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Integration of Education in Research and Production for Training Staff in the Field of Economic Cybernetics and Informatics

The improvement and modernisation of higher education is in our days a subject of study and large debates all over the world. This situation of the contemporary period is determined by the fact, that at present higher education is facing new scientific problems, new and greater social responsibilities, which ask for the permanent improvement of its structure and content, of its forms of activity.

In the present conditions science becomes an ever more active factor in material production. On account of this, some branches of science acquire a primordial role because they produce new methods and procedures of research, applicable both for the knowledge and better analysis of many domains of material production, of nature, society and human thinking.

The improvement of higher education — as a natural follow-up of the human progress in general — is an objective and urgent demand of economic, scientific and cultural development.

As far as the economy is concerned, the fundamental object of this development is the achievement of a dynamic modern economy, directed towards the use of most advanced technique — in its large sphere of domains and activities, in its entire complexity.

Starting from the major requirements of our economy, concretized in the broadening and improvement of the technical-material basis of the country, the building of our multilaterally developed socialist society, the training of specialized staff for production becomes a major condition meant to ensure the qualitative, improvement and quantitative increase of material goods and assets. Higher economic education, and within the education in the field of cybernetics and economic informatics is one of the main levers securing highly skilled specialists for our needs. In order to reach this desideratum, the education process has to ensure, with highest efficiency, the transfer of thorough

knowledge from concrete economic life, from the realities of production and must be able to give to students a good capacity of using the most modern methods specific to the optimum solution of economic processes and phenomena.

The high-rate development of our economy asks for optimum methods of planning and management, based on modern operative and exact calculus, which should ensure a high efficiency for the utilisation of the material and human resources.

If we consider that planning stands in close connection with all spheres of activity, that in our economy with a high degree of complexity — in which the quantifiable and quality sides of development occupy a central place in the strategy of building the manysidedly developed socialist society — for the establishment of the alternatives of economic growth and the characterisation of their efficiency, it is necessary to use, to an ever greater extent, the methods, procedures, techniques offered by cybernetics and economic informatics as well as the other modern branches of science. Starting from the economic objectives, cybernetics and economic informatics place at our disposal a large range of practical solutions regarding the working out of economic-mathematic models for enterprises, for industrial branches, for the entire economy, for the territorial profile, to help the activities of planning, organisation and economic management.

At present, when science and technology are progressing at an amazing rate, when the quantity of knowledge with direct possibilities for application in practice is doubling in intervals of about eight years, parallel with the ever more rapid moral wear of the previous information, the process of teaching and training undergoes profound mutations, receiving a new content and new dimensions.

Considering the major imperatives of social-economic development, in close corellation with the concrete economic realities and the prospects of development, higher economic education, regarded from the historic point of view, receives new dimensions and significance with the introduction, for the first time in our country, of the methods of cybernetics in the study-program of the Academy of Economic Studies in 1949, when the department of Economic Cybernetics was set up and when the relativelly small number of taching staff, with efforts inherent to any beginning, laid the bases of today's research laboratories (set up in 1963), through the acquisitioning of some desk calculators, meant to replace routine-work and to resolve the problems of economic and statistic calculus.

Since the very inception of the research laboratories of the Department of Economic Cybernetics, a major aim set forth was the achievement of an ever closer merging between the educational process, scientific research and material production. The study themes have been selected at the productive units the Department had had conventions of cooperation with, and were used as teaching material in the process of education. As far as the scientific research activities are concerned, the Department of Economic Cybernetics has set itself the target, as an objective of large perspectives, the improvement and modernisation of management methods as well as of planning and organisation of economic activities, on the basis of the implementation, on the one hand, of the analythical quantitative methods, and on the other hand, of the modern techniques and

means of data-processing with a view to the rigurous scientific substantiation of the complex process of decision-making in economy. Parallel with the aim propper of research and the implementation of the results obtained in production, the objective of special importance our Department had to cope with was the education of students in contact with these methods, techniques and modern means of calculus within the general framework of the educational process.

