upgrading the quality of managerial decisions. As applied to a higher education institution its management is first of all related with improving its competitive ability (external evaluation) and the quality of administrative decisions (internal evaluation) in education process.

According to ISO (Series 9000) the quality of a product (service or process) is the degree of its conformity with specific requirements (regulations or standards) (Davydova, 2004). It means that the quality of Higher Education (HE) is a balanced conformity of all aspects of educational processes, including the quality of education conditions (customer's evaluation), the quality of education processes and the quality of their results (consumer's evaluation). Hence, the quality of education is an integrated conception that is determined by numerous factors belonging both to the internal and external educational environments. At the same time as follows from the principle of university autonomy, education quality is ultimate responsibility of the university itself.

Competitive ability of a higher educational institution is competitive position of an educational system that is evaluated by standard internal and external indicators (Belyj and Romanova, 2002). It means that the performance of a university is assessed in the context of other educational institutions that have common attributes (such as location, type, subordination line, etc.) which forms the basis of benchmarking. The complexity of such evaluation is determined by multidimensional character of initial data, the possibility of just a qualitative assessment of many performance indicators, differences in structural and economic organization of different educational institutions and fuzzy criteria of decision making. It complicates the evaluation of competitive ability and makes estimations rather subjective.

Efficient performance of a higher educational institution is the degree of correspondence between actual results and those expected by the university top management (decision-making officials). It means that the efficiency in the administrative chain

"onditions-process-results" is assessed by internal (standard or specifically adopted) performance indicators: the quantity of state-funded places per an educational program, the quantity of text-books/PC per one student, the number of curricula, etc.

It is known that a TDS-type university is characterized by the following (Irikov, 2007): existence of procedures that thoroughly regulate educational activities and are characterized by numerous indicative and instructive indicators; planning of costs to be funded by the government, planned use of funds and other resources and strict financial discipline and cost-based budgetary funding which does not contemplate earning profit.

In case of a new type of Innovative Marketable University (IM-Uni) an educational institution should have the following organizational and economic features: development and implementation of local regulations and collective decisions that can ensure an independent information and economic activities that will not contradict national legislation dynamic costing that enables prompt (in real-time mode for example on a weekly basis) evaluation of each customer's payability or economic efficiency of a structural department or a process; targeted financing that presupposes getting profit from activities (independent off-budget economic activities).

As education market is saturating getting more global and competitive, the quality of educational services is becoming even more important leaving behind such issues as the cost of educational services, customer's expenses and servicing rating. Quality has moved from the category of strategic advantages into the class of competitive necessities and has strong effect on the satisfaction rate of the customer as the leader in evaluating the university's performance and competitive ability. In this relation a unified economic-and-mathematical evaluation method has to be developed to assess the current state of a university and its future prospects, i.e., assess its competitive ability.

From information and administrative standpoint to meet complex and contradictory requirements the university has to use mathematical and algorithmic means developed specifically for educational systems to support decision making (Irikov and Trenev, 1999). In expert's opinion the most advisable means of life-cycle management and competitive ability assessment is CALS- methodology (Sudov and Levin, 2002; Meleshko and Emel'yanov, 2010). This method ensures reengineering of existing business-processes of a university with an objective of multiple use of all curricula resources in the process of continuous education.

CALS (Continuous Acquisition and Life Cycle Support) is an information support of the life cycle of specialist training from the secondary education stage to the training of highly qualified personnel (candidates, doctors of Sciences) in relation to the education system. In other words, CALS is a tool of organizing and informing all participants in the specialist training and further working with him. The goal of using CALS-technologies in education (Meleshko and Emel'yanov, 2010) is to increase the efficiency and profitability of standard business processes of the university.

The main emergent effect of IMUNI management is the formalization and subsequent analysis of typical business processes and qualitatively new processes of scientific, organizational and production content. The interaction of such processes with each other opens up new opportunities in the activities of the university. The concept of "Business Process Reengineering" (BPR) implies a basic rethinking and redesigning of business processes of an organization in order to identify reserves, reduce costs and maximize the use of available resources.

RESULTS AND DISCUSSION

Management of educational programs in the framework of CALS-technology: The analysis of the existing set of educational programs is a substantial basis for the reengineering of business processes at the university (Meleshko, 2009).From the information point of view, the Educational Program (EP) is a document that defines the conditions, resources, learning strategies and the final result of educational activities. The educational program has quantifiable indicators which makes it possible to evaluate the effectiveness of its implementation. Implementation of an educational program unites all participants of the educational process. Accordingly, the evaluation of its effectiveness is related to the quantitative indicators of each participant in the business process and the links between educational programs.

