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From Knowledge to Wealth

Transforming Russian Science and Technology for a Modern Knowlege Economy

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Abstract

Russia possesses a sophisticated science and technology (S&T) infrastructure (research capability, technically trained workforce, and technical research universities) which, even today, is a world leader in many fields. Despite this world class basic research capacity, Russia's exports are primarily raw materials. At a time when wealth depends to an increasing degree on knowledge, Russia does not have an effective system for converting its scientific capacity into wealth.

Russia's S&T resources are isolated bureaucratically (they are deployed in the rigid hierarchical system devised in the 1920s to mobilize resources for rapid state-planned industrial development and national defense), functionally (there are few links between the supply of S&T output by research institutes and the demand for S&T by Russian or foreign enterprises), and geographically (many assets are located in formerly closed cities or isolated science/atomic cities). Overcoming these inefficiencies and adjusting the S&T system to the demands of a market economy will require a major program of institutional and sectoral reform.

Part I of this paper describes the ambiguous legacy of the Soviet S&T system and the status of the Russian S&T sector after 10 years of transition. Part II describes the evolution of the Russian system of intellectual property rights protection from Soviet times to the present and argues that Russia will never develop a successful commercialization program until it clarifies the ownership of the large stock of intellectual property funded with federal budget resources. Part III outlines a comprehensive 10-point sectoral reform program to improve the efficiency of government research and development spending and link the Russian S&T system with market forces.

This paper—a product of the Private and Financial Sectors Development Unit, Europe and Central Asia Region—is part of a larger effort in the region to foster understanding of technology commercialization issues. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Alfred Watkins, room H12-115, telephone 202-473-7277, fax 202-522-3687, email address awatkins@worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at awatkins@worldbank.org. February 2003. (57 pages)

FROM KNOWLEDGE TO WEALTH: TRANSFORMING RUSSIAN SCIENCE AND TECHNOLOGY FOR A MODERN KNOWLEDGE ECONOMY

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I. INTRODUCTION

Forty years ago, Korea, Israel, China, and Finland were relatively non-industrialized, scientifically unsophisticated, raw material exporters. Wood and forest products constituted 70% of Finland's exports during the 1960s and agricultural products constituted approximately 70% of Israel's exports during that same decade. Today, knowledge intensive products constitute more than 50% of each country's exports.

Over the course of several decades, each country managed to adopt and implement different, but internally coherent, economic development policies. These policies addressed a wide range of issues, all designed to increase the knowledge content of the country's economic base.[1] These included (i) policies to foster private sector development, improve the productivity and competitiveness of such "old economy" sectors as manufacturing and agriculture, and stimulate the development of new high tech enterprises, (ii) programs to create an education system designed to give students the cognitive and technical skills that they would need to prosper and thrive in the global knowledge economy, and (iii) policies to commercialize the output of the national research and development system, thereby converting knowledge into wealth.

As a broad generalization, this is probably an accurate description of the policies that any country must pursue if it hopes to become an active, prosperous participant in the global knowledge economy. But Russia may be facing a unique challenge. Forty years ago Finland, Korea, Israel, and China, all started with a relatively underdeveloped enterprise sector **AND** an underdeveloped science and technology (S&T) base.

The "starting point" for Russia, by contrast, is a combination of a depressed economic base characterized by a large stock of rapidly depreciating, obsolete industrial capital, and a sophisticated science and technology infrastructure (research capability, technically trained workforce, and technical research universities) which, even today, is a world leader in many fields. And yet despite this world class capacity in many fields of basic science, Russia's exports are primarily raw materials. According to a recent report by the Ministry of Industry, Science and Technology, "Russia's share of the world [export] market of high-tech products does not exceed 0.3%, which is 130 times lower than the U.S. share."[2]

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1 For details, see presentations on Hungary, Finland, South Korea, and Israel at the Helsinki Seminar on "Innovation Policy And The Valorisation Of Science And Technology In Russia," March 1 –2, 2001 available at the web site address http://www.oecd.org/dsti/sti/

2 "Role of the State in Creating a Favorable Innovation Climate in Russia," Background Report Prepared by the Ministry of Industry Science and Technology for the Helsinki Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia, March 1-2, 2001, Paragraph 3.

The challenge facing Russia, as defined by the Government's economic reform program is to develop a strategy for transforming Russia from a raw material exporter to a world class producer of knowledge intensive products[3]:

> "Over its many years of history Russian science has made an inestimable contribution to the development of our country. To a considerable extent Russia owes its status as a world power to the accomplishments of Russian science. Russia has the potential to develop in practically every area of scientific and technological progress. This is not only an object of national pride but a strategic resource capable of providing huge economic benefits to Russia.
>
> At the same time, in a situation in which state funding has been drastically reduced and [state] production orders have declined, science has almost totally exhausted domestic resources for its development. Today the question of whether Russia will be a state with a powerful economy and high-technology industry, whether it will restore a strong science, and whether Russian scientists will regain their positions in the world scientific community is more urgent than it has ever been."

On one level, Russia's starting point makes this task less daunting. Russia already possesses a sophisticated S&T base and a core of highly educated scientific personnel. It has to preserve and transform what already exists rather than devote decades to creating this critical resource from scratch. But on the other hand, Russia has to overcome a long legacy of institutional rigidities and dysfunctional institutional arrangements inherited from the Soviet system. Currently, many of the S&T resources are isolated both bureaucratically (in the sense that they are deployed in the rigid hierarchical system devised in the 1920s to mobilize resources for rapid state-planned industrial development and national defense), functionally (in the sense that there are few links between the supply of S&T output by research institutes and the demand for S&T by Russian or foreign enterprises), and geographically (in the sense that many assets are located in formerly closed cities or isolated science/atomic cities). Overcoming the inefficiencies embedded in these sunk costs incurred during the socialist period and adjusting the S&T system to the demands of a market economy will require a major program of institutional and enterprise reform which, in turn, will make the task more daunting, although no less necessary.