Since there is a permanent and steady preoccupation for placing the process of education on modern bases, the Department has made great efforts for the equipment of the laboratories with the most modern outfit eguipmeut of data selection and processing, necessary to the educational programmes andc hanelled the entire process of tuition towards creating closer links between the student's theoretical information and practice, inspired from the concrete economic life. This has created the possibility for the entire educational activity to be more organically linked with the needs of the economy, to ensure the appropriation of the new calculus techniques (mechanized, mechano-graphic and automated), the students acquiring the necessary knowledge and skill for the tackling and solving, on modern bases, of the esential economic problems. One of the main directions, of essential preoccupation, the leadership of the Department has followed from the very inception of this study-unit, and which has been an important bridge between concrete economic activity and the process of education, was the choice and implementation of the themes and results of scientific research — conducted and achieved by the staff of the Department of Economic Cybernetics — in the didactic activity, in students' training. In this way, on the line of the symbiosis between the process of education, research and production, the contribution of the Department's research laboratories has been considerable from the very beginning.

Having in view the activity of creating ever stronger links between edu cation and the requirements of social-economic life, the Department of Economic Cybernetics has improved and adapted its structures to cope with the necessities of the national economy, creating — with forms, methods and with a new concept — an adequate framework for the process of education for the cadres of specialists demanded by material production, granting particular attention to the solid content of tuition in the field of economic cybernetics and informatics. With a view to achieving the merger and indissoluble link between education, scientific research and production, the Department of Economic Cybernetics has worked out and applied a new organizational concept so as to be able to cope with the already mentioned major desideratum.

Thus, with the help of a structure based on the three main domains of the Department's activity (education, research, production) we have achieved — in a cybernetic concept — a triangular system subordinated to the same tridimensional aim: the training at a higher level of specialists for the fields of economic cybernetics and informatics and scientific research and productive activity. Figure 1 shows the concept of organisation of the Department, in a cybernetic system.

As has been pointed out, the activity of scientific research is taking place in the laboratories of the Department. This activity, based on contracts of scientific research with economic units, is directed towards the major problems of the national economy.

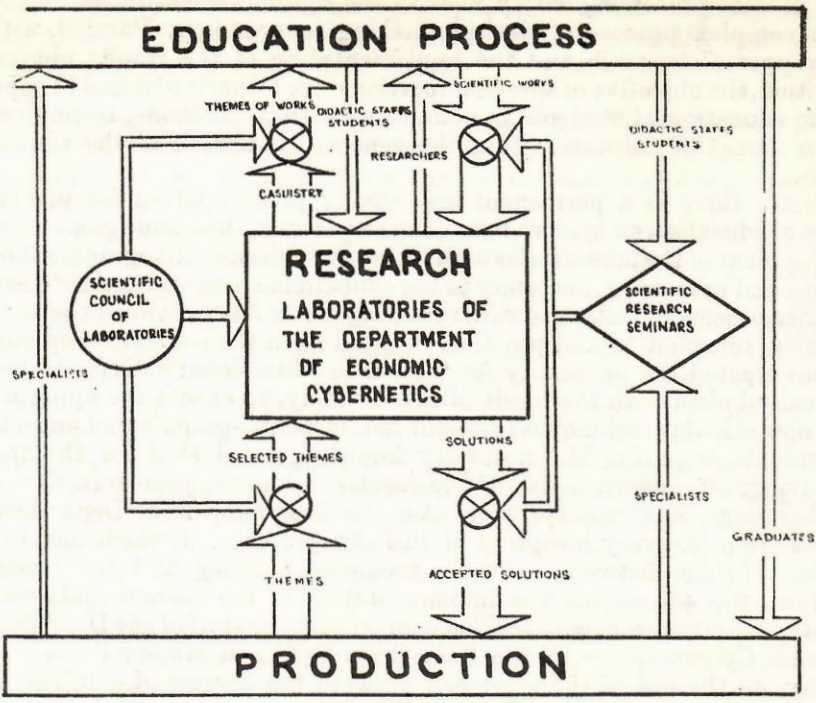

Fig. 1. The concept of the organizational build-up and activity of the Department of Economic Cybernetics.