The life cycle of training specialists is considered as a system of interrelated elements consisting in the relationships of structural and logical follow-up in levels and stages of getting an education. Elements of the life cycle are considered as educational programs, combined into sets according to the established levels and stages of education (Meleshko, 2009).

Multilevel organization of higher education in Russia and the actual transition to the European model of training specialists determine the application of such basic types of EP as Bachelor (B), Specialty (S), Master (M) and Postgraduate Studies (A). Training of highly qualified

personnel is carried out in Dissertation councils (DS), working on passports of scientific specialties. The transition to the European Model of education has ruled out such a class as postgraduate education. As a result, postgraduate educational programs became the third level of higher education and Doctoral studies (D) ceased to exist as a form of training highly qualified specialists at the state level.

At the same time, the principle of integration the EP into specialized chains has led to the emergence of new elements in the life cycle of training specialists and to the expansion of IMUNI capabilities (Meleshko, 2009). New elements are: specialized classes with high school students at the university (Schoo-University SU), academic training (Academic Training-AT), professional retraining (Professional Retraining-PR).

Figure 1 and 2 show graphs of the chains of educational programs implemented by universities in the late 20-early 21st centuries and now.

According to Fig. 1 a typical graph of chains of educational programs has a linear structure with weak branching. Only 2 vertices (A, DS) out of 6 possible have a nonzero contraction coefficient. The modified graph Fig. 2 consists of 8 vertices. It has a cyclic structure that allows you to specify structurally the iterative sequences of educational programs. Among all vertices, non-zero contraction coefficients have 6 vertices, 4 have nonzero branching coefficients. This structure of the modified graph allows you to set a wide variety of learning trajectories and realize the well-known principle of "education through life". The structural comparison of the two graphs shows the complexity of the last graph Fig. 2 by 17.5% more than the standard graph (Burkov *et al.*, 2001).

The life cycle of training specialists is viewed as a system of interrelated elements consisting in the relationships of structural and logical follow-up to the stages of getting or expanding education. Relations between the EPs are considered in the context of the formation of specialized chains that ensure the trainee to go through all stages of training within the framework of a single university. This approach allows us to describe educational trajectories through paired schemes (Titenko and Tutov, 2011). In these schemes, the left-hand side sets the condition for continuing the profile education according to the educational program written on the right-hand side of the scheme:

SU→S; SU→B; B→M; S→A; M→A; A→DS; A→AT; A→PR; AT→DS; AT→PR; D→DS; PR→DS; PR→B; PR→M; PR→AT.

The most important characteristic of the EP space in the training of specialists, including the highest
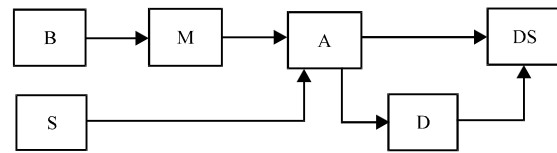

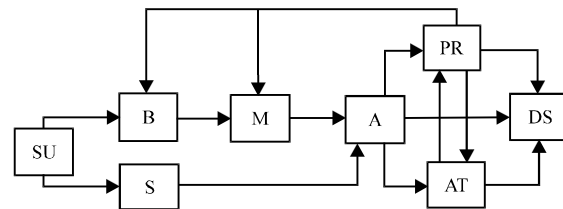Fig. 1: Typical graph of chains of educational programs

Fig. 2: Modified graph of educational program chains

qualification is the specialized chain of maximum length, providing the university with minimization of costs, provided the succession of the contingent of trainees, especially in the implementation of per capita financing by the state.

CONCLUSION

In conditions of unstable external environment, the university is forced to develop and use its own models and algorithms for assessing the efficiency and competitiveness of the university in the educational market. Efficiency and competitiveness of the university are determined, first of all, by the quality of the provided educational services and directly related to changes in the life cycle of specialists training. Hence, the task of managing the competitiveness of the university is associated with the task of managing the life cycle of training specialists.

It is considered reasonably necessary to unite specialized educational programs at all levels and stages of training into a single chain. To quantify the connectivity of educational programs of one profile, the graph of the chains of educational programs has been modified. It is expanded by new vertices that define new sequence relations at the input and output of the graph. According to the modified graph, the competitiveness of the university is estimated through the number of profile chains of maximum length passing through all the vertices of the graph. The presence of cyclic contours in the modified graph allows modeling the relationships between specialized educational programs or new elements equated to them. Such new elements in the modified graph

are scientific internships, professional retraining and specialized classes with high school students at the university.

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