

## МАШИНОСТРОЕНИЕ

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### PRIORITY RESEARCH ISSUES AND THEMATIC AREAS OF MECHANICAL ENGINEERING DEVELOPMENT IN KAZAKHSTAN

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На основе БД, выполненных НИОКР в ретроспективе 1992-2012 гг., выявлены приоритетные научные проблемы и тематические направления развития машиностроения в Казахстане. Проведена систематизация, количественное и процентное распределение НИОКР как по научным проблемам, так и по тематическим направлениям.

**Ключевые слова:** машиностроение, научные проблемы машиностроения, тематические направления развития машиностроения.



1992-2012 жж. шолуда ҒЗТҚЖ орындалған ДҚ, негізінде Қазақстанда машина жасауды дамытудың басымдылығы ғылыми проблемалары мен тақырыптық бағыттары айқындалды. Ғылыми проблемалар және де, тақырыптық бағыттар бойынша да ҒЗТҚЖ жүйелендіру, сандық және пайыздық белу жүргізілді.

**Түйінді сөздер:** машина жасау, машина жасаудың ғылыми проблемалары, машина жасауды дамытудың тақырыптық бағыттары.



Based on a complete R&Ds database of the 2012-1992 retrospective, priority research issues and thematic areas of mechanical engineering in Kazakhstan have been established. Systematization and quantification of the distribution percentage of R&Ds as on scientific issues and thematic areas are conducted.

**Key words:** mechanical engineering, scientific issues of mechanical engineering, thematic areas of mechanical engineering.

The Minister of Education and Science B.T. Zhumagulov in the forum "Development of science is the future of the country" [1]

announced the five priority areas of science, approved by the Supreme scientific and technical Commission (SSTC) of the Government of the Republic of Kazakhstan, one of the leading of which is the deep processing of raw materials and products, which requires solving problems of industrialization and technological development of the economic sectors.

The basis for industrialization, as is well-known, is the rapid development of mechanical engineering, so the scientific basis of mechanical engineering is of particular relevance.

Mechanical engineering is the most science-intensive industry with the highest proportion of output of innovative products that have a decisive influence on the sectoral and spatial structure of the global economy and individual countries. Output of the mechanical engineering are material carrier of all possible for practical (industrial and consumer) application of scientific and technological progress (STP) and constitutes the main part of world exports.

The main elements of modern mechanical engineering is to improve the means and methods of industrial organization, the transition to standardization, automation and informatization of the processes.

Informatization of scientific and technological development in Kazakhstan is the mission of JSC "NC STI" that holds unique STI funds, including fund of unpublished documents.. The Fund of unpublished documents of JSC "NC STI" was formed in 1992 and includes reports on R&D, candidate and doctoral dissertations, deposit manuscripts and intellectual products. Efforts to generate the fund are regulated by normative documents, which can provide a fairly complete admission of these documents to the JSC "NC STI". In this regard, it can be argued that the available information sources in the fund fully reflect the intellectual and scientific potential of the country, thus allowing reviewing retrospective and current state of development, as well as forecasting the development of the Kazakhstan science.

It is well known that the unpublished documents are a valuable source of information for scholars as the most generalized scientific papers for industrial specialists and governmental agents - as materials for decisions making. Based on the assumption of the

aforementioned role of the fund of unpublished papers, a detailed analysis of its material is of undoubted interest. The purpose of this research is to analyze the informational R&D materials from Fund of unpublished documents (FUD) NC STI RK, which makes it possible to determine the degree of elaboration of the scientific development of the engineering problems in Kazakhstan.

### **R&Ds in the field of development of mechanical engineering in Kazakhstan**

R&D reports are of considerable scientific interest. Currently (as of 01.01.12), the fund has 21,154 reports on R&D. In order to identify priority research issues and thematic areas, on which R&Ds were carried out, from R&D database we performed automated selective extraction of documents reflecting the development of mechanical engineering. Here are the names of 34 priority research issues. The analysis makes it possible to arbitrarily group the priority issues into 4 groups according to their scientific elaboration, i.e., identify the most scientifically supported problems, problems having significant scientific support, less scientifically supported problems and the least scientifically supported problems.