The choice of the themes, the subjects of the contracts accepted, is being done according to the criteria of the importance of the economic problem in the ensemble of our economy, according to the criteria of economic efficiency, in close relationship with the possibilities of generalizing the cybernetic models and information systems in units with similar profiles, according to the criteria of these themes' scientific interest, as well as the didactic interest, of this educational value.

After the solution of these themes, the results of research are analysed up to the moment of their actual implementation in production. This is being done at the scientific seminars of research, which are attended both by researchers, teaching staff and specialists in production — the end-users of the solutions which resulted from the activity of scientific research — as well as by students. The initiating of the research subjects within these seminars leads to the direct result, on the one side, of transition to the stage of the solutions' implementation in production, and on the other side, of selecting the particular cases for the process of education via the decisions passed by the Scientific Council. In order to illustrate the nature of the themes and problems which become "cases" for the educational process, we shall make a cursary presentation of the problems tackled in these seminars and the way this educational form is organized. The three seminars, "Economic-Social Forecasting", "Operations Research with Applications in Economy"

and "Information Systems with Applications in Economy", are debating in weekly or bi-monthly sessions theoretical or practical issues resulting from the activity of fundamental research on the bases of contracts, as well as problems linked with the present and future needs of economic-social development.

As a practical system of collaboration between the various research collectivities examining similar problems and as a scientific tribune, the seminars are good opportunities for debating the various points of view and concrete possibilities for the working out and implementation of the various cybernetics models, of the calculus methods and procedures, of the different informatics systems. As we said, these seminars are attended, besides the researchers, by teaching staff and specialists from various economic units. The State Planning Committee, the Central Board of Statistics, the Ministry of Foreign Trade and Economic Cooperation, the Ministry of Finances, etc.) and the students, especially those towards the end of their studies. Within the seminars to students get acquainted with the concrete ways and means of elaborating the patterns of long-term planning for economic and social development, with the practical modalities of applying the concepts, models and techniques of economic cybernetics, with the methods of operations research and implementation in economy, as well as with the methods, procedures and techniques of realization and implementation of the informatics systems used in the management of economic activity, of the data basesund banks, the use of applicative standard program packages, etc.

The steady work and the active drawing of the students into scientific research activity in laboratories, have been concretized, as was said, also through the participation of the students in the scientific seminars organized in the research sectors of the laboratories. The students get into contact and participate with and in the debates regarding the theoretical and applicative results obtained in the study of some particularly important themes generated by the present requirements of economic and social development.

Taking place at a high scientific level, the debates help the students form their own views about the scope of theoretical and applicative issues and problems — an important element in their training to become future specialists. At the same time, they are an opportunity for the students to get a deeper and more solid knowledge of the themes in discussion, the pattern-problems of economic growth, modern methods used in economic forecasting and planning, on the integrated systems of operative programming of production, on the informatic systems of technical-material supplies, mathematic application in economic modeling, a.s.o. More than that the students receive supplimentary information of great value, complementary to the basic theoretical and applicative knowledge appropriated at the courses, seminars and practice.

In the process of education — as a follow-up of the close connections between the sides of the "education-research-production" triangle — included are also a great number of highly-skilled specialists and experts, delivering lectures and holding seminars as well as practical sessions with students, either within the faculty, or outside it, in the units these specialists are coming from.

The choice of this line of education is motivated by the necessity of knowing by the students of the practical realities of the economy and of the implementation of the gains of modern science and technology (particularly of cybernetics and informatics) in the everyday activity of the various economic units. The lectures delivered by these specialists offer a favourable framework for sharing personal experience or the experience of the collective bodies these highlyskilled specialists belong to and carry on their activity with.

The participation of the teaching and academic staff in the research activity on the bases of contracts with economic units, considerably increases the efficiency of the process of education. This must be understood under its double facets: on the one side, the academic staff, by their effective participation in research activities realize a direct link with production, refreshing their stock of information and getting directly acquainted with the present economic realities as well as with those of the future; they appropriate new ways and means for the economic tackling of the existing processes and phenomena, thus being able, with research, to make their substantial contribution to the improvement and modernization of economic activities; and on the other side, being in the position to supply to the process of education a rich and varried material, based on concrete facts, inspired and selected out of economic realities of production.