For example, among the challenges that Russia faces are to:

- **Transform the wealth generated from natural resource activities into investments that will foster the emergence of a knowledge based economy.** As will be discussed in greater detail below, many of the current government policy papers and academic research monographs devoted to this subject can best be described as "logical wishfulness." Since natural resource rents are currently the primary source of wealth and capital accumulation, it is logical to assume that profits from natural resource extraction can serve as the primary

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[3] Development Strategy of the Russian Federation Until 2010, Chapter 3.3, "The Innovation-Based Development of the Economy," Moscow, 2000.

source of investment funds for high tech activities. But what public or private sector institutions and policies will transfer these surpluses from one sector to another? Industrial business groups? Private capital markets and venture funds? And is the transition from a resource extraction economy to a high tech economy simply a question of redistributing financial flows? Or will it require fundamental changes in the system of commercializing research and development and substantial improvements in the capacity of Russian enterprises to absorb and use technology? It is not clear that GOR is contemplating these questions, let alone developing coherent answers.

- **Commercialize the country's research capability and harness Russia's S&T assets to the job of creating a modern, knowledge intensive domestic economy.** Anecdotal evidence suggests that Russian enterprises prefer to import high tech, knowledge intensive equipment. There seems to be little domestic demand for Russian made equipment and very little high quality, high tech manufacturing equipment actually produced in Russia. At the same time, science intensive enterprises and research institutes typically find that there is relatively little demand for their goods and services inside Russia. Instead, their most lucrative markets seem to be outside Russia, either in other emerging markets or occasionally, in Western Europe or the US. Thus, while most countries are integrating their S&T sector with the development of a vibrant, globally competitive domestic enterprise sector, Russia would appear to be developing two independent systems – an enterprise sector that occasionally finds the financial resources to purchase technology and knowledge intensive equipment from abroad and an S&T sector that occasionally manages to sell Russian technology and knowledge intensive equipment abroad. Is this the most effective way to develop a modern, knowledge economy? Should these systems be more closely integrated? More importantly, given the relative technological backwardness of most of Russian agriculture and industry, at this stage in its development, should Russian S&T policy emphasize the consumption of imported technology or the production and export of domestic technology. Can Russia remain a technological powerhouse if the rest of the economy cannot compete in the global marketplace?

- **Develop linkages between science intensive SMEs and large national and international firms which can help local firms develop a high value added niche in the global value chain.** Enterprises do not exist in isolation. As they strive to serve ever more sophisticated customers with more technically demanding requirements -- in other words, as they attempt to find higher value added niches in the national or international value chain -- they must upgrade their skills and manufacturing sophistication. Unfortunately, linkages with the sort of national or international enterprises that can lift local enterprises to ever higher positions on the global value chain are still rather rare in Russia, in part because Russian firms generally do not have the management and strategic planning skills to develop these commercial connections. Consequently, even those firms engaged in high tech commercial production may be trapped in a dead end if all they are doing is exploiting their inherited intellectual capital and not investing in R&D or further technological upgrading, And yet, investing in

R&D or technological upgrading makes no sense if Russian firms have no access to sophisticated customers who are demanding these higher value added services and financial resources -- either from commercial banks or retained earnings -- to finance the investments that would be required to serve these customers. The manner in which these linkage/value chain issue are addressed will have a major impact on whether Russia makes a successful transition to a knowledge economy.

- **Encourage Educated Russians to Live, Work and Invest in Russia.** Applications to elite technical universities in Russia are at an all-time high. Normally, this would be a positive development, a sign that students believe that there is a productive rewarding future in Russian science. But anecdotal survey evidence suggests that students are enrolling in elite Russian technical universities because they believe it is the best way to get a visa for entry to the US and a job with leading US high tech firms. Until Russia manages to convince these students to use their skills and training domestically -- in other words until it creates a business climate and business opportunities that discourages wholesale brain drain -- Russia will have difficulty making a successful transition to a Knowledge Economy.

- **Improve the Business Climate**. Improving the business and investment environment so that both Russian and foreign businessmen are willing to invest in Russia is an absolute prerequisite for supporting the transition to a Knowledge Economy. Without improvements in this area, including measures designed to ease the entry of new high tech firms, it is unlikely that Russia will be able to tackle such items as reversing the brain drain, establishing more productive linkages between SMEs and larger national and international firms, or commercializing Russian innovations.

Why is it important for Russia to address these challenges and answer these questions?

- The existing S&T base is a wasting resource that has already eroded significantly and is in danger of continuing to erode rapidly. Russia cannot maintain a world class scientific establishment if it is built on a declining industrial base. As one observer from INTAS noted recently, "To date, rather than the S&T sector *pulling up* the rest of the economy, what we have witnessed in post-Soviet Russia is the rest of the economy *pulling down* the S&T sector." [4] [emphasis in original.]

- Unlike the fixed capital stock sunk into obsolete, poorly located industrial facilities, the existing scientific human capital stock is potentially much more flexible and mobile. This can be both a virtue and a defect. Like financial resources, it can be a source of capital flight or brain drain. But it can also be a potential engine of economic growth and private sector development if properly

[4] Daniel Berger, "The Russian Science & Technology Sector: *Quo Vadis*?," unpublished manuscript, November 2000.

harnessed alongside appropriate public sector management and private sector development policies.

- Ignoring the S&T sector as a unique factor of production -- on a par with land, labor and capital -- is tantamount to ignoring the one resource which is the key to development and prosperity in the 21st century "knowledge economy."

- Emerging evidence from a recent OECD international survey shows that inherited inefficiencies and contracting budgets are combining not only to affect education access and quality but are beginning to have an adverse effect on student outcomes which in turn will affect the availability of a well educated supply of human capital, familiar with new technology and capable of economic creativity. If Russia does not act soon to reverse these trends, it could lose the one factor of production that is critical to success in the Knowledge Economy -- a well educated labor force that is capable of both consuming and producing world class knowledge.

How can Russia cultivate productive linkages between its S&T resources and its enterprises, especially given the preponderance in Russia of large industrial enterprises and isolated S&T institutions? The crucial lesson from Finland and Israel, among others seems to be that a successful S&T strategy should be integrated into an overall private sector development and enterprise development/restructuring strategy.

This integration is currently lacking in Russia. The S&T sector does not have a history of communicating with the enterprise sector and responding to its needs. But until investment in the enterprise sector gathers momentum, enterprises will not generate an effective demand for Russian S&T. Thus, in many respects, "solving the Russian S&T problem" is inextricably linked to resolving the enterprise restructuring problem, with all that implies for improving the investment climate, improving public and corporate governance, reducing administrative barriers to entry and exit, improving financial intermediation, improving creditor rights in bankruptcy, etc. At the same time, given Russia's historical legacy of institutional compartmentalization, special attention should also be paid to developing linkages between the S&T sector and enterprises. The objective should not only be to ensure that the process of restructuring the S&T sector proceeds in pace with the process of restructuring the enterprise sector but to ensure that the restructuring of the enterprise sector drives the restructuring of the S&T sector.

