CENTRE FOR SCIENCE RESEARCH AND STATISTICS

# R&D STATISTICS IN RUSSIA: CHANGES AND CHALLENGES

***Dr. Leonid GOKHBERG,***
*Deputy Director*

This paper provides a background material for a presentation at the IV Iberoamerican Conference on Science and Technology Indicators, Mexico, 12-14 July 1999

# Contents

## 1. Introduction

The present-day situation of the Russian R&D sector reflects the impact of economic, social, and political factors associated with the dramatic changes of the transition from the Soviet Union to the Russian Federation and from central planning to a market system.

A drastic downsizing of R&D under severe economic crisis has been accompanied by qualitative changes testifying to the high viability of the Russian science and its gradual adaptation to the conditions of market economy. Elaboration and implementation of the national S&T policy in this new environment requires a comprehensive analysis of current R&D trends and assessment of its future prospects. Therefore, statistics is becoming a necessary tool for the development of efficient policies and its role is strengthening alongside with further complication of phenomena and processes taking place in the R&D sector.

This paper describes the modern historical background of the Russian R&D statistics. Its current organisation and the strategy of the Centre for Science Research and Statistics are examined from the viewpoint of responding to policy needs. Major methodological peculiarities and statistical surveys are discussed. The paper concludes with the nearest objectives to further promote R&D and innovation statistics in Russia.

## 2. Historical background

### *2.1. R&D statistics under centralised planning*

The economic system that dominated in the former USSR for over seventy years was based on the state ownership for all kinds of resources, and centralised planning. The major decisions were made by the supreme Communist party leadership and the government. The procedures of rigid administrative planning used elsewhere in the Soviet economy were applied to S&T as well.

Subsequently, the official role of statistics was limited to the control over the execution of plans by enterprises and the information support of the governmental decisions. Statistics was based on gross indicators and ill-suited to

analytical needs. The interest in methodological studies was reduced, sufficient achievements of domestic and international statistics were underestimated. The Soviet data were, as a rule, incompatible with the international standards because of the differences in the objects of surveying, definitions and classifications, methods of accounting, data collection and processing. The public access to the data and the scope of statistical publications were miserable.

According to the general principles of the Soviet administrative system, all statistical activities were implemented under the auspices of the respective governmental agency - the State Committee on Statistics of the former USSR. The Committee operated as a general-profile agency. The data collection was organised in a way mainly common for all sectors of the national economy (industry, agriculture, construction, etc.), including R&D, on the basis of universal mandatory reporting of legal entities. As a consequence, the resulting statistics lacked flexibility.

R&D statistics was one of the youngest branches of the Soviet economic statistics. However, it existed in the above environment and, being considered as a low-priority activity at the Committee on Statistics, fared poorly. A specialised division in charge of R&D data collection was established there only in 1987, although a few data series had been provided within a framework of labour and financial statistics. In comparison, it is worth noting that this field of statistics has been actively developed in the OECD area since early 1960s.

Up until 1989, the predominant concept of R&D data collection was the coverage of specific types of institutions (depending on the nature of particular surveys) versus activity-based approach used internationally. The raw data on R&D were grouped in accordance with the so called All-Union Classification of Branches of National Economy which included the branch ‘‘Science and Scientific Services’’. This given branch traditionally comprised research institutes, design organisations, experimental enterprises (without serial production), as well as some non-R&D organisations (for instance, on the exploration of marine products, weather monitoring, geological exploration, etc.). However, this sector did not cover those units of industrial enterprises and

higher education institutions directly performing R&D. Furthermore, the sector ‘‘Science and Scientific Services’’ was a subject only to employment statistics, and the data did not reflect even the overall national R&D effort.

Statistics on R&D funding was represented by the expenditure on science calculated as the sum of volume of all projects performed by R&D institutions (notwithstanding types of activity) and separately measured capital investment in S&T. Included there, the amount of work fulfilled on a contractual basis was credited both to performers and contractors. This meant, in fact, duplication in the measurement of costs, and the proportion of such double count reached, according to our estimates, one-third of the overall value. Such data on S&T expenditure till 1989 had been collected by the Ministry of Finance independently from those on personnel.

Being represented by a mixture of data which covered different universes of enterprises and were incompatible with each other, R&D statistics of that time misrepresented national R&D trends, especially in the international perspective. One of the major reasons may be attributed to the absence of a national S&T policy per se under the centrally-planned economy. The focus at the former USSR State Committee on Science and Technology (SCST) was put on development and control of S&T plans. This agency used to be a passive user of information on those plans’ fulfillment provided by the Committee on Statistics, whereas the latter did not have any interest to expand data collection beyond such utilitarian tasks. Thus, the lacking feedback between data users and producers did not allow to develop the Soviet R&D statistics in line with the international practice. That was true also for other COMECOM countries.

### *2.2. Reforms of ‘‘perestroyka’’*

Reforms of ‘‘perestroyka’’ in 1986-90 were in part a response to a disappointing record of economic and S&T growth. This policy reinforced decentralisation with more decisions made at enterprise and departmental levels. R&D institutions became more independent in the selection of research objectives and received a right to create project portfolios on the basis of negotiated contracts with enterprises.

Although it occurred that partial reforms in the absence of a real market environment could not correct distortions in a unbalanced R&D system (Gokhberg, et al., 1997).

Introduction of new economic and political arrangements for the R&D sector required respective approaches to measure R&D effort at different levels. In response, the Laboratory of R&D Statistics was set up at the Research Institute for Statistics of the USSR State Committee on Statistics in late 1988.[1] Its mission was to radically improve the methodology of R&D statistics. Since then methodological studies in R&D statistics has gained continuous character.

An immediate effort by the above Laboratory was to attempt systematizing R&D indicators which resulted in a subsequent publication accepted by the Committee on Statistics and recommended even by the COMECOM Statistical Division to Member countries (State Committee……, 1988). That time a few principles have been already formulated to become immanent for all further methodological and practical developments in R&D statistics (Gokhberg, 1990):

- Provision of a realistic picture of R&D input and output reflecting actual potential of the nation. Statistics should react to the requirements and priorities of S&T policy not only measuring current trends, but also allowing to predict future changes.

- Coverage of all R&D-performing institutions notwithstanding their departmental and sectoral affiliation.

- Introduction of international standards into R&D statistics. Statistical information on R&D in the country must be internationally comparable in order to include them into international data series.

- Links between R&D and other branches of statistics (employment, education, enterprise, foreign trade, etc.).

- A flexible system of data collection methods using its various forms adequate to specific statistical tasks. This requires high-quality planning and coordination of censuses, regular reporting, sample surveys, and sociological interrogations.

These principles served as a basis for considerable restructuring of the methodology and practice of R&D statistics undertaken during 1989-90 to meet a new challenge of more freedom for R&D units. The Laboratory designed a national R&D survey which was implemented by the Committee on Statistics in 1989 as a mandatory reporting of R&D units named 1-Science, and since then it has become annual. The survey for the first time made available coordinated data on R&D personnel, expenditure, and fixed assets for both the former USSR and its republics, including Russia. A set of indicators new for the national statistics but widely used by the industrially developed nations was introduced, including those on R&D personnel by occupation, current R&D expenditure by type of activity, etc.

