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RESEARCH AND DEVELOPMENT IN YUGOSLAV INDUSTRY

by

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Introduction

1. Research and development activity in Yugoslavia during the post-war period evolved under the conditions of powerful socio-economic progress. The first period of centralized management was followed by a continuous process of decentralization in which the initiative and creative endeavour of all the economic subjects (economic organizations and their associations)[1/], played an important role. In these conditions, research and development are becoming--from the point of view of science policy, programming and financing--not only the concern of the State but also of all the factors in the economy. Efficient utilization of all available personnel and research potentials requires, on the one hand, a freer activity of production and research organizations under the conditions of self-management and, on the other hand, finding effective forms and measures for co-ordination and programmatic unification of research and development. This is a very complex task for the implementation of which intensive efforts have been exerted in Yugoslavia, especially during the last few years.

2. According to the economic reform launched in 1965, intensive production and integration with the international division of labour are, at the present level of development of the national economy, the basic goals of this development. Such an orientation of all economic subjects lays particular stress on research and development as the basic components conducive to attaining the level of technology and productivity of the industrially developed countries.

1/ The term "economic organization" used in this paper refers, in addition to enterprises, to some other forms of autonomous economic subjects, such as co-operatives, ships and so on. All of them, together with autonomous institutions and other institutions outside the economy, are covered by the wider term of "work organization". The latter are either business or non-business associations established on the initiative of their members, or general associations and communities comprising all the organizations of a given sphere of social activity (economic chambers, community of universities, etc.)

The first results already show that the economic organizations and their associations, as the basic vehicles implementing the objectives of the economic reform, have taken the first important steps forward in the sense of programmatic orientation towards research and the ensuring of a broader material base for the financing of research and development. One should add to this the positive tendencies towards a longer-range and firmer linking up of the economy with autonomous institutes and research organizations at universities.

I. SCIENCE POLICY, PROGRAMING AND INVESTMENTS IN RESEARCH AND DEVELOPMENT

3. The defining of science policy and programming of fundamental and applied research and development were almost exclusively the concern of State bodies until a few years ago. Self-management and the economic autonomy of work organizations have brought about radical changes also with regard to the determination and implementation of science policy and the programming of research and development. The economic organizations and their associations are today the protagonists of enlarged reproduction, while research is the factor ensuring the level of technology and productivity. From this stems the immediate interest of the economy in having a direct say in the formulation of national policy in the sphere of science and in proceeding to self-organization with a view to ensuring a more rational utilization of research and personnel resources.

4. The financing of research and development in the post-war period may be divided into three phases. Centralized planning of scientific work characterized the period prior to 1957. Investments in research were almost entirely directed towards an outright budgetary financing of scientific institutions. This period had a positive effect on the laying down of the institutional foundation of research. The period between 1957 and 1963--when the federal and republic councils for the co-ordination of scientific activities and the federal and republic funds for the financing of scientific activities were formed--was characterized by a transition to the method of financing projects through contracts.

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5. Since 1963, the participation of the economy in the financing of research has been growing constantly. This is reflected not only in the share of state funds in the financing of certain projects, but also in the setting aside of funds by the economy for its own research projects.

Some aims of science policy

6. Science policy in Yugoslavia is an integral part of the general policy of social and economic development of the country. Science policy fixes the basic aims of research for a given period and determines the methods and measures for attainment of these objectives. This is in harmony with the system of planning in general, according to which only the general proportions of development are outlined in the social plan. The elements determining the policy of scientific research are, above all, the general elements of the socio-economic development of the country and the elements linked with the development of economic organizations. Policy is also influenced by the fact that Yugoslavia is a multinational community where the specific cultural and economic interests of the republics also come to expression.

7. The elements for the formulation and programming of research and developmental work were provided by the Federal Assembly through the adoption of the Resolution on Scientific Research, at the beginning of 1965, which laid down the guidelines for the development of scientific research. The Federal Council for the Co-ordination of Scientific Activities and the republic councils, bearing in mind the intentions of the resolution and of the policy of development of the economy and society as a whole, have elaborated a programme for the Development of Scientific Activities of Wider Interest for the period 1966-1970. The Federal Commission for Nuclear Energy, which is interested in the implementation of research in its field, has been included in this process. Economic organizations and associations of producers, as well as scientific institutions, elaborate their own specific programmes.

8. Co-ordination of research is a very complex and complicated task, especially since it depends on the voluntary participation of interested

organizations on the basis of their own interests. The Federal Assembly periodically examines the analyses and proposals of the Federal Council for the co-ordination of scientific activities, taking into account the broader aspects of the socio-economic development of the country as well as other factors of importance for the development of research, on the one hand, and the general development of the country, on the other.

9. The question of the long-term character of research targets and programmes is very important with regard to the formulation of science policy and programming of scientific research. It is obvious that long-term tasks are of lasting interest to the community and that they are mainly concerned with stimulating scientific activities linked to fundamental disciplines and long-term projects in the field of applied research. Short-term tasks fall predominantly within the sphere of interest of economic subjects.

10. Economic reform has ushered in broader processes where the economy exercises a direct influence on policy-making in the sphere of scientific research; it has, furthermore, aroused interest in programming research and development on all levels. The redistribution of social accumulations to the benefit of the economy has provided a material base for such orientation of the economy. The results attained in the first years have been rather modest, but the tendencies point to serious efforts by economic organizations to use their associations for programming common tasks. We should like to cite a few positive examples in this respect.

(a) The Federal Economic Chamber elaborates the methodology for defining policy in the field of research of interest to the economy. On the other hand, it has elaborated and is now implementing a long-term research programme directly concerned with the intensification of production.

(b) The Council for the Construction Industry of the Federal Economic Chamber, which encompasses economic organizations in the field of the construction industry and producers of building materials, has elaborated and is implementing a programme of joint research projects covering the period ending in 1970.

(c) The Association of Yugoslav Iron and Steel Plants, which encompasses

all iron and steel plants, has been programming and carrying out research of interest to their members for a number of years.

(d) Some business associations in the country are programming and financing scientific research of interest to their members, with considerable funds. This is a new moment in the financing of scientific research.

Investments in research and development

12. A statistical survey of investment in research and development only began after 1960. During the first period, the resources were provided predominantly by social funds, while the economy participated with considerably smaller resources. The role of the economy in the financing of research and development has grown considerably, concurrently with the growth of the economic power of the country and the increased interest of the economy in the results of scientific research.

13. Investments in research during 1961-1965 ranged from 0.64 to 0.88 per cent of the national income, as shown in the following table.