An important role in the educational process of training specialists in the fields of economic cybernetics and informatics is being played — besides the academic staff — also by the research staff of the Department of Economic Cybernetics, which ever since the inception of the Department laboratories (in 1963) are included in the academic corp, dealing with the training of students either during the lectures delivered to them, or during the hours of practicals or seminars.

The didactic process these people are engaged in is taking place either within the research laboratories, where the students carry on practical activities using the standard calculus outfit, or in the lecture and seminar halls of the Faculty of Economic and Statistic Cybernetics. With a view to organically linking scientific research and production, the research laboratories of the Department of Economic Cybernetics offer a large frame for the best-possible unfolding of the educational process, raising the efficiency of tuition to very high levels, thanks to the modern material facilities concretized in calculus equipment of a large range (equipment of law-grade mechanization, medium mechanization, mecanographic equipment, minicomputers and electronic computers) and by placing at the students' disposal a file of many concrete cases, inspired from research activity on the basis of contracts with productive units.

The steady preoccupation of the Department for the corresponding equipment of the research laboratories — following the line of the present and future requirements of the improvement and modernization of education in this country — has been concretized in the acquisitioning in 1970 of an electronic computer of the third generation and of the peripheric equipment of data processing for automated operations. This fact, important for placing education on a higher level of competence, has exerted a positive influence — besides the research-production activity — also over the structure of the

academic programs of the Faculty of Economic and Statistic Cybernetics. On this line it is important to underline that we have introduced in our programs lectures on: Build-up basis of electronic computing, operation systems, standard programs, a.s.o.

Parallel with the growing necessity of the utilisation of some automated means of calculus, and we mean ever more modern and bigger capacity means, in close dependence on the needs of research and production, of the utilization of a still richer repertory of standard programs also in direct relationship with the extension — through the academic plans and programs of education — of programing and using the electronic computers by all students at the Faculty of Economic and Cybernetics Statistic, as well as by several advanced grades of students in other Faculties of the Academy of Economic Studies, the laboratories of the Department have added new equipment to their capacity in 1974, now having also the teleprocessing system formed of displays terminals; printers, punched-card and punched-tape readers, operated from the distance.

This important step in the superior equipment of the research laboratories will create possibilities for the students to get training in the utilisation of the newest world methods and techniques of economic data processing and to become familiar with the techniques and procedures of tele-processing, multi-programming and time-sharing, which will be broadly used in economic units, in the nearest future.

The activity unfolded by the students in the Department's laboratories may be illustrated with figures pertaining to the considerable number of computer/hours used, the number of programs and operations conducted with computers (table 1) as well as with the number of hours allotted for data and program preparation.

Table 1

Students' practice on electronic computer

Academic year	1971/72	1972/73	1973/74	1974/75
No. of programs		7,000	10,500	12,000
No. of runs		70,000	105,000	110,000
No. of computer/hour	1,570	1,800	2,100	2,300
No. of impr./test	1,842	7,476	8,000	10,000

A rich didactic and scientific research activity has been conducted with the students in the laboratories of the Department of Economic Cybernetics. As has been pointed out earlier, the laboratory researchers have worked out lectures, compiled selections of problems, program-guides, etc. and have taken part in presenting some lectures, seminars and practicals (with 15 disciplines on an average per university year). Besides these activities they have been acting as tutors for the annual and diploma tests and papers (about 90 draft diploma-papers per academic year), which compulsorily (the condition for promotion!) include solutions to some problems of concrete economic

activity. Parallel with these important didactic activities, the Department's laboratories have also been conspicuous with the participation of researchers in guiding the practicals in production, in economic units, in computer centres and particularly within the own laboratories. In this sense we must note that the over 200 students (on an average) who have completed their annual practical work in production, each academic year, within the Department's laboratories have worked effectivelly, shoulder to shoulder with the research staff on the scientific research based on economic contracts. This method of work — the students acting together with the researchers — has proved to be extremely efficient in the process of education, a fact reflected in the very good results obtained, on the one hand, on the draft-diplomas, and at the work places, on the other hand. Within the didactic activities, besides the lectures and seminars conducted by researchers, a real contribution has been made to the completion, in optimum conditions, of the considerable number of practical themes (in the laboratories) concretized in the solution with the aid of data-processing equipment and especially the electronic computer, of a number of economic problems, included in the research activity based on contracts.