**The first** (the most scientifically supported) group may include the first 4 scientific problems, "Tractor and agricultural machinery building", "Mining machinery building", "Machine science and machine parts" and "Machinery for Food Industry", which respectively have 225, 116, 109 and 107 R&Ds, for a total of 557 or 54.8% of total R&Ds on development of the mechanical engineering. The second group may (with significant scientific support) include such scientific issues as: "Finish surfaces and coating" - 59 R&Ds, "Chemical and petroleum engineering" - 56 R&Ds, "Electrophysical and electrochemical treatment" - 38 R&Ds, "Robotics" - 36 R&Ds, "Metallurgic Machinery engineering" - 32 R&Ds, "Heat and strengthening treatment" - 28 R&Ds, "Building and Road machinery" - 28 R&Ds, "Propulsion engineering" - 22 R&Ds, "General engineering" - 20 R&Ds, "Space technology and rocket" - 19 R&Ds, "Turbine construction" - 18 R&Ds, and "Handling machinery" - 17 R&Ds, which together account for 373 R&Ds, or 36.7% of the total. The third (less scientifically supported) group, which has 71 or 7.0%

of R&Ds may include the following scientific engineering problems, "Foundry" - 12 R&Ds, "Machinery for light industry" - 12 R&Ds, "Cutting Materials" - 11 R&Ds, "Tool manufacturing" - 9 R&Ds, "Forging and stamping production" - 8 R&Ds, "Machine tool building" - 7 R&Ds, "Municipal engineering vehicles building" - 7 R&Ds, and "Mechanical engineering materials" - 5 R&Ds. The fourth (the least scientifically supported) group may include the following scientific problems: "Technology for Mechanical Engineering", "Manufacture of articles out of powder materials", "Production of non-metallic products", "Boiler fabrication", each having 2 R&Ds, and scientific problems of "Aircraft industry", "Special power plants", "Automotive industry", "Household appliances", "Other branches of engineering" and "Locomotive and car building", each having one R&D. The total number of the R&Ds is 15 or 1.5%.

As noted above, every problem has scientific thematic areas of research.

The analysis showed that the researches were conducted on 142 scientific subject areas. By the number of completed R&D data subject areas can be divided (as well as scientific problems) to the four groups. **The first** group (the most scientifically supported) includes 14 areas in which has 557 or 54.8% of total R&Ds, each thematic area of which has 68 to 25 R&Ds. In the second group (considerable scientific support) includes 27 thematic areas that cover 245 R&Ds, or 24.1% with a decrease in the number of R&Ds from 22 to 6 in each of the thematic areas. The third group (less scientifically supported) includes 32 thematic areas, which has 120 or 11.8% of R&Ds from 5 to 3 in each of them. **The fourth** group (the least scientifically supported), which includes 69 thematic areas, and has 94 R&Ds (up to 2 R&Ds in each thematic area), or 9.3% of total R&Ds performed in Mechanical Engineering.

The largest number of R&Ds of the scientific field are from the following thematic areas: "Design, construction and calculation of machines" - 68 R&Ds, "Machinery and equipment for elevators, flour, cereals and animal feed industry" - 60 R&Ds;

"Machines for threshing and harvesting" - 53 R&Ds; "Tillage machinery and tools" - 49 R&Ds "Metal coating" - 41 R&Ds "Chemical, petrochemical and oil refining machinery" - 40 R&Ds, "Machinery and equipment mechanization of animal husbandry" - 39 R&Ds, "Drilling

Equipment" - 36 R&Ds "Grain-cleaning, sorting and drying machines and systems" - 35 R&Ds, "Machinery for the main application of fertilizers, sowing and planting machines" - 31 R&Ds, "Processing with flow of energy" - 28 R&Ds, "Machines, facilities, equipment and installations for the tunnel works" - 26 R&Ds, "Theory, study and design of robots and manipulators" - 26 R&Ds and "crushing-and-grinding and processing equipment" - 25 R&Ds.

The pie charts 1-4 Below present thematic areas of key, the most studied scientific issues of engineering.