Table 1
(in millions of new dinars)

	1961	1962	1963	1964	1965
State funds	132.3	154.8	117.9	223	289
Economy	65	85	136	250	375
Total	197.3	239.8	312.9	470	663
Percentage of the national income	0.64	0.70	0.74	0.84	0.88

The above table shows that investments from state funds and total investments in research have been growing faster than the national income. However, the general level of investments is still below the corresponding proportion in the developed countries.

14. The index of growth in the forthcoming period, foreseen by the Plan of Development of Scientific Activities in the Period 1960-1970 is given in the following table.

Table 2
(1960-100)

	1965	1966	1967	1968	1969	1970
Social funds	289	280	296	315	337	360
Economic organizations	375	413	487	595	678	800
Total	664	693	783	890	1,015	1,160
Percentage of the national income (1960 = 100)	0.88	0.85	0.89	0.94	0.99	1.05

15. The foreseen rate of growth of investments in research amounts approximately to 14 per cent, so that at the end of the period under review total investments should amount to a little over 1 per cent of the national income. This is still inadequate if compared with the developed countries where this percentage is higher, but the tendency toward growth is very encouraging. A characteristic feature of the forthcoming period is that investments in research are becoming increasingly the concern of economic organizations as the main protagonists both of research programmes and enlarged reproduction. The percentage of the share of the economy is increasing and the share of state funds is decreasing, although both sources show an increase in absolute amounts. By the end of the period under review (1970), the investments of the economy in research will be about 70 per cent and those of social funds approximately 30 per cent. This is a rather high share of the economy, taking the ratio in the developed countries as a criterion. With the strengthening of the role of economic organizations in the financing of research, shifts have also occurred in the pattern of investments. Thus, State funds are intervening to a lesser extent in such fields as technical sciences, agricultural science etc., while their relative share in the financing of natural sciences and mathematics is growing.

16. It has been shown that there exist two basic sources of financing research and development, viz. by economic organizations and their associations, and by federal and republic funds. Other sources play no significant role in the implementation of research programmes.

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17. Table 3 below shows the structure of investments through the federal and republic budgets in the 1961-1965 period. It is characteristic that the resources of the Federal Fund for this period do not accompany the growth of the national income. The stagnation and instability of funds for research and development obtained through federal sources of financing has made it necessary to take some decisions with the aim of decentralizing functions and funds in this field also, of stabilizing these investments and bringing them into harmony with the growth of national income. The draft prepared for the Federal Assembly provides for securing, on a lasting basis, funds amounting to 0.2 per cent of the social product. A long-term stable orientation of State funds provides also a basis for the orientation of the economy in programming and financing research activities.

Table 3
(Structure in percentages)

	1961	1962	1963	1964	1965
Federal Commission for Nuclear Energy	57.5	50	48.6	46.5	43.9
Federal Fund	22.2	25	20.9	19.9	18
Republic funds	15.9	20.9	26.1	28.9	32
Federal funds for institutes of social sciences	4.4	4.1	4.4	4.7	6.1
TOTAL	100.0	100.0	100.0	100.0	100.0

18. Table 4 gives a survey of the distribution of resources of funds according to designation.

Table 4
(Structure in percentages)

	1961	1962	1963	1964	1965
Research	82.3	78.6	62.2	69.7	74.7
Investments	16.6	20.5	30.7	27.6	22.1
Remainder	1.1	0.9	7.1	2.7	3.2

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The percentage of investments is rather high. The purpose of these investments was to strengthen the institutional base for research and development. Since 1963 there has been a slight decline of investments in favour of the increase of the percentage of funds for research.

19. As regards sources of financing, a breakdown by fields of research is characteristic. The structure of investments from social funds is given in table 5.

Table 5
(Structure in percentages)

Field of research	1961	1962	1963	1964	1965
Natural sciences	6.2	4.1	6.6	9.2	22.7
Technical sciences	38.3	45.2	38.3	40.5	25.4
Medical sciences	4.5	6.4	4.4	6.5	5.0
Agricultural sciences	36.4	32.5	33.3	28.9	26.8
Social and humanitarian sciences	13.4	10.9	10.3	12.2	16.9
Remainder	1.2	0.9	7.1	2.7	3.2

Of particular interest for the development of industry are the investments linked to technical sciences and partly to natural and social sciences. The period under review coincides with the period of gradual economic strengthening of economic organizations, so that the resources of social funds earmarked for research of immediate interest to industry are stagnating or are beginning to decline.

20. The Federal Commission for Nuclear Energy directs a special group of research organizations oriented towards fundamental and applied research in such fields as nuclear physics, nuclear power, radiobiology etc. The groups engaged in the production of isotopes, in electronics and chemical-technological research devote from 15 to 46 per cent of their work to research of interest to industry, while other groups devote considerably less time to this type of research. The reason for a relatively low involvement of nuclear institutes in

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research problems is the narrow specialization of institutes in specific nuclear problems, the de-stimulative effect of the budgetary mode of financing, inadequate resources for this type of research within the framework of industry and the orientation of the economy, particularly industry, towards the solving of short-term immediate tasks which are on the level of development research and can be solved within the framework of industrial development institutes.

21. Changes in the system of distribution of income, the regime of prices and the credit system during the last few years have placed the economic organizations in a qualitatively new position with regard to the sources of financing, enlarged reproduction and expansion. As shown above, the share of the economy in the financing of total scientific research and development in 1965 was 56.5 per cent. The structure of investments of economic organizations and their associations, by scientific fields, expressed in percentages, was, in 1965, as follows:

Natural sciences	27.7
Technical sciences	60.3
Medical sciences	0.9
Agricultural sciences	6.2
Social and humanitarian sciences	4.9

22. From this, the following general conclusions maybe drawn:

(a) The investments of economic organisations are mainly funnelled into technical sciences, i.e. into the technological base;

(b) As technical and natural sciences account for 88 per cent of total investments in the economy, industry is asserting itself as the main vehicle of research in the economy of the country.

23. The protagonists of research work in industry are, on the whole, narrower groupings of economic organisations of the electronic industry; manufacturers of equipment for power plants; manufacturers of agricultural machines,

construction machines and machine-tools; manufacutrers and users of equipment for processing ferrous and non-ferrous metallurgy, and the chemical industry. The pooling of resources for joint research has no great tradition behind it. This process began only after the launching of the economic reform and it is estimated that, in 1967, 15 per cent of total investments in research in the economy were effected by means of joint programmes through chambers and other associations of producers. Joint investments were made mainly in industry.