The students guided by the laboratories' research staff have worked out models and algorithms for various concrete economic problems, intensively using the systems of data processing. Thus about 1,600 students worked in the 1973/74 academic year with the electronic computer, runing about 7,000 programs and making about 70,000 runs. Special importance has been granted to the implementation in the process of education of the results of the scientific research and production activity unfolded by researchers in the sense that a preoccupation has existed for the creation and improvement of the stock of cases based on solved research themes. Significant, for instance, is the 1972/73 academic year, when 7 studies and "selections of cases" were worked out (about 1,000 pages), and on the basis of the solved research themes more than 30 syntheses and information-materials (about 3,500 pages) were edited and placed at the students' disposal as study and documentation staff.

With a view to stimulating the students in their own research activity, an important role has been played by the leadership and guidance, by researchers and the academic staff, of some students' scientific circles and several students' scientific research themes. Significant in this sense is also the winning over of the students for some mixed collectives, where side by side with the academic staff and researchers they act on research themes based on contracts. Solely in the 1973/74 academic year over 300 students in the 4-th and 5-th grades carried on permanent or temporary (on the occasion of practicals in production) research activity, for solving the contract themes taken up by the laboratories. Similarly, a great number of students, who proved special skills for research were temporarily employed — working half-time — with the laboratories of the Department of Economic Cybernetics, earning corresponding sums of money.

Under the guidance of the academic staff and the laboratories' researchers, the students of the faculty carried on a sustained activity of research in the students' scientific circles. In the past two academic years there were five scientific circles: "Economic Cybernetics", "Operations Research",

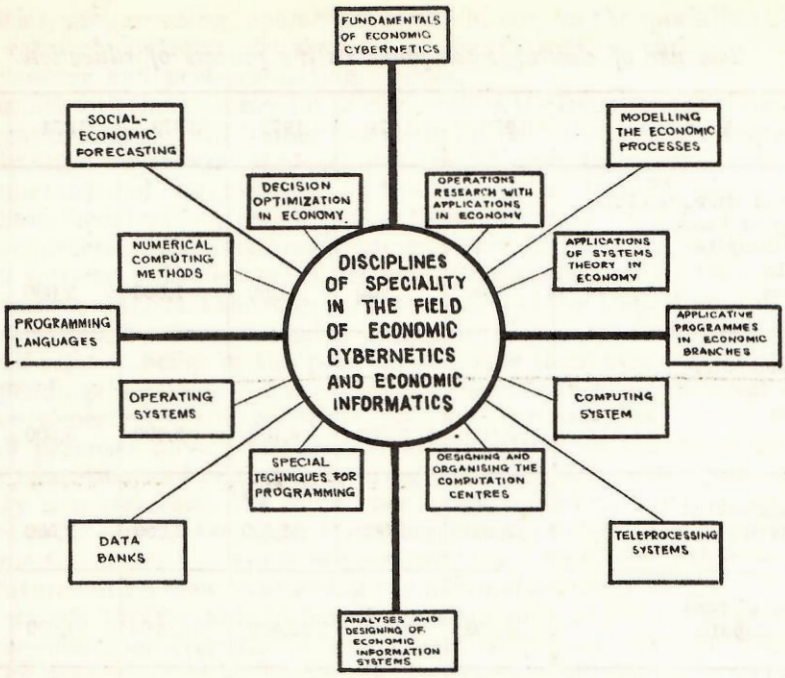

Fig. 2. Disciplines of speciality at the Faculty of Economic Cybernetics and Statistics

"Electronic Computers and "Automatic Computation Systems", "Economic and statistic calculus" and "Algorithmic Programming Lauguages", with a large participation of II, III, IV and V grade students. In the 1973/74 academic year, for instance, the number of active students in these circles was over 190, studying 65 themes in important domains with implications in the national economy.