However, these positive changes occurred in a situation when the Committee on Statistics still possessed all the responsibility to collect and disseminate statistical data, whereas users actually did not have any sufficient influence on statistics. Still existed differences between general principles of accounting and statistics in the country and those used internationally made it difficult, sometimes even impossible, to implement internationally recognised concepts into R&D statistics independently from the overall revision of economic and social statistics. Due to the bureaucracy in the former central statistical office and a lack of efficient support from the user agency, methodological recommendations by the above-mentioned Laboratory were adopted by statistical authorities with certain obstacles and only in fragments.

Furthermore, the order of the statistical data collection and processing which existed in the former USSR did not promote the dissemination of ideas on the international standartisation of R&D statistics. Only the central statistical office was responsible for the all-Union data aggregation and the completion of questionnaires of international organisations. The republican statistical agencies, e.g., the Russian one, have been yet delivered from the necessity of being acquainted with the international statistical standards.

---

[1] The Laboratory was headed by Dr. Leonid Gokhberg and composed of several scholars experienced in R&D statistics and analysis.

Therefore, the 1-Science survey methodology was a kind of a compromise between requirements of impartial assessment of R&D trends, requests of the government, and limitations put by the official statistics. Nevertheless, the survey positively affected both S&T policy and statistics bringing the latters closer to international standards. This was due to the fact that the emphasis was laid on R&D/ S&T activities of establishments (industrial enterprises, higher education and research institutes, etc.) rather than the overall accounting of their works. This change of methodology has paved the way for a better estimation of R&D personnel and expenditure. Many new indicators relevant for analytical purposes, like the estimate of R&D expenditure as a percentage of GNP, has been also in use since then.

### *2.3. R&D statistics in transition*

The transition to a market economy since 1991 has had a major impact on R&D. The dominance of state-owned enterprises has fallen sharply. A further factor has been the decentralisation of decisions with a decline in the role of the central government and an increase in that of industrial associations, enterprises, and local authorities.

It has been accompanied by a series of major organisation transformations, beginning at the highest levels of state management and extending to individual R&D institutes. The changes at the top occured as the Russian Federation supplanted the Soviet Union. Many branch ministries were closed. Privatization of R&D institutes, the establishment of large financial and industrial groups and the founding of technologically-oriented small businesses created new organisation forms for S&T activity. Changes at the top reflected the search for public policies to preserve the most valuable part of the R&D sector. In the individual R&D units, the changes reflected a search for ways to survive in the economic crisis that has burdened Russia since 1991 (Gokhberg, et al., 1997).

These new realities required more active role of a S&T policy agency which, in its turn, could not be realised without sufficient information support. This was officially recognised by the leadership of the Ministry of Science and Technology (MST) which initiated the establishment of the Centre for Science Research and Statistics (CSRS) at the beginning of 1991. Behind it, there was an idea to develop both R&D policy studies and statistics under the same auspices, thus providing for necessary links and feedbacks. It was assumed that such a combination would allow to produce statistics adequate to modern requirements, whereas, on the other hand, the policy elaboration could be better proved by relevant data.

At the same time, the disintegration of the USSR heavily aggravated the statistical system. The USSR State Committee on Statistics in charge of statistical methodology and surveying was abolished. The new statistical agency established on its base - the Intergovernmental Committee of the Commonwealth of Independent States (CIS) - has not have any legal rights for

primary data collection. Its authority has included only technical recommendations for statistical offices of the Member countries and obtaining from them a limited series of national totals.

As regards the State Committee on Statistics of the Russian Federation, its role until 1992 had been limited only to data collection in Russia and its transfer to the former USSR central statistical office for further processing. This agency, as a rule, was not involved in the studies in the methodology of R&D statistics and did not have any experience and resources for the implementation of international standards.

The transition to the market economy has caused complication of economic and social processes, formation of a new state regulation mechanism. In this respect, it has become impossible and senseless for the statistical office to keep all the information in one hands. The new situation has obviously required demonopolisation of the national statistical services, when particular governmental agencies should be entitled to participate in various ways in statistical data collection regarding areas of their responsibility.

In the first years of transition, the sharp economic crisis which strongly affected the R&D sector required making urgent decisions on S&T policy against the background of lacking comprehensive and regular information. Another development was the greater integration of Russia into the international R&D community. Participation of Russian scientists and engineers in international S&T projects, employment abroad of Russian researchers, and the establishment of foreign companies and joint ventures involving Russian and foreign organisations has meant the entrance of Russia into the international S&T market. Along with strengthened intergovernmental S&T co-operation, all these highlighted an urgency of adoption of the Russian R&D statistics to international standards adjusted to market conditions.

The official statistics faced with a need to reorganise its overall system but did not have any real capabilities to react to the modern changes in S&T and, consequently to meet the new requirements of market-oriented S&T policy-making.

Thus, methodological and organisational isolation of R&D data collection from the system of elaboration and implementation of S&T policy became a crucial factor which hampered further improvement of R&D statistics in Russia.

## 3. The strategy of CSRS

### *3.1. The mission and organisational structure*

The main objectives of CSRS activities have been identified as follows:

- to develop R&D and innovation statistics in the Russian Federation, and to supply policy-makers with comprehensive, up-to-date, and internationally comparable data;
- to analyse and forecast trends in S&T;
- to draw recommendations on development and implementation of the national S&T policy;
- to publish and disseminate statistical data, analytical reviews, and policy studies to inform Russian and international communities on the national S&T system in Russia.

Clear understanding of this mission has brought to a quite simple and transparent organisational structure of the Centre. It is comprised of three departments, and their responsibilities are reflected in the titles:

- Department of R&D Statistics;
- Department of S&T Policy and Forecasting;
- Department of Informatics.

Such an organisation which has been maintained since the establishment of CSRS is based on the obvious labour division aimed at the common predestination of the Centre. Decisive role in the success of this approach belonged to the careful selection of highly-qualified and motivated personnel. The core of the CSRS staff was formed out of the above-mentioned Laboratory of R&D Statistics' team which was assigned to the CSRS Department of Science Statistics and also that of S&T policy experts from the Academy of Sciences. Since then, new staff members have been hired as additional tasks requiring specific expertise have emerged.

Another important factor was a dual subordination of the Centre to MST and the Academy of Sciences. CSRS possesses extensive contacts with the government and its various agencies in particular, at the same time since the very

beginning the Centre has been also considered as a part of the scientific community. This gave a feeling of both user needs and internal problems of the R&D sector. It allowed CSRS to properly identify its role in developing new methodological and organisational approaches to R&D statistics and to become a leader in this area in Russia.