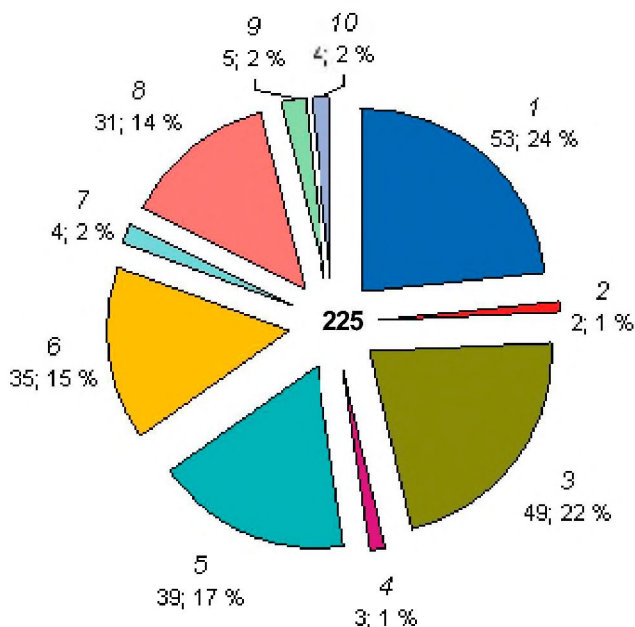


Fig. 1. Priority thematic areas of research on the issue of "Tractors and agricultural machinery" (clockwise): 1 – Machines for threshing and harvesting; 2 – Technologies for tractor and agricultural machinery building; 3 – Tillage Machines and tools; 4 – Loading and transport vehicles used in agriculture; 5 – Machinery and equipment for mechanization of animal husbandry; 6 – Winnowing, sorting and drying machines and systems; 7 – Other agricultural equipmen; 8 – Machines for the main application of fertilizers, sowing and planting machines; 9 – Tractor construction; 10 – General

Analysis of the data in the chart (Figure 1) shows that the greatest attention was paid to the research of: "Machines for threshing and harvesting," "Tillage Machines and tools", "Machinery and equipment for mechanization of animal husbandry", "Winnowing, sorting and drying machines and systems" and "Machines for the main application of fertilizers, sowing and planting machines". It should be noted that these thematic areas, as expected, characterize the main thrust for the development of agricultural production, the creation of competitive products and ultimately the food security of the country.

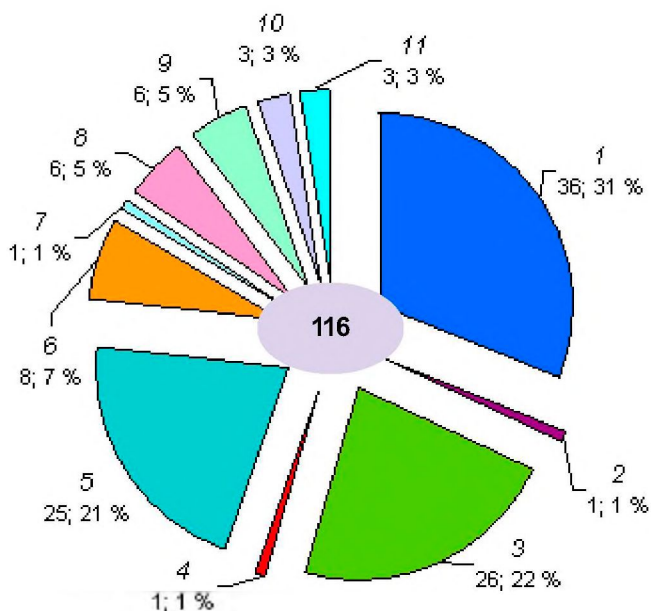


Fig. 2. Priority thematic areas of research on the issue of "Mining engineering" (clockwise): 1 – Drilling Equipment; 2 – Other mining equipment; 3 – Machines, facilities, equipment and installations for the tunnel works; 4 – Operating instrument of mining machines; 5 – Crushing and grinding and processing equipment; 6 – General problems of research, calculations and design in mining engineering; 7 – General; 8 – Machinery and Equipment for strip-mining; 9 – Equipment for underground transportation and egress; 10 – Machinery and Equipment for bailing operations; 11 – Equipment for Safe operation and Improvement of working conditions

The greatest number of scientific studies on the issue of "Mining Engineering" (Figure 2) present the thematic areas of "Drilling Equipment", "Machines, facilities, equipment and installations for the tunnel works", "Crushing and grinding and processing equipment", i.e., those areas, which emphasize raw-material orientation of engineering production and allow the improvement of the technological process of production, transportation, and getting the maximum amount of raw materials.