Special appreciations on the students' research activity have been worded on the occasion of the XVI-th session of scientific circles, when, as part of the sections organized within the faculty, with the aid of the laboratories, 46 expositions were presented, selected from among the themes debated in the circles and which presented clear theoretical and applicative value.

The interest shown by the researchers in the process of Education has been obvious also on the line of organizing some applicative works with students in various industrial enterprises and research units (The Electronic Computers Factory, the Designing Institute for the Light Industry (IPIU) the' Danubiana' Tyres Plant, the Central Board of Statistics, etc.) during the lecture and laboratory hours with the disciplines: electronic computers, the analysis and design of economic informatic systems, etc. Fruitful results were also obtained — in this direction of linking the educational process with economic practice — with the disciplines which had applicative activities within the Department's laboratories, particularly with the programming of electronic computers, applicative programs and calculus systems.

Table 2

The use of electronic computer in the process of education

Year	1970	1971	1972	1973	1974	1975 Jan-June
Number of students of the Academy of Economic Studies using the electronic computers	800	900	1,100	1,500	2,000	2,000
No. of computer hours in the education process	2,500	3,500	4,100	5,000	5,500	1,300
No. of elaborated programs	2,400	3,000	4,400	5,000	7,500	8,000
Total no. of runs on the computer	26,400	36,000	52,800	70,000	84,000	96,000
No. of punched checked cards operated	38,500	45,000	180,000	750,000	800,000	1,000,000

The special attention granted by the research-staff to the process of education is reflected also in the impressive number of consultation hours given to students (3,500—4,000 hours per year). These consultations are taking place either in the laboratories, or in the lecture and seminar rooms. The students may request daily consultations, and in the examination periods they may call on any scientific researcher for help. In the periods prior and during the examinations, the consultations are minutely organized, having, on the one side, the requests from a great number of students and on the other side, the differenciated specific of the consultation hours on disciplines, types of problems, a.s.o.

The promotion of the modern methods used in the process of education is a major proeccupation. By presenting the themes of the lectures, seminars or of other practical activities with optical-projectors, by the utilisation of programmed instruction, of some lecture-aids, multiplied schemes, models and pannels, micro-exhibitions — avoiding the monotony characteristic of the old-types of tuition — we have secured to the process of education a modern stature.

Another important activity, which underlines the preoccupation and contribution of the Department of Economic Cybernetics to modernising education, is that of specialising staff for various economic branches through forms of education; lectures within the laboratories on economic cybernetics, economic

informatics, programming, operations research, etc, for the specialists beneficiaries of research contracts, via the form of open lectures in various enterprises in the country and post-graduation courses.

Parallel with these courses for economic staff, the Department's laboratories have organized since 1970 trainer courses in the field of computer programming and ordination for lyceum students (we are referring to lyceums with grades of informatics) and, for instance, at the end of the 1973/74 school year 50 pupils have had training completed in these particular fields.

A characteristics worth-mentioning is that of covering, with collective research activity — the expenses pertaining to these operations. On this line let us make a note of the fact the research laboratories of the Department of Economic Cybernetics, by the sustained activity they have carried on, have succeded to be self-reliant, being in the position to cover their own expenses and all other spendings necessary for a modern process of education in the domain of economic cybernetics and economic and statistic calculus.

All premises have thus been created for the further development of modern education and research, securing to ourselves by self equipment, the necessary material base. We must once again underline that the results we obtained so far — results scored in the research laboratories of the Department of Economic Cybernetics — are sure premises which must be further developed in the future with a view to ensuring our national economy with highly skilled specialists and experts, able to handle the multitude of economic phenomena and processes characteristic to a dynamic, ever more powerful economy.

The achievements so far of the Department of Economic Cybernetics in the elaboration of a modern system of education compel the researchers and academic staff to continue their efforts, ever more harmoniously and ever more organically blending the sides of the education-research-production triangle.