This paper will examine the current status of the Russian S&T system and the government's proposals for reform. **Part I** will discuss the origins of the current problem. It will suggest that the Soviet Union bequeathed Russia with an ambiguous legacy in terms of S&T – a legacy of world class leadership in many fields of basic science and a laggard in almost all fields of industrial innovation. It will also suggest that this legacy was not an accident, but an inevitable consequence of the Soviet system. This section will also discuss the evolution of the Russia S&T system in the ten years since the break-up of the Soviet Union. Despite the profound changes that have taken place to date, the paper will suggest that this has been primarily a process of change without transition and reform. Thus, despite the many policy initiatives that were inaugurated

during this period, by themselves, these initiatives will not be sufficient to revive the S&T system or the Russian economy.

An important focus of the government's reform program concerns the issue of intellectual property rights. **Part II** will suggest that the intellectual property discussion in Russia needs to be viewed from two complementary but radically different perspectives. The first, and most commonly discussed perspective (in the west) involves the protection of western IP in Russia. From the vantage point of this prism, Russia adopted world class IP legislation in 1992 and 1993. For the most part, it complies with international norms and the membership requirements of the WTO. The weakness with Russia's IP laws lies in compliance and enforcement, but not the laws themselves. However, from the Government's perspective, the most urgent issue is not protecting western IP in Russia, as important as that may be, but rather, clarifying the ownership status of those objects of intellectual property that were funded with Soviet and Russian budget resources. The current IP legislation, which was drafted and approved before the privatization program and radically altered Russian property relations, does not address these issues. This has created a legislative void which leaves a significant portion of the Russian IP legacy unprotected and makes it difficult to commercialize this stock of knowledge. This section of the report will attempt to illuminate the main contours of the ongoing policy debate regarding **ownership** of budget funded IP and the government's desire to ensure that ownership ambiguities are resolved so that this IP can be "introduced into the economic turnover."

Finally, **Part III** will review the government's progress in restructuring the S&T sector. This section will argue that GOR has implemented a variety of noteworthy S&T restructuring programs designed to increase the flow of venture capital investment in the Russian economy and accelerate the growth of high tech SMEs. It is difficult to quarrel with any of these policy initiatives. Many should be promoted and scaled up. Yet by the government's own criteria, success has been elusive. What is missing? This concluding section will argue that there have been two principal missing ingredients. The first is a thorough reform of the S&T sector itself. Among other things, this would include reforms of the Russian Academy of Sciences and related reforms to improve the overall efficiency of government S&T spending. The second is a long term strategy for reviving the enterprise sector and, even more importantly, linking the restructuring of the S&T sector to the revival of the enterprise sector. If it is true that a healthy S&T sector cannot exist in the midst of an unhealthy enterprise sector, it is also true that the revival of the S&T sector will not occur without a demand by domestic Russian enterprises for innovation. This demand is beginning to emerge, but much more needs to be done to link the S&T sector with the enterprise sector. The paper will conclude by suggesting several possible options for strengthening these linkages.

II. EVOLUTION OF THE SOVIET/RUSSIAN S&T SYSTEM

A. Science in the USSR: The Ambiguous Legacy.

The Soviet Union bequeathed Russia an ambiguous S&T legacy, a sector described by one observer as "cutting edge and obsolete at the same time."[5]

That the Soviet S&T sector was cutting edge in many areas of basic research and engineering is beyond doubt. The Soviet S&T system could boast of world class research in several highly competitive scientific/technological areas including physics, astronomy and space research, chemistry and new materials, life sciences, earth sciences, mathematics and computer sciences, new technologies ranging from hydraulic and gas turbines, laser applications, high frequency plasma. This was coupled with a high level of public R&D expenditure, a highly educated population and a large corps of elite scientists/engineers, with a special concentration in basic research. In 1990, the number of R&D personnel in the ex-Soviet Union exceeded 2.8 million, of which just under two million were in Russia proper. That same year, Russia was the home of more than 4600 R&D institutes and devoted 2.03% of GDP to R&D expenditures, a comparable effort to that found in the OECD.[6]

Yet these undeniable scientific achievements did little to improve the overall health of the economy and may have even contributed to the economic stagnation that was beginning to manifest itself by the late-1970s and early-1980s. The Soviet R&D system was explicitly designed to work within a command economy that was mobilizing resources for national defense and rapid centrally planned industrialization. Despite repeated attempts at reform during the waning years of the Soviet Union, the Soviet S&T system could not respond, in terms of greater flexibility and innovativeness, to the requirements of a modern, high tech economy.[7] To the extent that the organizational structure bequeathed to Russia by the Soviet Union has not yet been reformed and overhauled, the inefficiencies and inflexibility of the Soviet system will continue to hinder development of the Russian economy.

The Soviet S&T system was a rigid, highly stratified, hierarchical administrative system. In visual terms, it can be viewed as a series of parallel silos, with few if any linkages or communication and feedback channels between silos. The Soviet S&T system was

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5 Ksenia Gonchar, Research and Development (R&D) Conversion in Russia, Report 10, Bonn International Center for Conversion, May 1997, p. 71.

6 All data are from Russia: A Science and Technology Profile, The British Council, 1999, Chapter 3. The profile itself was written and compiled by Dr. Leonid Gokhberg, Deputy Director, Center for Science Research and Statistics, Ministry of Industry, Science and Technology.

7 See for example, Jack Martens, "Measuring Soviet Performance in Industrial Innovation: The Implementation of New Inventions," Paper Prepared For: *Technology and Transition in the USSR, A NATO Science Policy Workshop,* University of Birmingham17-20 September, 1991. This article shows that USSR innovational speed in both the civilian and defense sectors lagged significantly behind that of the West.

explicitly designed to foster specialization and minimize communication and interaction between different strata since these command and control functions were the exclusive prerogative of the central planning apparatus. More importantly, this organizational structure fostered the nearly total separation between the supply of R&D, which was carried out by the various research institutes on the basis of government funding which was supplied irrespective of demand for innovations, and the R&D demands of the enterprise sector which were largely divorced from the supply of innovations generated in the research institutes.[8] As one observer noted, a discussion about applied R&D in the US or Japan "would be mostly about large companies such as IBM or Mitsubishi Electric and the small ones that have been highly innovative. This is because most applied R&D in market economies (apart from defense) is company financed, company directed, and company performed....In the Soviet Union, however, enterprises did not have this role but rather they maintained the tradition of passivity with respect to R&D. R&D was largely supplied to the enterprise as a free good."[9] Not surprisingly, the diffusion of innovations was a weak point of Soviet R&D. Even if Russian scientists developed an innovation, Russian enterprises were generally slow to utilize the results of that scientific activity.