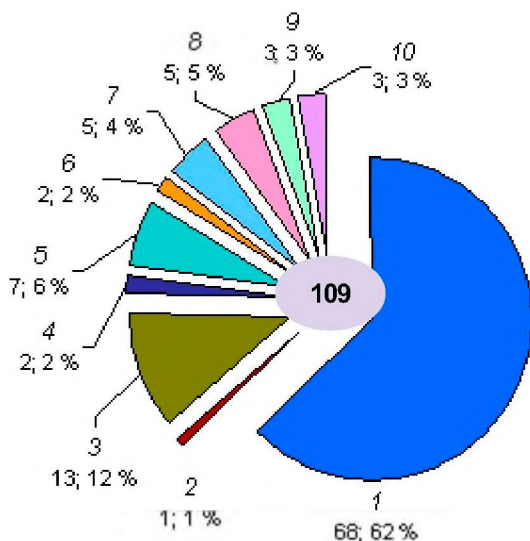


Fig. 3. Priority thematic areas of research on the issue of "Machine science and machine parts" (clockwise): 1 – Design, construction and calculation of the machines and mechanisms; 2 – Shafts and axles; 3 – Transmissions; 4 – Bearings; 5 – Reliability and durability of machines; 6 – General problems; 7 – Strength and bearing capacity of units and parts of machines; 8 – Friction, wear, lubricants; 9 – Hydraulic and pneumatic machinery and their elements; 10 – Joints

The basis for the establishment of mechanisms and machinery of theoretical developments in design, design rationale, kinematic, dynamic, strength calculation of individual components, parts, and the whole machine itself. It is gratifying to note that in a scientific problem of "Machine science and machine parts" (Figure 3) the highest number of research, namely 62% of total number of studies on this issue are held at the thematic area "Design, construction and calculation of the machines and mechanisms". Other thematic areas of complementary theoretical positions on the establishment of mechanisms and machines, justifying the construction of shafts and axles, calculation and choice of transmissions, and the rationale for the choice of bearings, strength calculations and the reliability of nodes longevity of machine parts, the effect of friction on wear of mechanisms and parts, the rationale for drive mechanisms and their compounds.

Kazakhstan ranked second in the world production of flour and it is no mere chance that the thematic areas "Machinery and equipment for elevators, flour, cereals and animal feed industry" of the scientific problem "Mechanical engineering for Food Industry" (Figure 4) is the most scientifically-developed, and is 56% from all the research on this issue. Others research works on this issue were distributed roughly equally between 7 and 9% of total number of the R&Ds, except for thematic areas: "Machines and equipment for alcohol, liquor, wine, brewing industry and non-alcoholic drinks" and "Food machinery and general-purpose equipment", which have much less R&Ds. Nevertheless, it should be noted that all the thematic areas of research challenge improving machine interface technologies, and advanced processing of raw materials and as a result of receipt of goods with an additional added value.

In conclusion, we would like to emphasize that the core formed by an array of reports on the R&Ds reveals not only the scientific issues and thematic areas of research, but also provides ample opportunities for the analysis of R&Ds on the development of mechanical engineering in Kazakhstan.



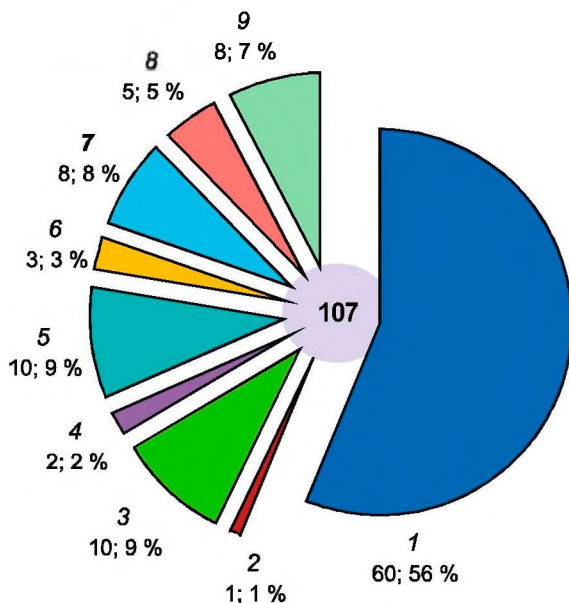


Fig. 4. Priority thematic areas of research on the issue of "Mechanical engineering for food industry" (clockwise): 1 – Machinery and equipment for elevators, flour, cereals and animal feed industry; 2 – Machines and equipment for alcohol, liquor, wine, brewing industry and non-alcoholic drinks; 3 – Mechanical engineering for Food Industry; 4 – Food machinery and general-purpose equipment; 5 – Machinery and equipment for fat-and-oil industry; 6 – Machinery and equipment for baking, macaroni products and confectionary industries; 7 – Machinery and equipment for food-canning, vegetable-drying and food-concentrate industries; 8 – Theory, design and testing of machinery and equipment for food industry; 9 – Machinery and equipment for Dairy industry

## Literature

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