### *3.2. Understanding of user needs*

To identify potential users and screen their interests was and still is a corner-stone of the CSRS strategy. In a democratic society, the government is no longer the only user of statistics. It should be also targeted to entrepreneurs, analysts, general public, and international community. Moreover, the mechanism of elaboration and implementation of S&T policy has become more sophisticated involving coordination of interests of different authorities (the Parliament, the President Administration, the Federal Government and its particular agencies, regional governments), non-government organisations, industrial associations, enterprises, and scientific community per se.

Initially, in 1991-92, MST was considered as the first immediate user of R&D statistics. The Ministry is the federal agency responsible for developing, coordinating and implementing state S&T policy; determining the government R&D budget; coordinating the general development of the Russian S&T, and promoting international co-operation in this sphere. The Ministry’s officers were supposed to make well-balanced decisions on S&T policy under new economic and political conditions. Although, they were not provided yet with the needed information and sometimes even did not understood a possible outcome of the relevant data availability.

Comprehensive investigation of short-term and long-term objectives of MST has become an integral part of the CSRS planning. It was decided to gradually start introducing CSRS statistical developments into current and prospective decision-making. Each new project provoked further interests thus helping to shape demand for more ambitious statistical activities of a larger scale. It was already true for the first CSRS projects aimed simultaneously at the inventory of available data and assessing the state of its sources after the break-up of the USSR, and also summing up the Soviet R&D

trends. This study resulted in the first in Russia specialised publications on R&D statistics (CSRS, 1992a, 1992b).

To meet requests of different MST departments, in 1991-93, CSRS developed techniques and practical tools (questionnaires, software, and data bases) for a variety of ad-hoc surveys. Among the most important of them there were those devoted to the following subjects:

- Stock and flows of R&D personnel at the Russian Academy of Sciences.
- Unemployed scientists and engineers (qualification, gender and age, occupation, causes of unemployment, and job placement).
- Post-graduate students in major universities (activity, qualification/experience, career intentions, parents' qualification and occupation).
- Money income of researchers (value and sources, secondary employment, and living conditions).
- Emigration of researchers (stock, qualification, and countries of destination).
- Inventory and state-of-the-art of unique research installations.
- Experimental base of R&D units (availability, privatisation, personnel, equipment, and production).
- Production of scientific instruments.
- R&D expenditure in defence industry R&D institutions in conversion to civil orientation.
- Development of new technologies (destination, technical level, and transfer).

This demonstrates a spectrum and speed of CSRS activities already in the first years of its existence. Most of the above studies were implemented and resulted in publications, though few of them finished with only technical recommendations. Nevertheless, the internal outcome of such intensive efforts was the increased methodological experience, the creation of capacities for data processing, analysis, and publications. Externally, the growing reputation and efficient results of

CSRS have attracted attention of other interested bodies, like the Parliament, the Presidium of the Russian Academy of Sciences, the Ministry of Economy, the Ministry of Finance, the Ministry of Labour and others, which have also become clients of the Centre. Later, governments of Moscow and St.Petersburg, where major R&D efforts have been traditionally concentrated, has joined the CSRS clientelle looking for information and ideas to efficiently use local R&D capacities in the cities' interests.

Another user group comprises of research and analytical centres, universities, and individual scholars dealing with economic and S&T studies. A profound concern about the fate of the Russian science has naturally caused an interest of mass media in Russia and abroad to the CSRS analyses. This has been extensively used in newspapers, magasines and TV programmes worldwide.

International organisations (OECD, UNESCO, EC, UN Economic Commission for Europe, and Pacific Economic Cooperation Council) widely use the CSRS studies for specific purposes and publications. The examples are the European Reports on Science and Technology Indicators 1994 and 1997, the UNESCO World Science Reports 1996 and 1998, Pacific Science and Technology Profiles published by APEC/PECC, etc. National governments and research centres have also become users of the CSRS publications. Among the collaborative projects there are reports on Russian R&D (Gokhberg et al., 1997; Gokhberg, 1999) and comparative publications with Korean (CSRS, STEPI, 1997a) and German (Gokhberg et al., 1999) colleagues.

In order to meet the information demand, the Centre has launched a publications programme which becomes more and more ambitious. Wide data dissemination is considered by CSRS as a key public output of R&D statistics. It is recognized, that in the long-run well-styled statistical and analytical publications will have a strong impact on increasing prestige of the Russian R&D both domestically and internationally. Here the Centre again has applied an active marketing policy which has brought to different types of publications. The major of them are, as follows:

- annual statistical publications on the Russian R&D and innovation, including large and pocket yearbooks (CSRS, 1992c, 1994a, 1994b, 1995a, 1995b, 1996e, 1997b, 1998a, 1999a);

- comprehensive analytical reviews (CSRS, 1992b, 1993a, 1998c; Gokhberg and Mindeli, 1996)

- ad-hoc publications devoted to the results of specific studies (Nekipelova et al., 1994; CSRS, 1996c, 1996d; Gokhberg, 1998). Further publications were entitled as series ‘‘Monitoring of Russian Science’’ that included analytical reviews on such policy relevant issues, as public awareness of S&T, sectoral and regional aspects of industrial innovation, labor motivation of scientists and engineers, newly awarded doctoral degrees, international migration of researchers etc.;

- monthly information bulletins containing current statistics, the most recent data or analyses obtained, and short-term forecasts of major macro-economic and R&D indicators;

- weekly express-information briefs on R&D and innovation indicators.

Regular publications of updated directories of the Russian R&D institutions grounded on the CSRS data bases (the first English edition - CSRS, 1996a) have been also highly appreciated by various users, including domestic and foreign businesses searching for partnerships with Russian R&D units in specific fields.

The CSRS methodological recommendations have been unusual for the statistical system established under the centralised planning. To resolve this problem and provide relationship of trust between the Centre, data users and the Committee on Statistics, specially tailored publications have been issued, including articles in general statistical journals and a terminological glossary (Gokhberg, 1996c).

Involvement of CSRS in international efforts in R&D statistics has had extremely strong effect on domestic developments. Firstly, an access to the OECD methodological experience and observership in NESTI actions cannot be underestimated in terms of knowledge gaining and adapting to Russian statistics. The 1993-94 OECD review of S&T and innovation policies in the Russian Federation was an important

step in convincing national policymakers to promote revising Russian R&D statistics on an internationally accepted basis.

CSRS was also strongly supported by Eurostat in the framework of the TACIS-financed Project on R&D and Innovation Statistics in the Russian Federation for 1995-97. As its priority subject areas, the project covers statistics on government R&D funding, human resources in science and technology (HRST), innovation, sectoral and regional R&D and innovation statistics, and output and impact of R&D. The project also focuses on statistical methods, data bases, software, and publications. Along with it, CSRS experts participate in Eurostat Working Party meetings on R&D and innovation statistics.

Such strategy, being implemented continuously and insistently, has finally attracted strong interest to and, subsequently, demand for R&D statistics in Russia. This resulted in the targeted financing of related activities and the division of responsibilities between key players in the current organisational system of the Russian R&D statistics. A significant step forward in methodological and practical improvements has been made.