Soviet R&D was divided into four distinct sectors, or silos:[10]

- *The Academy Sector.* The Academy of Sciences, created originally by Peter the Great, and related branch academies specialized in basic research and was at the pinnacle -- in terms of prestige, funding, and manpower skills -- of the Soviet R&D system. In 1990, the 535 institutes of the Academy of Sciences accounted for approximately 10% of the total research and two thirds of the basic research conducted in the USSR.

- *Higher Education Sector.* This sector was primarily responsible for training scientists, engineers, and researchers. Except for a small number of elite universities and engineering schools, the higher education sector was not expected to be a center of R&D. During the latter half of the 1980s, universities received 10% of the budget funds allocated to R&D, but they employed 1/3 of the R&D specialists and almost 50% of the highly skilled personnel. Because they received less funding but had more personnel, universities began engaging in contract research with enterprises as well as with academic and industrial institutes in order to supplement their funding. Thus, at the beginning of 1992, 450

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8 By comparison, the US, as well as other OECD countries, have gone to great lengths to discourage compartmentalization and encourage closer links between industry, universities and laboratories in the pursuit of basic and applied research. For details, see the discussion in Section IV, below.

9 Leonid Gokhberg, Merton J. Peck and Janos Gacs, "Introduction," in L. Gokhberg, M. Peck and J. Gacs, Russian Applied Research and Development: Its Problemsn and Promise, (International Institute for Applied Systems Analysis: Laxenberg, Austria, 1997), p. 3.

10 For a description of the Soviet S&T institutional structural see, Leonid Gokhberg, "Transformation of the Soviet R&D System," and Viacheslav Alimpiev and Alexander Sokolov, "The Institutional Structure of Applied R&D," both in Gokhberg, Peck and Gacs, *op cit.*

educational institutions were engaged in some kind of R&D. However, in terms of absolute spending on research, educational institutions remained relatively small, accounting for approximately 6% of all R&D spending in Russia. The financing situation for these institutions remained disastrous as both budget financing and contract research withered during the onset of the transition.

- *Industrial R&D Sector.* This sector was engaged primarily in applied R&D. During the Soviet period, each branch ministry organized its own branch R&D institute which served the branch as a whole rather than specific enterprises.[11] Decisions about what research to perform were taken by the branch ministry as part of the central planning system. This organizational structure tended to promote specialization which hampered the diffusion of technology across sectors. Moreover, because branch institutes had a monopoly on applied research in their specific sector, the quality of their output was generally below world standards. Nevertheless, if they wanted to innovate, enterprises had no choice but to get their research from the corresponding branch institute. But since enterprises were under no obligation to innovate, they frequently did not utilize the output generated by the branch institutes. The end result, therefore, was a complete divorce between the supply of sectoral research and the demand for this research. In 1990, the industrial R&D sector accounted for 75% of the applied research, 88% of the development research, and 78% of total research conducted in Russia that year.

- *Enterprise Sector.* Institutes in this sector were attached to specific enterprises and were mainly engaged in adapting R&D supplied by other R&D institutes to the specific production requirements of that enterprise. Financing for this work was supplied by the enterprise, rather than the federal budget. Although this sector of the R&D establishment had the closest link to production, it was also the least developed sector, accounting for approximately 5% of total R&D spending.

In addition to bureaucratic stratification, the Soviet R&D system was characterized by a large degree of geographical segregation. More than 50 closed science cities, or *naukogorodoks*, were established during the Soviet period. For security reasons, many were deliberately located in isolated areas or in gated, secure compounds adjacent to civilian cities. These cities generally contained one or two specialized enterprises and related research institutes. Again, by explicit design, there was almost no linkage between the output of these science cities and the R&D needs of industrial enterprises in the surrounding civilian cities. Funding for these science cities was supplied almost entirely from the budget, rather than from any commercial sources. Consequently, their work had very little commercial orientation. When budget funding dried up, many of these cities and their science intensive town-forming enterprises were no longer viable going concerns.[12] Nevertheless, they continued to contain high concentrations of some of Russia's best S&T assets.

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[11] During the 1970s, there were approximately 70 branch ministries.

[12] For a description of economic conditions in the closed science cities, see OECD, Science, Technology and Innovation Policies, Federation of Russia, Volume I, Evaluation Report, (Centre for

B. Transition and Decay -- Change Without Transition

The USSR/Russian S&T system changed significantly since the collapse of the FSU. But while the changes have been profound, they have not produced a successful transition to a market based S&T system, nor have they generated a successful partnership between science and industry, one that can serve as a resource to support a dynamic innovative economy. As one recent report noted, "The achievements of Russian S&T...contributed to the perception that, once freed from the rigidities of central planning, it would provide the basis for high technology exports and economic growth."[13] Unfortunately, that has proven not to be the case.

A 1994 OECD evaluation of the Russian S&T sector talked candidly about the need to downsize what the report termed an "oversized, ill-adapted system in rapid deterioration."[14] Downsizing has occurred but not as part of a long term strategy to revive and revitalize the core of a smaller but more economically dynamic and robust sector. Rather downsizing has been mostly by default as opposed to by design. It has been inefficient and unplanned, a policy of survival of the unfit as those with the best skills leave and those with weaker skills remain behind. As a result, Russian science, which in the words of the OECD evaluation, was "one of the greatest creations and most valuable possessions of civilization," is eroding rapidly, to the point where its long term survival is in doubt.[15]

Co-Operation with the Economies in Transition: Paris), 1994 and K. Gonchar, *op. cit.*, p. 42-47. Recent reports suggest that scientists and entrepreneurs in these cities may be developing a more commercial orientation. See for example, Stefan Wagstyl, "Research In Russia: The Campus Town Housing The Country's Scientific Institutes Is Adapting To The Market Economy," Financial Times, May 8, 2001.