24. The programme of development of scientific activities in the period 1966-1970, elaborated by the Federal Council for the Co-ordination of Scientific Activities, and which is a component of the Social Plan in the field of science, has set the tasks and targets and provided the mechanism for a more active and direct integration of research with economic and social development. The whole concept of investments is based on the intention to promote a rapid growth of investments from decentrailzed sources. Thus, the rate of growth of investments by the Federal Fund amounts to 8 per cent, by the republic and provisional funds to 12 per cent, while investments by the economy are growing at an even higher rate.

25. Table 6 below gives a comparative survey of indices of the growth of investments in scientific research by sources of financing and the partial share of the economy for the period 1966-1970.

Table 6

	1965	1966	1967	1968	1969	1970
Total investments	100	114	130	148	169	193
Economy	100	118	143	164	194	229
Percentage of investments by the economy	58.4	59.6	62.2	64.6	65.8	69

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26. Finally, it should be noted that nuclear research which, in 1965, accounted for 63 per cent of total investments in research, is, from the points of view of programmes and conception, financed by the state funds for the financing of research and development.

Priority trends in research and development activities

27. The extensive development of industry in the post-war period resulted partly in an inadequate defining of trends in the field of research and development. The system of financing scientific institutions, on the one hand, and a certain linking of technological progress to the purchase of foreign expertise, on the other, did not sufficiently stress the significance of research work. This is, to a certain extent, a normal development in the developing countries in the phase of forming their own institutional base. A negative aspect is undoubtedly the insufficiently intensive utilization of the results of research in industry.

28. The creation of an institutional base and the trends in research in the past period depended directly on investments by state funds. In the period 1957-1965, financing of research in the fields of nuclear energy, electronics, chemistry, construction and physics was stimulated predominantly through the budget. It may be especially stressed that the level of research attained in the following fields has obtained international recognition: automation, electronics, nuclear physics, radiation chemistry, testing of materials, construction industry, electrical equipment for power plants, and certain non-ferrous metals.

29. A determined selection with regard to the growth rate of some branches of industry could be noted during the last few years. The basic parameters are the raw materials base and conditions of sale in the domestic and external markets. In the conditions of intergration of the Yugoslav industry into international competition, the level of technology and productivity play an ever greater role. An intensification of production and a broader integration into the international division of labour - aims set by the

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economic reform - call for long-term planning in the fields of economic development and research. Emphasis should be placed on those branches where domestic resources, the level of technology, research and cadres ensure competitiveness in the domestic and external markets.

30. Bearing in mind the foregoing criteria, priority is accorded to research connected with non-ferrous metallurgy, electric power, petrochemistry, pharmaceutical and food industries, electronics, construction industry and building materials, and certain groups of the engineering industry (complex installations, manufacturing industries, construction and agricultural machines). Research in the field of automation should be added to this.

31. Research in the field of management in the economy is still at its initial stage. Even the institutional base is just being established. However, the levels of equipment and technology do not ensure business results of themselves; management, under the conditions of increased interdependence in the process of economic activity at all levels, is becoming an ever more important factor.

32. The Federal Economic Chamber has elaborated a long-term research programme in those fields; together with the Federal Fund for Scientific Research and with the economic organizations, it jointly finances the implementation of this research programme. This comprises the system of information, general market proportions, programming of production and stocks, transport, investment decisions and other problems in the field of management where optimal results may be obtained with the help of quantitative methods and computers.

33. Planning, the economic system and the system of distribution of income at all levels constitute significant fields of research under the conditions of further development of self-management in Yugoslavia. Only a scientific base may provide a foundation for ensuring the full freedom of action of economic organizations and to ensure, at the same time, the optimisation of complex systems in the economy on all levels.

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II. INSTITUTIONAL AND PERSONNEL BASE OF RESEARCH AND DEVELOPMENT

34. The dynamic socio-economic development of Yugoslavia in the post-war period has conditioned the emergence of a number of scientific research institutions. Furthermore, the situation regarding personnel in production and research has been considerably improved both with regard to numbers and structure.

35. In 1940 there were only 79 scientific research institutions, 69 of which were linked with academies of sciences and universities. In 1965 there were 763 autonomous scientific research institutions, scientific organizations within the framework of academies of sciences and university institutions as well as major research and development organizations within the framework of economic organizations. The total number of independent researchers amounted to approximately 7,000 in 1965. Although the number of institutions does not show, at the same time, the level of research work, it nevertheless points to a close interdependence between socio-economic progress and the level of scientific research and development activities. The network of university institutions and the number of students and graduate technicians are an important index for determining the base for research and technological progress. As compared with 24 faculties and schools of higher learning and two higher schools in the academic year 1938/1939, there were 126 faculties, schools of higher learning and academies and 140 higher schools in Yugoslavia in 1965. The number of students amounted, in the academic year 1938/1939, to 16,719 and, in the academic year 1965/1966, to 116,276; and the number of technicians increased from 2,502 in 1939 to 13,010 in 1965.

Institutional base.

36. Both the organization and structure of the institutional base were shaped, in the period after 1956, by changes in the system of management of the economy at all levels and, in particular, by the constant process of decentralization and "de-etatization." While the so-called autonomous institutes were responsible for scientific research during the period of centralized management of the economy, research and development units in industry itself are

asserting themselves to an increasing degree at the present time. The economic organizations which have become independent in the system of self-management with regard to adoption of programmes and decision-making, as well as with respect to distribution of accumulation, are influencing, through programming and financing, the implementation of the institutional base as a whole.

37. The entire research activity in Yugoslavia is evolving through autonomous institutes, research and development organizations and scientific institutions at universities and academies of sciences. Official statistics have only recently begun to follow this activity; in doing so, however, they have not always applied precisely-defined criteria with regard to the coverage of organizations in the field of research[2/] Special stress is placed on this, for the reason that determination of the number of research organizations and units within economic organizations has not been done with sufficient precision.

38. At the end of 1965, the number of institutions of interest to industry was as follows:[3/]

Table 7

Field of research	Institutes, research organizations: Autonomous	Within universities	within academies	in economic organizations	Total
Natural and mathematical sciences	31	49	9	7	36
Technical sciences	111	68	1	105	285
Social sciences	79	21	21	1	122
TOTAL	221	138	31	113	503

2/ In Yugoslavia, statistics began to follow research and development only in 1964; the methodology is being constantly improved and expanded.

3/ Communication of the Federal Institute of Statistics, No.265, 24 November 1966.- Scientific research organisations, situation on 31 December 1965.