## 4. Current organisation of Russian R&D statistics

In order to overcome organisational barriers between statistics and policy-making and to promote methodological improvements, in 1992, MST approved the Conception for S&T Statistics. It was proposed that this policy agency would take the authority for the development of R&D statistics.

In large-scale economies with extensive R&D base, statistical offices seem to be uncapable to meet alone various information inquiries of S&T policy agencies, at least in terms of resource availability. They always face with other requests of higher priority from the national governments, therefore intervention of S&T policy agencies in related statistics is essential. This involves formulation of user needs in statistical data, financial contributions, and sometimes even broader responsibilities up to data collection, processing, analysis, and dissemination by its own forces. Although these interventions differ by extent, strong interrelations between policy and statistics offices are vital in all cases for organising state-of-the-art R&D statistics. Such a conclusion is

basically proved, for example, by successful experiences of the US National Science Foundation, S&T policy agencies in France, Germany, and Japan.

The Russian R&D statistics has followed similar organisational pattern.[1] The Statute of MST approved by the Government of the Russian Federation on July 12, 1993, proclaimed its general responsibility for the development of the methodology of R&D statistics, the implementation of the respective surveys, the introduction of international standards, and the analysis of trends in S&T.

This decision was followed by a joint statement issued by MST and the State Committee on Statistics in December 1993 with the aim to coordinate efforts in this area. Owing to this document, CSRS has increased its direct responsibilities for the methodology of R&D and innovation statistics, surveying, data analysis, and publications. CSRS has been also authorised to represent the Ministry in relations with the interested international organisations in the field of R&D statistics.

Since then, a new organisational scheme of the Russian R&D statistics has taken shape. It supposes differentiated approach to data collection depending on the nature of surveys (see Fig. 1).

Following from the bottom to the top, CSRS formulates proposals for the annual programmes of the State Committee on Statistics orientating to the policy requirements. These proposals usually cover national R&D and innovation surveys and one or two additional ad hoc surveys that should be implemented according to the information requests of the highest levels related to S&T (the President, the Parliament, the Prime-Minister). The list of such surveys is agreed between MST and the State Committee on Statistics. Being included in the latter’s programme, the surveys become mandatory and are financed from the federal budget allocations on statistical activity. The methodology, questionnaires and instructions for data submitting and processing are prepared by CSRS. The Committee on Statistics evaluates these tools from a viewpoint of concordance with the statistical standards

[1] By the way, this approach implemented in Russia seems to be the only exclusion among other Central and Eastern European economies in transition where R&D statistics is still run by the statistical offices.

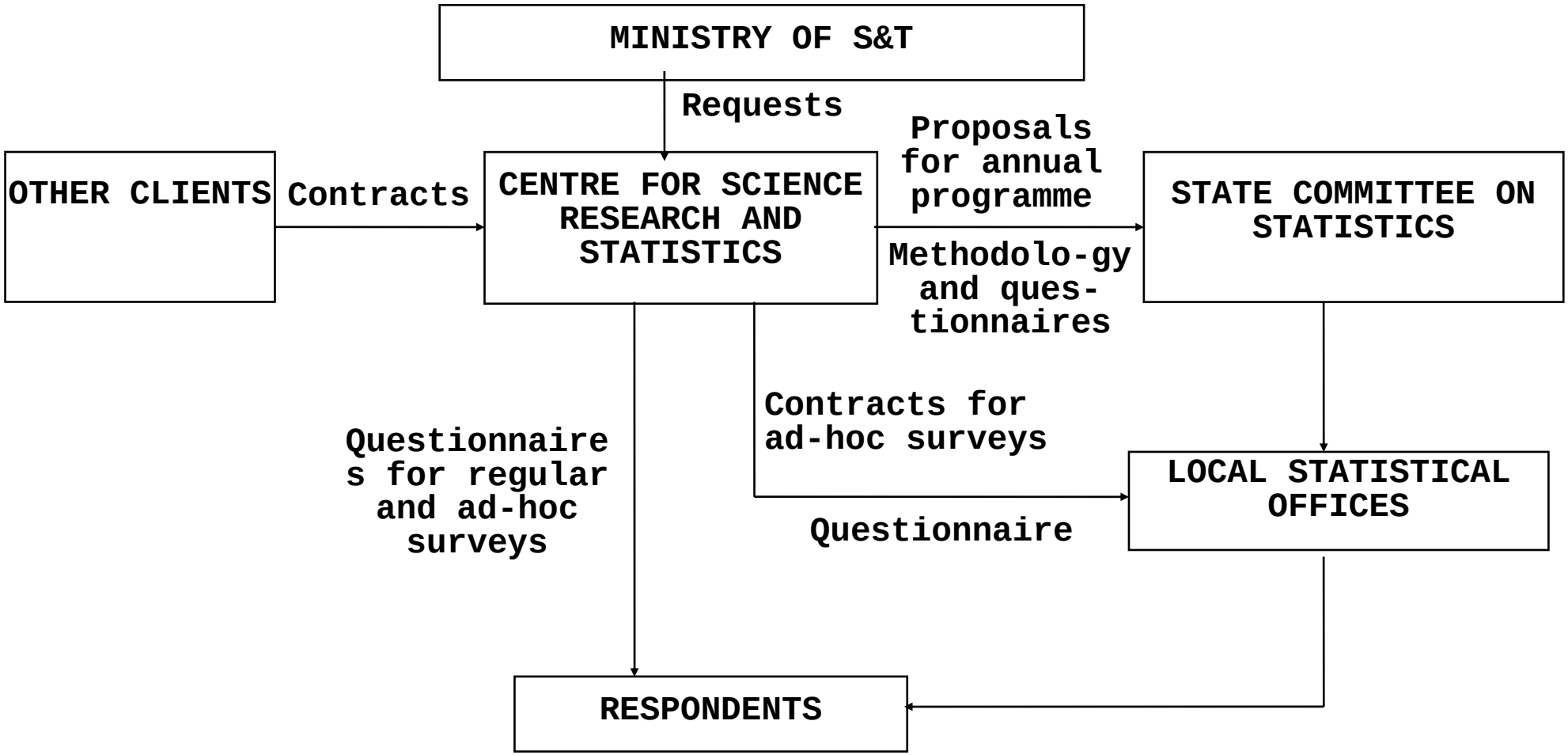
(SNA, national classifications, etc.) and after the approval provides for data collection via its local offices.

Along with it, the Centre also formulates proposals for MST and some other interested major governmental agencies: the Ministry of Economy, the Ministry of Labour et al. This set of proposals includes different types of projects involving surveying, analysis, and publications. Here CSRS again develops all the methodology, but also the required software and data bases. Data collection, analysis, and publications are implemented by CSRS itself at the expense of specific projects. An example is the survey of government R&D funding.