13 Russia: A Science and Technology Profile, *ibid.*, p. 31. This sentiment was echoed by a recent government report which declared, "The gap between the large number of patents awarded to Russian citizens and the low level of technology employed in production can be explained by the unfavorable innovation climate and the absence of a single nation-wide innovation system capable of connecting the national scientific potential and the direct results of its activity with the market." "Role of the State in Creating a Favorable Innovation Climate in Russia," Background Report Prepared by the Ministry of Industry Science and Technology for the Helsinki Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia, March 1-2, 2001, Paragraph 88.

14 According to the OECD, "the expansion of S&T institutions tended to be driven not by economic considerations but by the value attached to technological prestige and by the bureaucratic interests of state administrative hierarchies. Once established, R&D organizations grew inexorably, following the pattern of extensive growth typical of the whole economy. There is no doubt that, in relation to the scale of the economy and its real level of development, Russia now has an excessively large S&T sector." See OECD, Science, Technology and Innovation Policies, Federation of Russia, Volume I, Evaluation Report, (Centre for Co-Operation with the Economies in Transition: Paris), 1994, p. 16.

15 During a recent interview, Boris Saltykov, the former Minister of Science, was asked whether Russian science was already clinically dead or merely on life support systems. See, Boris Saltykov, "Is Russian Science a Cherry Orchard," *Nezavissimaya Gazeta,* February 16, 2001, p. 8.

This phenomenon of change without transition is manifested in both the supply of and demand for science in the Russian economy. It can be seen, for example, in (i) the patterns of S&T spending, (ii) the evolving structure of the S&T labor force, and (iii) the evolving structure of R&D institutions (the supply side of the equation) as well as in (iv) the demand for scientific output by Russian enterprises.

(i) S&T Spending. R&D spending from all sources as a share of GDP decreased from 2.03% in 1990 to 0.93% in 1998 before rising slightly to 1.06% in 1999. It is now far below the OECD average of 2.4%. It is important to keep in mind that GDP was falling during most of this period, so in absolute terms the decline was even more significant. For example, in constant 1991 prices, federal government budget appropriations on S&T declined from RUR 25 million in 1991 to RUR 4.56 million in 1999, a decline of nearly 80% in real terms.[16] In view of the fact that only a portion of appropriations resulted in actual expenditures, the published appropriations data may actually underestimate the severity of the decline.

As a result, Russian S&T spending on a per capita basis is far below the levels observed in most OECD countries. According to the Government's economic reform program, "In 1998 domestic spending per capita on R&D in Russia was $61, compared with $794.40 in the United States, $715 in Japan, and $510.60 in Germany. Consequently, by 1999 in terms of spending on science Russia found itself in a group of countries with little scientific potential (Hungary, Greece, Portugal and Poland)."[17] Russia's relative situation is even worse when measured in terms of government spending per scientist. In 1996, for example, total R&D spending per scientist amounted to $189,000 in the US, $148,000 in Japan, $177,000 in France, approximately $150,000 in Germany and the UK, and $5000 at the Russian Academy of Sciences, the pinnacle of the Russian scientific establishment.[18]

At the same time that the quantity of spending has declined, the source and quality of spending has not adapted to the requirements of a market economy. In 1999, for example, the Russian government was still financing 54% of R&D expenditures (compared to an OECD average for government R&D financing of 35%) and Russian industry was financing 35% of total R&D outlays (compared to an OECD average of 62%).[19]

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16 S&T at a Glance, 2000, Center for Science Research and Statistics, Ministry of Industry, Science and Technology, Figure 4.1 and Figure 4.3.

17 For details see, Development Strategy of the Russian Federation Until 2010, Chapter 3.3, "The Innovation-Based Development of the Economy," Moscow, 2000.

18 Quoted in Natalia Zolotykh et. al., Creation Of Legal, Organizational And Economic Conditions For Innovation Activity As A Factor Of Activation Of Effective Modernization Of Branches Of Industry, Report On The "Analysis Of The Status Of The Innovation System Of The Russian Federation" Prepared Under Contract N ERB IC15-CT98-1002, stage N 1, 1999, p. 89.

19 International grants accounted for the remaining portion of Russian R&D funding. All data are from Daniel Malkin, "Science and Technology in Russia: Trends and Policy Challenges," unpublished OECD manuscript, 2001. Malkin asserts that the reported share of business R&D spending in Russia

As recently as 2000, approximately 70% of government financing was defined as institutional funding of R&D institutions; in other words, subsidies frequently provided on a per capital employment basis designed to maintain staff, facilities and equipment. Only 22% of government financing was allocated to support what the government itself defined as its priority objectives and a paltry 8% was distributed on the basis of competitive selection procedures. [20] Not only was this spending inefficient in the sense that most of it was an untargeted subsidy (which the government could ill afford), but it actually hampered restructuring. It gave institute managers an incentive to stay in business and maintain excess employment in the hope of obtaining a larger subsidy. And it diverted government resources from more productive uses within the S&T sector.

(ii) S&T Labor Force. The evolution of the S&T labor force is another clear example of change without substantial reform. As the OECD recommended, the sector has downsized but, contrary to OECD recommendations, in ways that did not leave it smaller, stronger and economically more viable. For example, the number of R&D specialists in Russia declined from 1.9 million in 1990 to 872,000 in 1999, a decline of 54%. Of this total, nearly 75% still work in federally owned institutions and only 5% work for privately-owned enterprises or institutions.[21]

However, despite the decline, the average age of R&D workers has increased dramatically, due primarily to the failure to recruit younger workers. Today fewer than 8 percent of higher school graduates are choosing scientific careers. At the same time, the share of researchers aged 50 and over exceeds 35% and the share of scientists in the most productive age group (30 to 40 years of age) has plummeted. Consequently, the sector is in danger of disappearing, rather than transiting to a smaller, more sustainable basis.

The low pay received by R&D workers is a key factor behind these unfavorable labor force trends. The average pay for researchers in the S&T sector was only $65 per month in 1999, in large part reflecting the sharp decline in government spending for R&D coupled with a failure to find alternative, commercial sources of support. This led one government report to declare, "despite the low level of earnings in science, Russia has

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is a "statistical illusion" and that the real business share is actually much lower and the real government share correspondingly higher.