39. A deeper analysis of the volume and results of research and developmental work leads to the conclusion that autonomous institutes hold a central place in research and development activity. This role is predetermined primarily by the research personnel and their experience, as well as by the degree of organization of scientific research. It is of interest to present a survey of founders of autonomous industry-oriented institutes:

Socio-political communities	65
Universities and academies of sciences	52
Economic organizations	49
Groups of founders and others	55

40. The organizations founded by the Federal Executive Council and the executive councils of republics and other social bodies were established, on the whole, before 1960, i.e. they date from the period of centralized formulation of science policy, programming and financing of research and development. The administrative period of management of the economy, i.e. the Government's influence on the planning of the entire economic and social activity, was characterized by the financing of research institutions rather than the financing of projects. This period played an important role in laying down the foundation of research and development in the sense of training of research personnel and attainment of a determined level in fundamental and applied research.

41. The year 1960 ushered in a period in which economic needs exercise a direct influence on policy, programming and financing of research and development activities, primarily in the field of technical sciences. A more developed industry has emancipated itself to a considerable extent from dependence on foreign partners in the spheres of construction and technology and has thereby asserted the need for using its own research capacities with a view to evolving its own technical solutions.

42. This period is of particular significance for the integration of production and research, i.e. for the assertion of science as a productive factor. On the other hand, a series of problems has arisen with regard to autonomous

institutes, primarily because of the demand of economic organizations that the time needed for realization of projects should be shortened and because economic organizations have failed to show a sufficient degree of understanding for fundamental and long-term research. At first, there was a greater number of such problems. However, it can be said even now that the period of adjustment of autonomous institutes to the needs of the economy has not yet been completed and that the lack of sufficient understanding by economic organizations of long-term problems has not yet been overcome. Ways conducive to solving this problem are as follows:

(a) Determination of a favourable ratio between planned and fundamental projects on the one hand, and short-term projects implemented by autonomous institutes on the other. This is also linked to the search for adequate sources of financing - State funds and economic organizations.

(b) Further development of developmental-technological services in economic organizations, which will make possible the elaboration of long-term programmes compatible with autonomous institutes.

43. The above survey shows that approximately 50 autonomous institutes have been founded by economic organizations. They have come into being mostly since 1960 through the transforming of laboratories of large enterprises into autonomous research institutions. Even today, these institutions use, in most cases, from 70 to 90 per cent of their capacities on the basis of contracts concluded with their founders; however, they also carry out projects for other partners as well;

44. These organizations, closely linked to economic organizations, have very rapidly asserted themselves in their respective fields. Thus, for instance, in the fields of electronics, electrical engineering, machine-tools, petrochemistry, some branches of engineering, non-metallic-minerals etc., the autonomous institutes closely linked to the economy, have asserted themselves as the vehicles of technological progress and fundamental research. Considerable funds have been invested, in recent years, in research and development in some industrial groupings, particularly in electronics, electrical

engineering and machine-building. According to incomplete indices, investments in research in electronics exceed by far the average investments in the Yugoslav industry. Thanks to this, the growth rate in electronics ranged, in the period 1955-1965, between 15 and 30 percent, while the assortment and quality of goods have been considerably improved. Investments in research have been accompanied by intensive investments in the training of research personnel, so that the rate of growth of technicians with university education ranged, during the same period, between 20 and 40 per cent. In chemistry particular attention is paid to organic chemistry where, in addition to important investments, large investments have been made in research and development capacities. Several specialized research institutions are active in this field, resulting in high productivity and a relatively high quality of products. In classical electrical engineering and machine-building, an important role in improving and mastering new products is played by research and development centres, which have made it possible to penetrate gradually into the international market with products which entail less direct physical labour and material and more developmental research and study.

45. The leaving of basic accumulation in the hands of the economy has opened a process of closer and long-term linking up of autonomous institutes with economic organizations and groupings. This positive tendency was particularly marked in the initial stages of the reform. A number of autonomous institutes and economic organizations are signing long-term contracts for the financing of planned long-term research programmes. It is essentially a process of linking up research with production, which has developed successfully in the Yugoslav economy in past years and which is assuming varied forms.

46. Autonomous research organizations in the field of economic sciences are also adjusting their activity to the requirements of the economy at the present stage of development. Until a few years ago, basic research in this sphere was oriented towards general economic theory (political economy etc.) and macro-economic problems (planning, investment policy etc.). Today, there

are a number of specialized economic institutes whose activity is directed towards the needs of economic organizations and their associations. Among them, we would mention from eight to ten institutions in the field of promotion of business operations and management of economic organizations, such as the Institute for Market Research, Institute for the Economics of Investments, Institute for the Economics of Industry, Institute for Foreign Trade etc. All these institutes offer direct services to economic organizations and their associations on the basis of determined projects or long-term contracts.

47. Economic institutes which cover a wider field of research are also specialized to a greater extent. Their departments and teams for research in various fields of interest to individual economic subjects (management and information in economic organizations, analyses with a view to adopting optimal investment decisions etc.), organize this research as an inter-discipline activity. Finally, we should like to draw attention to the institutional framework within which the documentary-information activity is evolving as a significant component of scientific and technical progress. Formerly, all autonomous scientific organizations in this field were exclusively financed by the budget and their activity was not sufficiently linked to the economy. Today, these institutions are financed by state funds only for specific projects, so that they are increasingly assuming the character of services that provide the economy and scientific institutes with scientific information and documents. They play a particularly important role with regard to establishment of centres for scientific information and documentation in economic organizations and associations of producers, as well as with respect to the training of personnel in this field.

48. Research and developmental activities in economic organizations have expanded during the last few years. A number of organisations and laboratories, especially in large enterprises, have already asserted themselves. However, this process is still at its initial stage and it is still to be

seen what the effects will be. The process of integration of scientific research and productive technology and construction, characteristic of modern industrial production, contributes to the further strengthening of the institutional research base in industry.

49. The significant results achieved in recent years with regard to the expansion of, and positive structural changes in university education in Yugoslavia have not been accompanied to a sufficient extent by a simultaneous development of research work at universities.

50. This shortcoming has been noticed and measures have been taken to ensure a broader integration of universities into research activities in the field of fundamental sciences and with regard to the needs of the economy. The following activities should be mentioned here:

(a) The Federal Fund for Scientific Work will allot, in the course of 1967 and 1968, resources for the equipment of all university centres with modern computers for training and research.

(b) The policies of the Federal Council for the Co-ordination of Scientific Activities and the Federal Fund for the Financing of Scientific Activities until 1970 will provide for a greater participation by university laboratories in fundamental research and for equipment of laboratories at universities.

(c) Larger economic organizations assist the universities in equipping laboratories with up-to-date means of research and training. This is particularly true of faculties in larger industrial centres, e.g. Nis (Faculty of Electronics), Tuzla (Chemical-Metallurgical Faculty), Zenica (Metallurgical Faculty) etc.