Certainly, in all cases those activities are orientated to current and forthcoming objectives defined by the users. However, methodological developments are often time-consuming, though the users cannot wait for a long time. Otherwise they may loose an interest in new statistical projects. This factor forces CSRS to continuously develop methodological efforts for the future use, sometimes without any external financing. The money returns in the medium or long-run when surveys bring practical results for the users. Such projects shape another component of the CSRS annual programme.

The Committee on Statistics in some sense has become a user of the CSRS products. This concerns methodological recommendations related to R&D issues to be incorporated into general statistical projects like, for example, input-output

# Fig.1. Data collection system for R&D and innovation statistics in Russia



tables for the national economy or methods of measuring output of industrial enterprises. The Centre regularly contributes to the main publications of the Committee on Statistics, including its yearbooks, with the R&D and innovation data.

## 5. Major statistical surveys

The CSRS activities during last few years have been aimed at establishing a new system of R&D and innovation statistics in the Russian Federation meeting requirements of the market economy and compatible with the international standards. Methodological studies combined with practical efforts have been focused on the following major areas:

- R&D input;
- government R&D funding;
- human resources in S&T;
- output and impact of R&D;
- innovation.

Supporting activities required for organisation of R&D statistics have been developed. These include first of all:

- statistical methods;
- software;
- data bases;
- publications.

Thus, all necessary building-blocks have been provided to really form a full-scale system for R&D and innovation statistics.

The set of annual surveys was revised. Nowadays it includes the national R&D survey, the survey of government R&D funding, and the national innovation survey.[1] These surveys ware designed according to the up-to-date standards and address challenges of macroeconomic, industrial, and S&T policies. The data on governmental priorities for budget R&D funding produced by CSRS is one of multiple examples.

### 5.1. National R&D survey

The new annual national R&D survey is generally based on the Frascati Manual recommendations. It covers all R&D-performing units and is limited only to R&D versus previously dominated broader concept of S&T activity. Due to such an approach, the surveyed population was decreased by some 200 units involved in S&T activities other than R&D. In 1997, it constituted for over 4.1 thousand institutions performing R&D.

As stated earlier (Gokhberg, 1993), the survey was designed in view, as follow:

- to be in line with the overall revision of concepts, definitions and classifications of the Russian statistics;
- to reflect specific features of R&D in the transition process (institutional transformations, variety of sources of funds and types of property, etc.);
- to be appropriate for institutions of different types and for statistical services.

The obsolete sectoral classification which reflected artificial barriers between R&D, higher education and universities, was replaced by that compatible with the OECD sectoring. It was adapted to the institutional structure of the domestic R&D base, taking info consideration functions, sources of funds, legal status and mode of control over R&D units (see Figure 2). Other general classifications implemented in the survey include those by ISIC sector (according to the newly introduced Russian •lassification of Economic Activities, Products and Services), region, type of institutions, and size of reporting unit (in terms of employment).

[1] The survey methodologies were described in: (Gokhberg, 1995; 1996a; Gokhberg and Gorodnikova, 1996; Gokhberg and Kuznetsova, 1996, 1997).

**Figure 2. Sectoral Classification of R&D Units in Russia**

**Government sector**

R&D units administered by:
legislative and executive bodies;
law and order bodies;
Ministry of Foreign Affairs;
Ministry of Finance; Central Bank;
Ministry of Defence;
Ministry of Health, Russian Academy of Medical Sciences;
Russian Academy of
Sciences and its departments (Urals Department, Siberian Department, Far East
Department);
Russian Academy of Agricultural Sciences;
R&D institutes serving primary and secondary education, culture, physical training and sport.

**Business enterprise sector**

R&D - units of :
industry (industry Ministries/agencies/departments, concerns, joint-stock companies,
intersectoral state associations, associations, intersectoral scientific and
technological complexes);
agriculture and forestry;
construction;
transportation;
communications;
banking/finance (excluding the Central bank);
trade;
communal and consumer services.

**Higher education sector**

higher education institutions:
R&D units, experimental stations, clinics administered by or associated with higher
education institutions;
R&D units serving higher education.

**Private non-profit sector**

R&D institute of:
volunteer professional and scientific societies and associations;

public (non-government) organizations;
philanthropic foundations;
private individuals, etc.

Classification of major fields of S&T was developed with respect to breakdown of personnel and expenditure data. Fields of S&T cover:

- natural sciences (mathematics and mechanics; physics and astronomy; chemistry and pharmaceutical chemistry; biology and psychophysiology; geology; geography (excluding economic and social));
- engineering;
- medical sciences;
- agricultural sciences;
- social sciences (economics; law; pedagogics; psychology (excluding psychophysiology); sociology; political sciences; other);
- humanities (history; philosophy; philology; arts).

The questionnaire consists of the following sections:

A. ***R&D personnel***

This section contains indicators on the stock of full-time R&D personnel by occupation and qualification, researchers by age and gender (biennially), field of S&T. It is also envisaged to biennially collect data on flows of R&D personnel by occupation, with the emphasis on major inflows (after graduating universities, from other R&D institutions) and outflows (voluntarily, due to staff reduction).

Along with the above head-count data, full-time equivalent (FTE) estimation of R&D personnel by occupation was introduced. For this reason, indicators on mans-days of part-time employees (by occupation) were included in the questionnaire. Aggregated data divided by a normal annual number of working days are supposed to be equal to part-timers' FTE and taken together with the number of full-time R&D personnel provide respective national totals. As the FTE concept has not ever been used earlier in the Russian R&D statistics, such a simplified technique for its calculation is assumed to be a first attempt in this respect.

### *B. R&D expenditure*

R&D expenditure is considered by type of costs (excluding depreciation), major field of S&T, type of activity, source of funds, socio-economic objective, and product field.

The specific conditions of the Russian R&D system, where, for instance, universities or the Academy of Sciences institutes (which belong by definition to the government sector) perform R&D for industry, required to apply expenditure breakdowns to all sectors of performance.

Furst of all, it refers to distribution of intramural R&D expenditure by socio-economic objective (biennially). The classification of socio-economic objectives is compatible with the Eurostat NABS and at the same time reflects national specificities. It influences the grouping of objectives in the following six major groups:

- economic development;
- social objectives;
- general advancement of research;
- exploration and exploitation of the Earth and atmosphere;
- civil exploitation of space;
- defence.

Further disaggregation of those major objectives into detailed ones is envisaged. Subsequently, the latters can be regrouped into socio-economic objectives used internationally. Table 1 illustrates the correspondence between the Russian, OECD and Eurostat NABS classifications of socio-economic objectives.

In the case, when it is impossible to link a particular basic research project to a concrete objective, that one should be treated within the objective ‘‘General advancement of research’’. It covers projects intended for general advancement of natural and social sciences, and humanities. Research in economics, policy and management of science should also be included in this sub-group.