20 Spending data are from Russian Science and Technology at a Glance, Figure 4.6. In his April 3, 2001 address to the nation, President Putin recognized the need to change the government's approach to science funding, declaring, "today it is necessary to define clearly the priorities of the state financing of scientific activity and at the same time change the mechanism of its financing, in the way - amongst others - that our domestic scientific foundations have doing for several years now. Their approach is to finance on competitive grounds specific research projects rather than research organizations."

21 Russian Science and Technology at a Glance, 2000, Figure 3.7. This data would appear to contradict statistics in Figure 3.6 of the same publication which indicate that just over 60% of R&D personnel are employed in the business enterprise sector. The apparent contradiction is caused by the fact that many research personnel are employed in 100% government-owned, corporatized research institutions.

managed to retain an impressive scientific potential. Driven by inertia, the continuation of many research projects has been motivated by purely scientific interest. This, however, cannot last long. The researchers admitting of this kind of motivation are aging and will soon be compelled to retire. There is actually no one to replace them: younger people cannot be satisfied with the level of income that can be earned in science today."[22]

These unfavorable labor market trends have given rise to fears that Russia is experiencing three simultaneous types of brain drain. The first is an internal brain drain as well trained scientists leave the sector for better paid employment elsewhere in Russia, as taxi drivers, bankers, businessmen, etc. The second is an external brain drain as skilled workers leave Russia for employment abroad as scientific workers.[23] And finally, a technology drain coupled with "techno-nationalism." Simply stated, the perception in Russia is that western programs ostensibly designed to find civilian work for Russian scientists formerly employed in the design and production of "weapons of mass destruction" are thinly disguised attempts by Western firms and governments to get cheap access to Russian inventions and know how and to identify the most promising scientists who will be encouraged to emigrate or stay in Russia and work for foreign firms. Either way, Western firms get Russian technology and know how for a comparative pittance.

At the same time, a spirit of "techno-nationalism" is giving rise to fears that western sponsored venture capital funds (TUSRIF, EBRD Regional Venture Capital funds) shy away from financing domestic high tech projects that may compete with Western firms. As GORs report for the Helsinki conference explained when discussing EBRD-supported Regional Venture Funds (RVFs), "RVF head-managers are very reluctant to consider high tech projects, including for reasons having to do with what can be called "techno-nationalism," i.e., out of fear (often well-grounded) that a high-tech project amply financed by a RVF may be a strong challenge to Western industrial leaders controlling a particular regional market. This kind of fear is all the more relevant since most projects in the "traditional" industries (food industry, etc.) are oriented toward domestic market demand first and foremost, whereas high-tech projects are the most efficient in the event that their products are sold internationally."[24]

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22 "Role of the State in Creating a Favorable Innovation Climate in Russia," Background Report Prepared by the Ministry of Industry Science and Technology for the Helsinki Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia, March 1-2, 2001, Paragraph 87.

23 From another perspective, this external brain drain could also be seen as the creation of a Russian diaspora community. If properly harnessed, this community could become a resource for development, providing capital, fostering partnerships, etc. between high-tech firms in Israel, Silicon Valley and Russia. There is fragmentary anecdotal evidence to suggest that this reverse flow is already taking place. For example, one speaker at the Helsinki seminar was the former director of one of the USSR's scientific research institutes in Kiev. He left Ukraine 10 years ago to take a job with a major multinational firm. In that new capacity he managed to direct some low level research contracts to his former colleagues in Kiev, enough to keep the institute alive, if not exactly thriving. He has since started his own start-up research firm with German financial backing and is now directing a much larger volume of high skilled research contracts to his former institute.

24 "Role of the State in Creating a Favorable Innovation Climate in Russia," op. cit., Paragraph 32. For similar sentiments, also see "State Policy Concept of the Russian Federation in the Area of International Science and Technology Cooperation," Moscow 2000. Section 3.6 of the Concept

(iii) Structure of R&D Institutions. Between 1990 and 1999, the number of R&D institutions declined by 12%, from 4646 in 1990 to 4089 in 1999. However, the number of research institutes (primarily those belonging to the Russian Academy of Sciences and those formerly controlled by branch ministries) increased by 50% during this period while the number of institutions in the higher education and enterprise sector declined by nearly 30%. Consequently, in 1999 research (2603) and design organizations (360) still outnumber higher education (387) and industrial enterprise R&D institutes (289).[25] The main R&D institutions in developed market economies tend to be associated with the higher education and enterprise sector -- the two R&D sectors with the closest links to industry. In Russia, by comparison, the overwhelming portion of R&D is still carried out in those R&D institutions that are farthest removed from the needs and demands of the enterprise sector. As one observer noted, "Two factors – the weak innovation capabilities of Russian industrial enterprises [which will be discussed below] and the relative isolation of the branch research institutes from industrial enterprises – have a negative impact on competitiveness and the design, manufacture and marketing of products in Russia. Indeed, these two factors could therefore be said to be the most significant obstacles to the transformation of the Russian R&D system into the desired Russian system of innovation."[26]

(iv) Demand for S&T. At the onset of the transition process, the expectation was that private enterprises would finance the bulk of the S&T spending, much as they do in market economies elsewhere. As private enterprises increased their demand and funding for innovation by contracting with institutes and conducting their own in-house research, they would establish priorities and set the research agenda. The government would recede into the background and play a less dominant role – certainly in comparison to its role during Soviet times.

This proved to be a premature expectation, at best. Government funding decreased substantially, but private demand for R&D has not picked up the slack. As a result, the government is still the dominant source of funding for R&D, albeit at a much lower absolute level than before. The choice, as one observer noted, "was government funding

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Paper declares, "To ensure the technological safety of the country, it is necessary to set up a system of state accounting and control of technology transfer for civil applications, the development of which involved federal budget funds. The main attention here should be devoted to issues of protection (including legal action) of intellectual property from leaking or being illegally used abroad. To ensure technological security it is necessary to exercise strict state control over foreign support for Russian scientists and organizations which used to work in the area of defense in Russia in their transition to the development and manufacture of science intensive products for civil applications.

25 Data are from L. Gokhberg, N. Kovaleva, and I. Kouznetsova, Innovation Management in Russia: A Review of Training Needs and Opportunities for Growth, The British Council, 2001, p. 6.

26 *Ibid.*, p. 7. The authors go on to state, "A major factor discouraging economic growth through innovation are the barriers that exist between those conducting research and development and those in industry. The institutional and organizational principles of the ex-Soviet R&D system created such barriers, emphasizing research but giving less attention to other aspects of innovation."

or none at all."[27] And with continued government funding came continued government dominance over R&D priorities.