51. The institutes of academies of the sciences play a minor role in research for industry. These institutes contribute to applied research through co-operation with independent institutes, mainly in the field of social sciences.

52. The position of research institutes within the framework of the Yugoslav self-governing system is identical to the position of any other self-governing work organization. The research institutes are managed by the workers employed in a given research organization. This is done in harmony with the law and internal norms of self-management of the research organization. The

bodies of self-management in the research organization are the council, the board of management and the scientific council.

53. The council is the supreme governing body of the organization and is responsible for the formulation of research programmes. It makes decisions relating to the general principles of life and work of the organization. It gives approval in matters concerned with questions of co-operation and collaboration with other organizations and exercises a number of other functions in keeping with the law. As scientific activity has been declared by law to be of special social significance, the social community and some interested organizations delegate their representiatives to the councils of the research organizations. The scientific council of a research organization is a self-governing body concerned with programming and the formulation of the science policy of the research organization.

54. The system of self-management has been implemented consistently in the field of distribution of income in research organizations as well. Scientific and other workers in research organizations are entitled to an income proportionate to the share of each individual or group in the earning of the income of the work organization as a whole. Further, every scientific worker is entitled to exercise influence, through the work of the scientific council, with regard to selection of the programmes of the research organization, the adoption of these programmes and the setting of future research tasks.

55. Among the self-governing rights of a research organization, there is the right to integrate into higher forms of self-management, associations of research organizations or associations of economic organizations. There is a series of examples in the country of association among such organizations. It is stressed that such examples are positive from the point of view of the linking up of research and its results with the needs of the economy and industry.

Co-ordination of research and integration processed in research work

56. Co-ordination of research and development work is effected through the federal and republic councils for the co-ordination of scientific activities, as well as through the influence exercised by associations of producers on the

co-ordination of the programmes of institutes in all spheres. The basic and lasting aim of co-ordination is the rational utilization of available resources. In the conditions of the strengthening of self-management, co-ordination is being implemented through the following indirect influences:

(a) Through the defining of national policy in the field of scientific research and developmental activity, which provides the foundation for the adoption of programmes at all levels;

(b) Through the financing of the activities by state funds and the funds of associations of producers, the granting of funds is made dependent, in a number of cases, on integration, i.e. on the programmatic unification of research;

(c) A higher degree of integration of the economy in appropriate groupings (e.g. iron and steel industry, electric power etc.) objectively creates conditions for a long-term programmatic co-ordination of research in various fields.

57. In spite of serious efforts in this field, co-ordination of research and development activity is a significant problem in Yugoslav industry. The impact of different technologies, construction and systems in the enterprises belonging to the same groupings (mostly as a result of the purchase of different licenses and conclusion of co-operation agreements with foreign partners) impede, in particular, the process of integration of research and development.

58. The programmes financed from state funds were co-ordinated in order to avoid duplication in research. This is connected, in the first place, with development and orientation of the structure of the economy, which is the main beneficiary and financier of this research. The intensification of integration processes in Yugoslav industry contributes to the solving of the very complex problem of programming research and development. Actually, integration in production and in research are interdependent processes.

59. Scientific institutes also take positive initiatives with regard to a lasting integration of their activities. This applies, in the first place, to the programmes providing for the establishment of joint institutes in various fields (e.g. in the fields of chemistry and nuclear energy). The aim is to ensure joint programming of activities, to co-operate on the international plane, etc.

Personnel base for research and development

60. One of the characteristics of post-war development in industry is the shortage of technical personnel in almost all branches of the economy. Thus, for instance, of almost one million persons employed in industry and mining, in 1957, only 6,000 employed had higher education. A few indices illustrate the rapid growth of higher education in Yugoslavia, as well as positive changes of structure in the sense of massive training of technicians indispensable to the development of modern economy, particularly industry. The increase in the number of students at schools of higher learning and the change of structure, by scientific disciplines, are shown in the following table:

Table 8

Number of students Academic year	Total number of students	Index of growth	Structure in percentages				
			Natural sciences	Technical sciences	Medical sciences	Agric. sciences	Social and human scien.
1938/39	16,719	100	- a/	16	12,5	11	60.5
1959/60	85,500	510	3.7	23	12.9	9.3	51.1
1965/66	116,276	700	7.8	27.5	11.9	6.6	46.2

a/ Number unknown, included in social and humanistic sciences.

The most characteristic growth has been registered in the field of technical and natural sciences and mathematics. This growth would be even higher if admission to the faculties were not restricted as a result of limited capacities.

61. The Plan of Social and Economic Development for the Period 1966-1970 foresees that 76,500 citizens will be graduated from universities in this period and that the number of students in schools of higher learning will amount to approximately 125,000. The policy plans further positive structural changes in keeping with the requirements of the economy.

62. From the point of view of our study, the statistics reveal the following

situation, in 1965, with regard to the number of personnel employed in research and the number of teaching staff at universities.

Table 9

Number employed in scientific institutions
(outside universities)

	1964	% of employed	1965	% of employed
Scientific workers	4,682	21	6,143	25
Researchers with university education	1,511	7	1,618	6
Technicians and higher school education	6,724	31	7,736	31
Other personnel	9,061	41	9,356	38
Total	21,978	100	24,853	100

Table 10

Number of research workers by branches of science
(outside universities)

Scientific activity	1964	%	1965	%
Natural sciences	889	19.0	1,566	25.5
Technical sciences	1,778	38.2	2,184	35.8
Medical sciences	300	6.4	406	6.6
Agricultural sciences	745	15.9	844	13.5
Social and humanistic sciences	970	20.5	1,143	18.6
Total	4,682	-	6,143	-

The above surveys show that the number of employed in research increased, in the period 1964/1965, by 14 per cent and that the number of researchers increased by approximately 30 per cent (in technical sciences by 20 per cent).

63. The majority of the teaching staff at universities also participate in research; therefore, it is of interest to give a survey of university teaching

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staff by branches of science in the academic year 1965/1966. It is estimated that the teaching staff at universities spends about 40 per cent of its working time in research.

Table II

Teaching staff at the universities

Scientific activity	Full-time staff	Part-time staff	Total
Natural sciences	659	182	843
Technical sciences	2,134	1,882	4,016
Medical sciences	1,894	483	2,377
Agricultural sciences	1,240	183	1,423
Humanistic and social sciences	2,489	730	3,219

64. Using comparative analyses, it may be concluded that the number employed in research in Yugoslavia amounted, in 1962, to 2.4 per 1,000 inhabitants between the ages of 14 and 64. The programme for the advancement of scientific activities in the period 1966/1970 provides for an increase of research workers outside universities to 9,000-10,000 in 1970, i.e. by about 50 per cent as against 1965.