As far as general university funds are concerned, then contrary to the OECD and Eurostat classifications they are considered among sources of R&D funding, but not within the list of socio-economic objectives, as, according to the

Russian practice, all respective projects may be allocated to particular objectives. The same approach was applied to the government budget R&D survey providing for compatibility of performer- and funder data.

Table 1. **Key between Russian, OECD and Eurostat NABS (1993) socio-economic objectives**

| Russia | OECD | NABS (1993) |
|---|---|---|
| 1. Economic development | 1+2+3+4 | 2+5+6+7 |
| 1.1. Agriculture, forestry and fishery | 1 | 6 |
| 1.2. Production, distribution and rational utilization of energy | 3 | 5 |
| 1.3. Industry | 2 | 7 |
| .3.1. Increasing economic efficiency and technological development | | 7.0+7.1+7.2 |
| .3.2. Extraction and processing of non-energy minerals | | 7.3 |
| .3.3. Chemical industry | | 7.4 |
| .3.4. Manufacture of motor vehicles and other means of transport | | 7.5 |
| .3.5. Electronic industry, manufacture of radio, television and communications equipment | | 7.6.1+7.6.2 |
| .3.6. Software development | | 7.6.3 |
| .3.7. Manufacture of electrical machinery and apparatus | | 7.7 |
| .3.8. Manufacture of instruments | | 7.9 |
| .3.9. Manufacture of non-electronic and non-electrical machinery | | 7.8 |
| .3.10 Manufacture of textile, clothing and leather goods | | 7.11 |
| 3.11. Manufacture of food products and beverages | | 7.10 |
| 3.12. Other manufacturing products | | 7.12+7.13 |
| 1.4. Construction | | 2.2 |
| 1.5. Transport | 4 | 2.4 |
| 1.6. Communications | 4 | 2.5 |

| | | |
|---|---|---|
| 1.7. Infrastructure and urban and rural planning | 4 | 2.0+2.1+2.3+2.6+2.9 |
| 1.8. Services | 2 | |
| 2. Social objectives | 5+6+7+9.1 | 3+4+8+11 |
| 2.1. Environment protection | 5 | 3 |
| 2.2. Protection of human health | 6 | 4 |
| 2.3. Social development and structures | 7 | 8 |
| 3. General advancement of research | 9.1 | 11 |
| 4. Exploration and exploitation of the Earth and atmosphere | 8 | 1 |
| 5. Civil exploitation of space | 10 | 9 |
| 6. Defense | 11 | 13 |

The distribution of intramural current R&D expenditure by product field according to the respective national ISIC-compatible classification (see Table 2) is also envisaged biennially, as well as product and process R&D expenditure.

As a note, indicators on total value of projects, including those in S&T, have been kept. This maintains continuity of data series and indicates re-orientation of R&D units to non-R&D activities, if so.

***C. R&D fixed assets.***

This short section is aimed at measuring stock of R&D fixed assets, e.g., of equipment.

In order to facilitate current decision making under rapidly changing economic situation, an abridged mid-year R&D survey is also a part of the annual statistical programme.

Table 2. **Classification of product groups for R&D expenditure distribution.**

| | Title | ISIC Rev 3 Division/Group/Class |
|---|---|---|
| 1. | Agriculture, hunting, forestry | 01+02+05 |
| 2. | Mining | 10-14 |
| 3. | Manufacturing | 15-37 |
| 4. | Food, beverages, tobacco | 15-16 |
| 5. | Textiles, wearing apparel, fur, leather | 17-19 |
| 6. | Wood, paper, printing, publishing | 20-22 |
| 7. | Wood and cork (not furniture) | 20 |
| 8. | Pulp, paper and paper products | 21 |
| 9. | Publishing, printing and reproduction of recorded media | 22 |
| 10. | Coke, petroleum, nuclear fuel, chemicals and chemical products, rubber and plastics | 23-25 |
| 11. | Coke, refined petroleum products and nuclear fuel | 23 |
| 12. | Chemicals and chemical products (excluding pharmaceuticals) | 24 minus 2423 |
| 13. | Pharmaceuticals | 2423 |
| 14. | Rubber and plastic products | 25 |
| 15. | Non-metallic mineral products (stone, clay, glass) | 26 |
| 16. | Basic metals | 27 |
| 17. | Basic metals, ferrous | 271+2731 |
| 18. | Basic metals, non-ferrous | 272+2732 |
| 19. | Fabricated metal products (except machinery and equipment) | 28 |
| 20. | Machinery equipment, instruments and transport equipment | 29-35 |
| 21. | Machinery (not elsewhere classified) | 29 |
| 22. | Office, accounting and computing machinery | 30 |

| | | |
|---|---|---|
| 23. | Electrical machinery | 31 |
| 24. | Electronic component (included semiconductors) | 321 |
| 25. | Television, radio and communications equipment | 322,323 |
| 26. | Medical, precision and optical instruments, watches and clocks (instruments) | 33 |
| 27. | Motor vehicles | 34 |
| 28. | Ships | 351 |
| 29. | Aerospace | 353 |
| 30. | Other transport n.e.c. | 352+359 |
| 31. | Furniture, other manufacturing n.e.c. | 36 |
| 32. | Recycling | 37 |
| 33. | ELECTRICITY, GAS AND WATER SUPPLY (UTILITIES) | 40+41 |
| 34. | CONSTRUCTION | 45 |
| 35. | SERVICE SECTOR | 50-99 |
| 36. | Wholesale, retail trade and motor vehicle, etc. repair | 50-52 |
| 37. | Hotels and restaurants | 55 |
| 38. | Transport and storage | 60-63 |
| 39. | Communications | 64 |
| 40. | Financial intermediation (including insurance) | 65-67 |
| 41. | Real estate, renting and business activities | 70-74 |
| 42. | Computer and related activities | 72 |
| 43. | Research and development | 73 |

| | | |
|---|---|---|
| . | | |
| 44 | Other business activities n.e.c; | 70+71+74 |
| . | | |
| 45 | Community, social and personal service | 75-99 |
| . | activities, etc. | |
| 46 | Education | 80 |
| . | | |
| 47 | Health and social work | 85 |
| . | | |
| 48 | Other community, social and personal service | 90-99 |
| . | activities | |
| 49 | GRAND TOTAL | 01-99 |

### 5.2. Survey of government budget R&D funding

Until 1994 data collection on government R&D funding had been implemented as part of the administrative procedure of budget planning. It covered only governmental department totals (budget R&D expenditure of the previous year, that expected for the current year, and appropriations for the next year).

In 1994, CSRS undertook the first attempt to survey government R&D funding. Since then it has become a subject of statistical studies that, certainly, are still related to budget planning procedures but have its own objectives. The 1994 survey was aimed at, as it traditionally used to be, measuring all the funds spent by governmental departments under the Section 06 ‘‘Science and Technology’’ of the federal budget. This assumption made the data internationally incompatible. The survey also did not cover newly established public foundations (the Russian Foundation for Basic Research, the Foundation for Research in Humanities, and the Foundation for Promotion of Small Enterprises in Science and Technology); as well as budgetary financed priority R&D programmes that required specific methodological approaches.