In retrospect, the private sector's failure to increase its demand for R&D and innovation is not surprising, given the overall economic downturn following the onset of the transition process. In the context of the struggle for survival, innovation, like maintenance, became a luxury that could easily be postponed, at least for a while.

In 1998, only 6% of all surveyed Russian enterprises engaged in any form of innovative activity. By comparison, one-third of US companies were reported to be "innovationally active."[28] Of those Russian firms which did innovate, only 18% of their innovation expenditures were related to the development of new products, services, and new production processes. The comparable figure for OECD firms exceeded 33%. In addition, survey data suggests that most innovationally active Russian firms are not trying to enter foreign markets. Their goals are less lofty. They are simply trying to preserve their existing share of the Russian and CIS markets. As a result, innovation spending by Russian firms has a low R&D content (marketing, packaging, etc.) which, in turn, leads to a low demand for science and technology outputs. "Most of Russia's enterprises are too inert....Russian businesses never rush to catch up on sophisticated foreign technology."[29]

Survey data suggests that a larger percentage of SMEs are inclined to be more innovatively active compared with larger firms and that their innovation activities tend to display a much greater R&D intensity. However, there are still too few SMEs to have any noticeable impact on the aggregate demand for S&T. Moreover, the business/innovation infrastructure – tax, capital and financial markets, administrative barriers –inhibits the emergence of a vibrant SME sector. Consequently, SMEs are still not in a position to be the engine of innovation that they are in OECD countries. Large enterprises, on the other hand, tend to have a more stable financial position and diversified source of revenues. They have the financial means to innovate and account for the majority of innovation activity actually currently taking place in the Russian economy. Not surprisingly, more than two-thirds of innovation expenditures are

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27 Leonid Gokhberg, Merton J. Peck and Janos Gacs, op. cit., "Introduction," Chapter 1, p. 4. The Helsinki paper notes, in Para 46 that the aggregate share of business sector R&D financing increased from 15.5% in 1997 to 17.3% in 1998. But the report goes on to caution that "these figures should not be interpreted as a sign of the business community's growing interest in R&D. The share of the business sector's grew only because of the drastic decrease in the share of government spending in the wake of the 1998 crisis."

28 All data on innovation activity are from Leonid Gokhberg and Irina Kuznetsova, Technological Innovation in Russia, Centre for Science Research and Statistics, Moscow 1998 and Sergei Glaziev, Il'dar Karimov, and Irina Kuznetsova, "Innovation Activity of Russian Industrial Enterprises," in Gokhberg, Peck and Gacs, *op. cit.*

29 "Role of the State in Creating a Favorable Innovation Climate in Russia," Background Report Prepared by the Ministry of Industry Science and Technology for the Helsinki Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia, March 1-2, 2001, Paragraph 18.

concentrated in two sectors – chemicals and chemical products and machinery and equipment. At least in Russia today, these sectors are dominated by large firms rather than SMEs.

C. GOR's Response: The Innovation Based Development of the Economy

Reversing the decay of the S&T sector has now become a government priority. As articulated in statements by President Putin[30] and the Government's economic reform program, the government's objective is to ensure that Russia's S&T prowess becomes a resource for economic growth and industrial revitalization so that Russia can transform itself from a "colonial" economy, dominated by raw material exports, to a high tech, science intensive development stage based on the achievements of domestic S&T. As the Government's reform program declares, "The creation of favorable conditions for innovation will make it possible to modernize the technological base of the Russian economy and fundamentally improve the competitiveness of domestic products." [31]

The Government's economic reform program outlines a three stage program to achieve these objectives.[32] The objective of the first stage, lasting from 2000-2002, is to

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30 Vladimir Putin, "Russia At the Turn of the New Millennium," January 4, 2000. In that statement, President Putin observes, "The quick progress of science, technologies, and advanced economy is underway in only a small number of states...The lack of capital investments and insufficient attitude to innovations resulted in a dramatic fall in the production of [Russian] commodities that are world competitive in terms of price-quality ratio. Foreign rivals have pushed Russia especially far back on the market of science-intensive civilian products. Russia accounts for less than 1% of such commodities on the world market, while the USA provides 36% and Japan 30%."

31 Development Strategy of the Russian Federation Until 2010, Chapter 3.3, "The Innovation-Based Development of the Economy," Moscow, 2000. These sentiments are repeated in the 2001 update of the Government program. For example, the draft chapter entitled "Reforming the Science Sector: Areas and Key Measures," declares, "The key objective of the state long-term science and technology and innovation policies is *setting priorities for the development of the science and technology and innovation sectors*, which have an impact on the production efficiency upgrade and improvement of the competitive power of products." Except where explicitly noted, all quotes in the remainder of this section are from The Innovation Based Development.

32 The background paper which the Ministry of Industry, Science and Technology (MIST) prepared for the Helsinki Seminar also outlines a slightly different three stage development program. According to the MIST program, the Russian economy will pass through a resource (colonial) stage and an investment stage before finally reaching the innovation-based stage of development. During the colonial stage, raw material exports are used to generate an economic surplus which is invested in new industrial equipment during the investment stage. Foreign investment is a major source of innovation and technology for Russian industry. During the investment stage, the state will emphasize the establishment of a favorable business climate and business will "learn to organise internal co-operation at their enterprises, establish efficient ties with research centres, consulting firms, consumers and suppliers, promote co-operation with other companies in search of new business and investment opportunities, and upgrade the educational level of their personnel." During the innovation stage, the demand for innovation switches from foreign sources to domestically produced innovation. A related three stage model of Russian economic development can be found in A. Svinarenko, Y. Kuzminov, B. Kuznetsov, et. al., The Main Directions For Structural Policy And Sector Markets Regulation, Higher School of Economics, Moscow 2000 and

"maintain the technological base of those industries with a stable demand on domestic and world markets." During this stage, innovations will be oriented toward the modernization of existing production facilities based on resource conserving technologies. The resources to finance these investments will be derived primarily from retained earnings and depreciation allowances. State financial support should be supplementary and provided on a "repayable basis."