65. Of particular interest for the creation of a modern research base is the development of inter-discipline higher education. This applies particularly to personnel trained for modern management. Inter-discipline education is not traditional in Yugoslavia. Actually, a system of such studies is just being elaborated. Several universities and institutes are organising post-graduate studies, periodic courses and seminars. However, even regular post-graduate studies in these fields are becoming increasingly a component of university programmes. In 1964, a total of 289 students completed these post-graduate studies. In 1965, their number increased to 361.

Social bodies and associations of procedures in the co-ordination of research and development

66. The Federal Council for the Co-ordination of Scientific Activities is a social body which carries out activities within the framework of the rights and

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duties of the Federation in the field of scientific research. Similar prerogatives are held in the republics by the republic councils for the co-ordination of scientific activities. These councils follow, study and co-ordinate scientific activities, make proposals and suggestions to competent bodies with regard to questions of interest in scientific work, stimulate co-operation among scientific organizations, co-ordinate scientific relations and co-operate with foreign countries etc. The councils adopt outline programmes of scientific activity and fix research programmes and tasks, in the Federation and the republics take part in the financing and lay down criteria for utilization of these funds.

67. The federal or the republic assembly appoints one half of the members of the councils from among the ranks of outstanding research and other social workers, while the remainder is delegated by economic, scientific and other organizations and bodies designated by the assembly.

68. The federal and republic funds for scientific research finance the research programmes adopted by the councils. The funds are made up of resources from the Federation and the republics in a percentage fixed by the social plan of the Federation or a given republic. In addition to these resources, the funds may include for the work resources obtained in the form of credits from the banks, funds transferred by work organisations etc.

69. The Federal Commission for Nuclear Energy organizes and conducts research in the field of nuclear science. The Federal Commission is composed of the representatives of the interested economic and social organisations and the social community, as well as a number of research and other workers. The technical policy of the Commission is laid down by the Technical Council, composed of technical commissions for various branches. The Commission is financed from the federal budget. Since 1967 financing has been gradually transferred to the federal and republic social funds for the financing of research.

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70. Associations of producers are a significant factor in the co-ordination of research and development. The tasks set by the economic reform for economic organizations have resulted in a number of positive measures taken in the enterprises. All this has been accompanied by further efforts towards a broader programmatic unification of kindred enterprises within various production associations. In the associations, programmes for the division of work are elaborated on the level of the republic or the Federation. One of the important tasks of associations is also the distribution of research programmes.

71. On this plane, under the conditions of intensified activity of the economy, such associations of producers as the chambers, groups of branches and business associations form special bodies for co-ordination of research and development. The fundamental tasks of these bodies are co-ordination of research, integration of research and economic organizations, and programmatic unification on the level of the association. It is characteristic that research workers have begun to be elected to the boards of management of chambers and business associations, which imparts a new quality to the efforts directed towards the co-ordination of research.

Stimulation of research and development through measures of the economic system

72. The place and role of scientific activity in the SFRY have been determined by law. Scientific activity has been given the rank of activity of exceptional social interest. In this connexion, the law designates the scientific organisations where the interested citizens and representatives of organisations and the social community participate in the management of affairs of particular interest to society.

73. One of the very important acts regulating the position of research work in Yugoslavia is the Resolution on Research Work, adopted on January 12, 1965. The resolution proceeds from the assumption that further significant progress of the economy and social services, as well as improvement of the social standard of working people, can be realised primarily through a constant growth of labour productivity, modernisation of conditions of work and fuller integration of the economy into the international division of labour. The

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indispensable changes and progress in the economy and social life call for a broader, more comprehensive and effective development and application of the achievements of science and technology in production and in other fields of social work and creative endeavour. Scientific activity has been declared by the resolution to be an essential factor in the development of the economy of the country. It has been recommended that measures of economic policy should ensure a more stable appropriation of funds for research and that the work organizations in the economy, together with work organizations in the field of scientific research, should be responsible for setting tasks and fixing programmes of scientific research. Particular stress was placed on the necessity of international co-operation and exchange.

74. Finally, it was stressed that the mutual linking up of fundamental, applied and developmental-technological research was conditioned by concrete tasks and levels of scientific knowledge.

75. In regard to the legal provisions regulating work in the sphere of research, mention should be made of the facilities provided for investments in scientific research, which is a kind of indirect financing of research. This is of particular significance for those aims of science policy which are directed towards a broader participation of the economy in the financing of science activities.

76. After the economic reform, and in keeping with the resolution of the Assembly on scientific work, recommendations were made to all credit institutions to accord high priority to the credit requirements of scientific research organizations. The social funds for scientific research may use part of their resources for granting credit facilities to scientific institutions.

77. One has also provided for the possibility of postponing repayment without the obligation to pay interest, if research and technological development have not produced the expected results for one reason or another. Finally, certain fiscal obligations of economic organisations have been reduced in an amount depending on the total investments of the economic organization in research in the year past.

There is no limitation on where the investments are made; thus, economic organizations are stimulated to invest in other scientific institutions outside their organizations.

III. INTERNATIONAL CO-OPERATION IN INDUSTRIAL RESEARCH

78. Yugoslavia's policy on the international plane is guided by the principles of mutual interest of partners, equal rights and non-interference in the domestic affairs of other countries. From this stems Yugoslavia's great interest in international co-operation in the field of industrial production.

79. International co-operation in the field of research is developing in the world today in many forms and methods and its volume is rapidly expanding.

80. Yugoslavia, joining in this process, set as a task that co-operation in the field of research and development should contribute to the general technological progress of industry and to the further development of the institutional base in Yugoslavia. The achieved level of research makes it possible to subordinate activity on the international plane to realization of an ever more determined function of science as a factor of economic progress in the country. On the other hand, changes in the socio-economic system constantly enlarge the role and interest of economic subjects in the programming and realization of international co-operation in the field of research.

81. Yugoslavia has been developing bilateral co-operation within the framework of agreements on scientific and economic co-operation and through agreements at the level of producers. Further, Yugoslavia participates in the work of various specialized agencies of the United Nations (UNESCO, ILO, FAO etc.) and co-operates in other international governmental organizations (OECD, COMECON, IAEA, etc.). Stress should be laid on some questions of co-operation with the developing countries. Yugoslavia's policy is that - in developing all forms of international co-operation, multilateral and bilateral - special attention should be devoted to measures aimed at accelerating the development of the developing countries. In addition to pursuing this policy in international forums and assigning its most eminent experts and research workers to responsible

posts in the developing countries, Yugoslavia is making efforts to promote bilateral relations in the field of research as well. The present degree of development points to the need for promoting new forms of international co-operation likely to contribute to technical progress.