Evaluation of the survey results and better knowledge of OECD/EU experience gave an opportunity to develop principally new for the Russian statistics methodology to survey government R&D funding both meeting national peculiarities and internationally standardised practice.

Methodological grounds of improving of the budget R&D funding survey were determined by the following principles:

- The survey should satisfy needs of national policy-makers in comprehensive data fitting into existing budgetary procedures and covering various forms and channels of budget R&D funds allocation. As requested by MST, the survey should provide both totals and details for the Section 06 ‘‘Science and Technology’’ of the federal budget (i.e. budgetary financed civil R&D and related activities).
- The focus should be on R&D rather than on S&T. Taking into account that not only R&D, but other activities are also partly financed from the Section 06 of the federal budget, the latters should be considered separately.
- Concepts, definitions and classifications used in the survey should be in line with those of the national R&D survey providing concordance between funder- and performer-based data.

Following aforementioned requirements, an advanced version of the government R&D funding survey have been launched since 1995. In accordance with the composition of the budget R&D funding system the survey was actually being designed as a set of partial surveys targeted to:

- ministries, governmental agencies, and specific public foundations intended to promote S&T;
- government S&T programmes;
- state research centres;
- federal economic (goal-oriented) programmes aimed at broader socio-economic objectives, but containing R&D components.

All surveys are co-ordinated from the viewpoint of methodology, data collection and processing procedures. Such an approach of co-ordinated specific surveys in order to compile national totals is a brand new one for the Russian R&D statistics.

The questionnaires include the following major sections:

A. Budgetary appropriations on S&T by type of costs (both actual and planned for the current and next years). Funds from the Section 06 of the federal budget cover only current expenditure, therefore capital one is presented in a separate position. Breakdown of intramural current expenditure by type of costs met usual types of expenditure as in the

classification accepted in the R&D budget planning in Russia, namely:

- labour costs;
- social fees;
- purchasing of equipment (at the expense of current costs);
- energy costs;
- rental fees;
- other costs, n.e.c.

B. Current expenditure on S&T from the federal budget by type of activity (R&D, S&T education and training, S&T services, administration and other activities).

C. Current expenditure on R&D from the federal budget by type of R&D (basic research, applied research, and development) and field of S&T.

D. Intramural current expenditure on R&D financed from the federal budget by socio-economic objective and field of S&T.

This section of the questionnaire gives an opportunity to identify actual priorities in budget R&D financing versus those officially clamed.

### 5.3. National Innovation Survey

The gradual introduction of market mechanisms has shown a need for innovation studies, including the type and source of innovation, the stimulating factors and obstacles to innovations, the resources, and output. The objective was to develop and implement an innovation survey compatible with the OECD Oslo Manual and the Community Innovation Survey of Eurostat.

The survey was implemented in two stages. As the first stage, an ‘introductory’ survey was completed in the autumn of 1995. It was based on an abridged programme covering approximately 17,000 extracting and manufacturing enterprises selected from industrial census statistics. These included enterprises of all sizes and types, forms of property, e.g. small-sized enterprises and foreign joint ventures; as well as newly established enterprises which were not yet manufacturing products and temporarily idle enterprises.

In order to gather statistics on the ‘real’ state of innovation activities in Russia, all types of innovation were

covered. Most of the enterprises contributing to innovation included those which have purchased disembodied technologies (e.g. patents, licences, industrial prototypes, and other types of industrial property) or those which are engaged in any other kind of activity connected with the introduction of new and/or improved products and processes.

The interpretation of the concept of 'introduction' was broadened for fuller coverage of enterprises intending to introduce innovations in production. Thus, innovation was identified not only at its final stage (e.g. when equipment is in operation) but also at the initial and interim stages of introduction (e.g. new equipment is being assembled but not yet in operation). Respondents were also asked questions on future activities, whether they planned to develop or introduce new or improved products and processes in the subsequent three years.

The survey results allowed for analysis on enterprises active in innovation; enterprises inactive in innovation; enterprises foreseeing innovation activity in the near future; and, enterprises engaged in the different type of innovation activity.

This introductory survey for the first time in Russia provided information to produce a general picture of innovation activity in Russian industry, and identified a population of innovative enterprises. It also provided the enterprises the opportunity to adjust their accounting methods in order to facilitate the transition to a more complicated second stage innovation survey.

The second stage implemented in 1996-97 was a full-scale survey covering all industrial enterprises, for a detailed study of trends in innovation and determining factors. Since then, this survey has become annual and mandatory. A questionnaire consists of the following major sections:

- expenditure on technological innovations by type of activity and source of funding;
- expenditure on product and process innovations (e.g. on R&D);
- sales of innovative products (e.g. exports);
- objectives of innovation activity;
- acquisition and transfer of new technologies.

Further improvement of the innovation survey refers to the coverage of the services sector. A pilot study on telecommunications as one of its most rapidly developing branches is envisaged for 1999.

### 6. New projects and nearest plans

Taking account of the urgent policy agenda, e.g. the measures stipulated by the Conception of Reforming Russian Science approved by the Government in 1998, CSRS is developing new statistical and analytical activities. The most important of them refer to the following areas:

- Human resources for S&T (HRST)

HRST as such represent a much broader category that R&D personnel. That is why an ambitious idea of an integrated data collection on HRST (including stocks, flows, education and training, earnings, etc.) concerns different sections of the national statistics: population, employment, education, R&D, life standards, and so on. It requires not only methodological contributions but also strong coordination of data collection exercises undertaken by different agencies (State Committee on Statistics, MST, Supreme Certification Committee, Ministry of Interior, etc.). Recommendations on such a comprehensive data collection system are being developed. On the basis of an inventory of existing data an analytical report on qualified manpower will be published in 1999.

Other ongoing CSRS projects in this domain contribute to decision-making on social security measures for scientists and engineers, policies on S&T education and ''brain drain''. In 1997-98, surveys on researchers employed abroad under contracts and on labour motivation of scientists and engineers were implemented, accompanied with subsequent publications.

- Technology balance of payments

To compile a national technology balance of payments (TBP) CSRS in 1999 performed a survey of exports and imports of technologies by type of transfer patents, licences, know-how, R&D contracts, engineering services, etc.) and by country. The data is available for economic activities and regions, thus allowing for both detailed analysis and the TBP compilation at the national level.

- Advanced manufacturing technologies

In order to assess the technological level of industry sectors a survey on development and utilisation of advanced manufacturing technologies based on computers and microelectronics was implemented in 1999. For this purpose, a classification of technology groups was prepared.

- Information technology

The emerging Information Society has significantly challenged statistical activities. A survey on information technology (IT) products and services was designed and intended for implementation in 1999. Its major indicators include availability of hardware, software and computer networks, expenditure on IT by type of costs across sectors of economy; production of IT products and services (by type), current and capital expenditure, and employment in the IT sector by occupation.