82. The developed hierarchical model for establishing multilateral relations has the effect of separating research organizations from their direct partners abroad. Therefore, there exists an interest in linking up Yugoslav institutes with similar organizations abroad directly by means of joint programmes and projects. Fruitful co-operation has been developing over several years in the field of chemical cynetics, between Institute "Jožef Štefan" in Ljubljana and the University of Belgrade, on the one hand, and the Institute for Electro-Chemistry of the Academy of Sciences of the USSR in Moscow, on the other. Negotiations are being conducted concerning direct co-operation between the Institute "Mihailo Pupin", Belgrade, and the Institute for Automation and Telemechanics of Moscow in connexion with extensive research projects, such as the hybrid computer. There are such links in other fields, too. One may objectively expect that these forms of co-operation among direct partners will be expanded. The new measures for a broader linking up of our economy with foreign partners are laying a wider base for co-operation among direct partners in the field of research.

83. An analysis of bilateral arrangements and the majority of programmes of international organizations show that fundamental research is, on the whole, the object of these programmes. There is little development research. The reason for this is undoubtedly the tendency to protect license secrets, as well as other concrete motives.

84. Yugoslavia is paying particular attention to important international gatherings and joint projects. Yugoslavia is the host and organisor of the traditional international gathering "Science and Society" at Herceg-novi and of the Centre for Advanced Studies (CAS) in the field of cybernetics. Particular importance is attached to the projects that Yugoslavia is executing for the needs of OECD on the theme: "Science and Technology and Economic Growth".

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RESEARCH AND DEVELOPMENT IN YUGOSLAV INDUSTRY

SUMMARY

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Submitted by the Government of Yugoslavia

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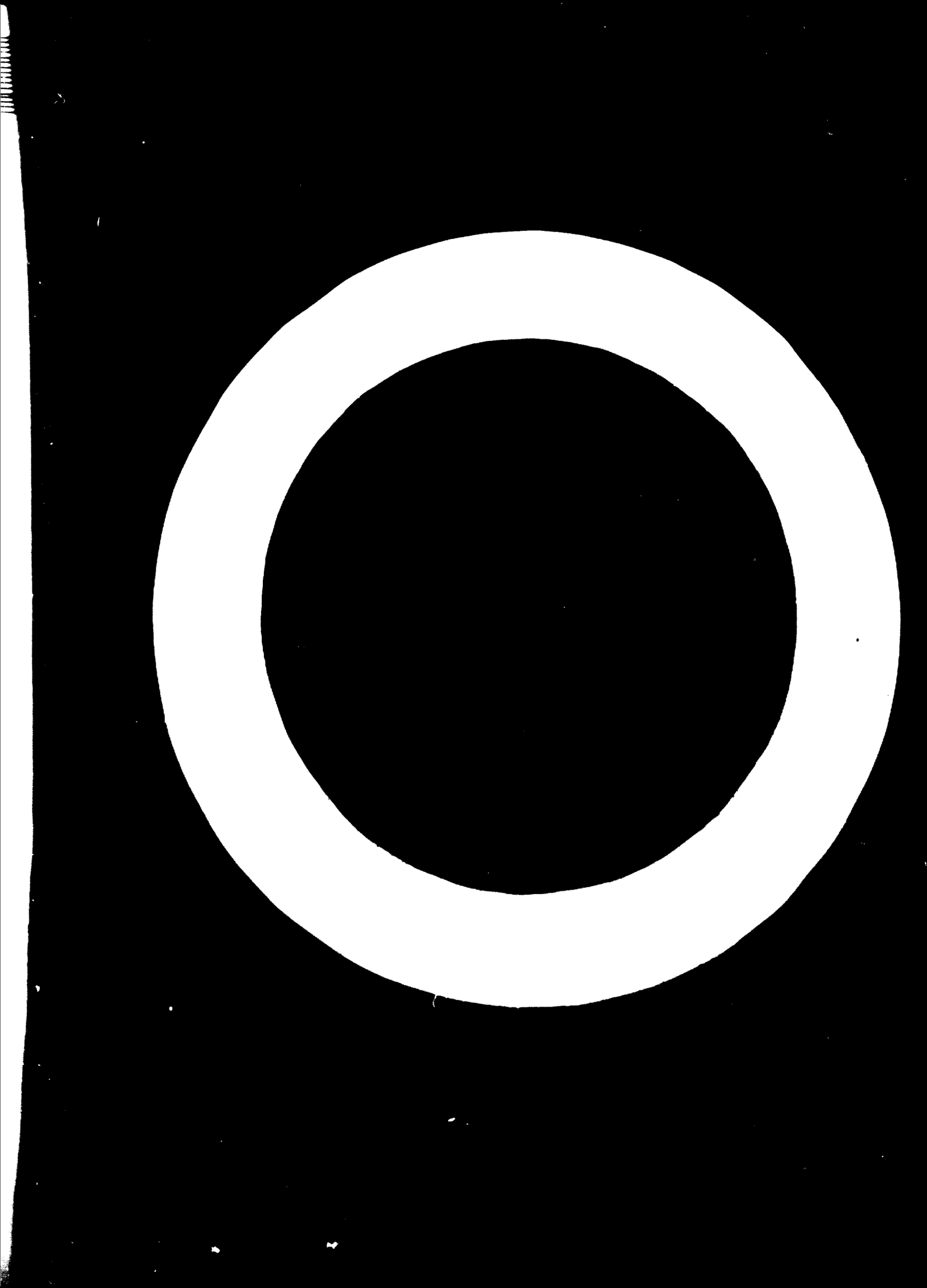


1. Technological progress has played an important part in the achievement of rapid growth in national income and in the establishment of industry as the basic motivating factor of Yugoslavia's economic advance since the last war.

2. The radical social-economic changes which have taken place in Yugoslavia through the process of decentralization of management and resources have caused the formulation of policy, the programming and the financing of research and development activities to become the concern not only of society, but also of the economic sectors themselves. The economic reform, initiated in 1965, particularly established research and development as the basic means for realizing its desired aims, namely, intensification of production and effective industrial specialization.