- Forecasting of major R&D indicators

CSRS started short-term (monthly and quarterly) forecasts of employment and average wages in R&D for eventual use in current budget adjustments at MST yet in 1995. They are based on a combination of various statistical methods (time series decomposition, regression, rhythm models). The system further expanded to broder set of indicators and medium (yearly) and long-term horizons, e.g. in the framework of the Interdepartmental Programme on S&T Forecasting started by the Russian Government in 1998, with CSRS authorised to coordinate activities of organisations involved.

- Sociology of S&T

Sociological methods naturally complement to statistical ones enriching traditional data and analysis with understanding of hidden tensions, opinions, etc. Sociological studies at CSRS have been focused on the situation at the academy institutes, behaviour of R&D institutions to survive under crisis conditions, career intentions of scientists and engineers, their attitudes to ward government policies, and public awareness of S&T. The latter attracted a strong interest and was a subject to annual statistical surveying in 1996-99.

- Higher education

Trends in higher (university) education has been a focus of CSRS studies since the very beginning, given its role in both supplying qualified professionals and performing R&D. Therefore along with the coverage of universities as R&D-performing units in the framework of R&D and allied surveys, education indicators per se have been a subject of particular emphasis. In this respect, annual data books on higher education statistics published by CSRS, numerous contributions to national and international methodological and analytical projects should be mentioned.

## Bibliography of major CSRS statistical publications


Centre for Science Research and Statistics (1992a) Research and Development in the USSR, Data Book: 1990, Moscow.

Centre for Science Research and Statistics (1992b) Science in the USSR: Analysis and Statistics, Moscow (in Russian).

Centre for Science Research and Statistics (1992c) Science and Technology in Russia: 1991, Moscow.

Centre for Science Research and Statistics (1993a) Development of Science in Russia, Moscow (in Russian).

Centre for Science Research and Statistics (1993b) Science and Technology Indicators in the CIS, Moscow.

Centre for Science Research and Statistics (1994a) Russian Science and Technology at a Glance: 1993, Moscow.

Centre for Science Research and Statistics (1994b) Science and Technology in Russia: 1993, Moscow.

Centre for Science Research and Statistics (1995a) Russian Science and Technology at a Glance: 1994, Moscow.

Centre for Science Research and Statistics (1995b) Science and Technology in Russia:1994, Moscow.

Centre for Science Research and Statistics (1996a) Directory of R&D Institutions in Russia, Moscow.

Centre for Science Research and Statistics (1996b) Higher Education in Russia, Moscow.

Centre for Science Research and Statistics (1996c) Innovation in Industry Sectors, Moscow (in Russian).

Centre for Science Research and Statistics (1996d) Russian Academic Science in Opinions of Scientists, Moscow (in Russian).

Centre for Science Research and Statistics (1996e) Russian Science and Technology at a Glance: 1995, Moscow.

Centre for Science Research and Statistics (1996f) Science and Technology Indicators in the CIS, Moscow.

Centre for Science Research and Statistics, Science and Technology Policy Institute (1997a), Priorities for Science and Technology in Russia and Korea: A Comparative Study, Moscow - Seoul.

Centre for Science Research and Statistics (1997b) Russian Science and Technology at a Glance: 1996, Moscow.

Centre for Science Research and Statistics (1998a) Russian Science and Technology at a Glance: 1997, Moscow.

Centre for Science Research and Statistics (1998b) Science and Technology in the Regions of the Russian Federation, Moscow.

Centre for Science Research and Statistics (1998c) Technology Innovation in Russia, Moscow.

Centre for Science Research and Statistics (1998d) Research and Development in the Russian Higher Education Sector, Moscow.

Centre for Science Research and Statistics (1998e) Innovation in Russia. Data Book, Moscow.

Centre for Science Research and Statistics (1999) Russian Science and Technology at a Glance: 1998, Moscow.

Gokhberg, L. (1990) Scientific Potential of the USSR, VINITI Publishers, Moscow (in Russian).

Gokhberg, L. (1992) Case Study on the Needs, Availability, Concepts, Definitions and Classifications in the Field of Science and Technology Statistics in the Russian Federation, UNESCO, Paris.

Gokhberg, L. (1993) Science and Technology Statistics in Russia: Current Status and Perspectives, Conference on Science and Technology Indicators in Central and Eastern European Countries, CCET/DSTI/EAS (93)161, OECD, Paris.

Gokhberg, L. (1995) Innovation Statistics in the Russian Federation. National Experience and Consequences for the Revision of the Oslo Manual, Group of National Experts on Science and Technology Indicators, DSTI/EAS/STP/NESTI(95)6, OECD, Paris.

Gokhberg, L. (1996a) R&D and Innovation Statistics in the Russian Federation: New National Surveys. In: Science and Technology Statistics in the Partners in Transition Countries and the Russian Federation, OECD/GD(96)56, Paris.

Gokhberg, L. (1996b) Organisation of the Russian R&D Statistics: Responding to Policy Needs, CCET/DSTI/EAS(96)110, OECD.

Gokhberg, L., (Ed.) (1996c) Statistics of Science and Innovation: Concise Terminology, Moscow, Centre for Science Research and Statistics (in Russian).

Gokhberg, L. (1998) Financing of Science in the Economies in Transition: A Comparative Analysis, Centre for Science Research and Statistics, Moscow.

Gokhberg, L. (1999) Russia: A Science and Technology Profile, the British Council, Manchester.

Gokhberg, L., and Kuznetsova, I. (1996) The Russian Innovation Survey: Methodology and First Results, CCET/DSTI/EAS(96) 116, OECD.

Gokhberg, L., and Kuznetsova, I. (1997) Innovation Survey Results for Russia. In: Innovation Measurement and Policies. Luxembourg: Office for Official Publication of Publications the European Communities, 1997.

Gokhberg, L., N. Gorodnikova, J. Wudtke (1999), Volkswirtschaft im Übergang: Ein Vergleich der FuE-Indikatoren in Rußland und Deutschland. Zentrum für Wissenschaftsforschung und- statistik,

Wissenschaftsstatistik im Stifterverband für die Deutsche Wissenschaft, Moskau-Essen.

Gokhberg, L., and Gorodnikova, N. (1996) Statistics on R&D Budgetary Allocations in Russia. In: Science and Technology Statistics in the Partners in Transition Countries and the Russian Federation, OECD/GD(96)56, Paris.

Gokhberg, L., and Mindeli, L. (1996) Research and Development in Russia: Trends of the 1990s, Centre for Science Research and Statistics, Moscow.

Gokhberg, L., M.J. Peck, and J. Gacs (Eds.) (1997) Russian Applied R&D: Its Problems and Its Promise, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Nekipelova, E., Gokhberg, L., and Mindeli, L. (1994) Emigration of Scientists: Problems, Real Estimations, Moscow.

State Committee on Statistics of the USSR (1988) Science: Branch Subsystem of Statistical Indicators, Moscow (in Russian).