3. Until a few years ago the policy and programming of fundamental and applied research and development was almost exclusively the concern of the State. With the assertion of economic organizations and their associations as the basic protagonists of extended reproduction, radical changes have been introduced in the method of establishing and implementing the policy and programming of scientific work. Though this process is inchoate, a series of economic organizations, chambers of industry and other associations are already programming a scientific research and development activity with a wider interest and earmarking funds for the attainment of the established aims. It is estimated that in 1961 only about 33 per cent of the total sum spent on research was accounted for by industry itself, whereas in 1965 the comparable figure reached 57 per cent. State authorities are increasingly concentrating on programming and financing fundamental research and certain long-term projects, while industry is assuming the role of the basic protagonist in applied and development research. By 1970 industry is expected to be accounting for about 70 per cent of the total expenditure on research work.

4. The earlier moderate development of industry concept had an insufficiently defined research and development objective which affected the results of research work. Industrial reform, in establishing intensification of production as a basic aim, specifies a selective economic-industrial development as an essential consideration, thus making it necessary to set up research priorities. Relevant studies are now in progress and have as their guide-lines the national resources, the position of the home and foreign markets and the attained level of technology and research.

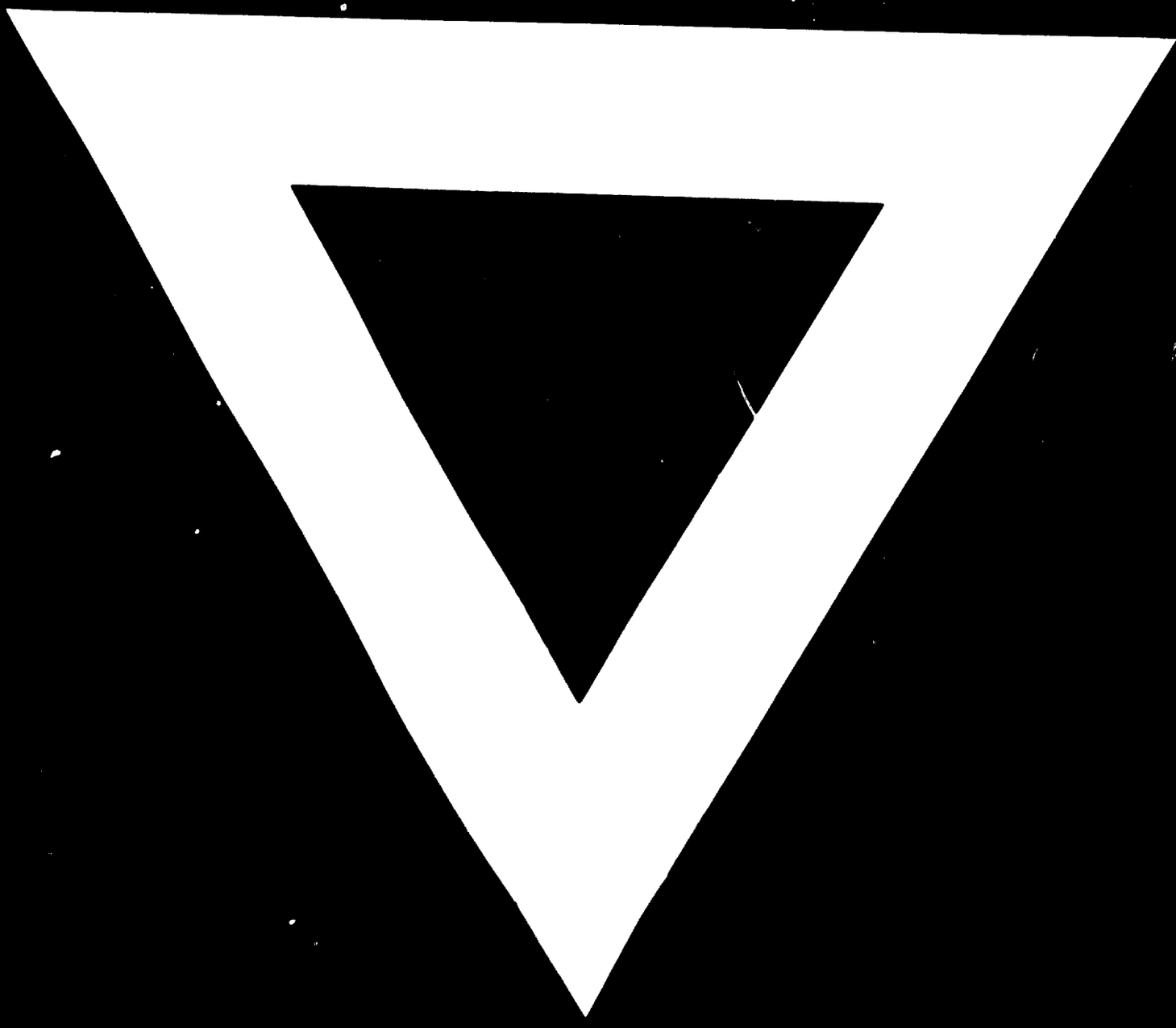
5. Parallel with the constant strengthening of the institutional base of research in recent years, qualitative changes have also occurred in its structure. There has been a rapid increase in the number of independent institutes founded by economic organizations and their associations and of research and development units in the factories themselves. Simultaneously the links between the producers and the research institutions are being consolidated on long-term lines, with a view to making scientific work the basic factor for stimulating the country's technological and economic progress. Though there are positive examples of industrial links with the universities, the role of these institutions in applied research still remains under-asserted.

6. The increased number and improved pattern of institutions of higher learning, as well as the growing number of trained engineers and other specialists, has created the conditions for strengthening the work level and for introducing modern technology and research. Although the number of researchers does not approach that found in highly industrialised countries, the number of Yugoslavs engaged in research activities in 1964 was 2.4 per 1,000 population aged from 15 to 64 years, which compared with 3.5 in Belgium, 3.8 in France, over 10 in U.S.A. and U.S.S.R., etc. This base, however, is constantly expanding. This is also indicated in official statistics

which show that in 1965 the total personnel engaged in research was 14 per cent greater than in 1964, while the number of researchers proper was up about 30 per cent.

7. Basically, co-ordination of research work in Yugoslavia is the responsibility of federal and republican councils for scientific work, as well as of the business associations of enterprises and chambers, whose function in this respect is increasing every day. Indirectly this activity is assisted by financing from social funds, by international co-operation, by measures of the economic system, etc. Research organizations are granted special fiscal privileges including tax and customs exemptions to stimulate the development of their activities.

8. International scientific-technical co-operation plays a special part in the technological progress of Yugoslav industry. Every variant is promoted, from direct co-operation of enterprises with foreign associations to bilateral and multilateral relations. In view of the level of development today, particular interest attaches to the association of our institutes with similar foreign institutes on joint programmes and projects.



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