During the second stage (from 2003-2007), Russian enterprises will "employ state-of-the-art" technologies and enter domestic and foreign markets with world class research intensive products," eventually gaining market share in "sectors where domestic producers have not been represented." Progress in this area will require shifting economic priorities and emphasis away from resource extraction and towards investment in value added, high tech manufacturing. "The defining reference point in economic policy should be to increase the percentage of products of the processing industries both on the domestic market and in exports; to build up the percentage of high-technology products; and to move from primarily price-based competition relying on low costs to competition based on improvement of the attractiveness of production to consumers." Financing for this stage will come, "first and foremost from the raw material sector as well as from the sale of military equipment. All the levers of government management need to be brought into play in order to bring the short term benefits to investors that are derived from the sale of raw materials and semi-manufactures into accord with the national objectives of long term, highly profitable and stable growth along the innovation-based track of economic development." In addition, private finance from pension funds, insurance companies and credit unions will also be marshaled, along with foreign loans that will be repaid "through the export of commercial end products."

In the third, innovation based stage of development (2007-2010), the state will support the development of innovation infrastructure. As a result, domestic demand for innovation will increase and relations between research and production will be strengthened. Meanwhile, "the **state's** [emphasis added] attention will turn to new forms of scientifically innovative, engineering activities that utilize the latest information technologies. The state's attention should gradually shift from the quantitative to the qualitative aspects of support." At the same time, the private sector will develop and support efficient specialized scientific and technological enterprises and assume responsibility for training personnel and developing technologies.

In terms of the specific measures to launch Russia on this three stage path, the report highlights various "practical measures" that should be implemented in the sphere of science policy and commercialization policy. In the area of science, the report recommends such policies (listed in the order they are presented in the report) as (i) increasing funding for fundamental research and other high priority state science programs; (ii) increasing the percentage of government funds allocated on a competitive grant basis; (iii) employing "parity and repayable" funding mechanisms to support commercially significant R&D projects; (iv) inventorying the existing [stock of state-

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also in Y.Kuzminov and A.Yakovlev, Economic Modernization: Global Tendencies, Main Constraints And Strategy Options, Higher School of Economics, Moscow, 2000.

funded] research that has potential for further development and "provid[ing] incentives for the mutual exchange of technologies between the defense and civilian sectors" and (v) deepening the integration of science and education.

With respect to technology commercialization, the paper recommends such principal measures as: (i) developing a system of extra-budgetary venture investing and funding for high risk projects. "State support for the venture business is necessary until industry shows interest in it." (ii) developing a system of state and private insurance for innovation risks; (iii) supporting the formation within financial industrial groups of insurance companies that would insure credit risks associated with the commercialization of innovative products; (iv) developing innovation-oriented small business via the creation favorable conditions and infrastructure (technology innovation centers, incubators, techno-parks, etc.); (v) restoring cooperative relationships between educational, research and industrial organizations; (vi) developing a system of extra-budgetary funds to support R&D in the interest of various industries; and (vii) developing and expanding a system for training management personnel.

Last but not least, the report stresses the importance of "drawing intellectual property into economic circulation and providing dependable protection against its unsanctioned use." As the report notes, "Unless they are put into economic use, items of intellectual property, produce no revenue, steadily grow obsolete and very quickly lose any realistic potential for use....In the transition to an innovation-based economy, special importance attaches to questions of the protection and use of *intellectual property* as a special type of intangible product. The formation of a regulatory space for intellectual property should be completed in the country and the specific responsibility of government agencies for it should be defined in the near future."

Indeed, as a sign of the importance of intellectual property issues in the mind of GOR officials, three of the four Priority Measures enumerated in the Innovative Economy section of the Government's Social Policy and Economic Modernization Action Plan for 2000-2001[33] involve intellectual property. These include proposals to (i) develop key policies for involving in the economic turnover the results of research and development created with the budgetary financing; and to define measures for their implementation;[34]

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33 As approved by Government Directive No. 1072-p, dated July 26, 2000.

34 Simply stated, this refers to the process of commercializing inventions that were financed, in whole or in part, with funds from the USSR, RFSR, or Russian Federation budgets. For all practical purposes, this includes almost 100% of the existing stock of inventions and a large, but smaller, percentage of the current flow. As one report noted recently, "Taking into account that the overwhelming majority of scientific-research, experimental-design and technological works is performed in Russia at the expense of federal budget resources, the lack of clarity on the subject of ownership, use and disposal of the results obtained in the course of these works is one of the most serious factors, restraining innovation activity." Cited in Creation of Legal, Organizational and Economic Conditions for Innovation Activity as a Factor of Activation of Effective Modernization of Branches of Industry: Analysis Of The Status Of The Innovation System Of The Russian Federation, Report prepared under Contract N ERB IC15-CT98-1002, stage N 1, May, 1999, by the International Institute of Applied Technology, Transtechnology, ANVAR Innovation Agency, and Moscow State Aviation Technology University, P. 45.

(ii) improve the legal and regulatory framework governing the protection of intellectual property rights and other results of intellectual activity; and (iii) develop a procedure for making an inventory and valuation of the intellectual property objects.

III. Intellectual Property (IP)[35] - Much Ado About Nothing?

Why are IP issues important? Unknown or unclear ownership creates uncertainty which acts as a deterrent to investment. No rational individual would purchase a house without obtaining clear title and no rational investor would invest in agricultural improvements without clear title to the land. The situation with IP is analogous. It is an intangible asset whose rights of ownership and use need to be clarified if commercialization is to occur. [36]

These concerns have provoked an active debate in Russia about the ownership of IP "created at the expense of budget resources." On the one hand, this is a fundamental debate since, as noted above, it is impossible to commercialize something if the ownership is unclear or uncertain. But while clarifying ownership is necessary, it is not sufficient. Clear titling is only a means to an end. The ultimate objective is not clear titling *per se* but rather the creation of an efficient system of industrial innovation and technology commercialization based on the efficient transfer and dissemination of IP "from the lab to the market." This section will outline the major contours of the existing Russian IP legislation and ongoing debate related to budget funded IP.[37] The discussion of IP legislation focuses on three distinct periods and sets of issues:

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35 From a legal perspective, intellectual property covers a number of related but distinct issues, including: (i) Patents; (ii) Industrial Designs; (iii) Utility Models; (iv) Trade Marks and Service Marks; (v) Appellation of Origin of Goods; (vi) Computer Programs and Data Bases; (vii) Topologies and Integrated Micro Circuits; (viii) Achievements in Selection; and (ix) Copyrights and Allied Rights. Except as noted explicitly in the text (for example in An 1 discussing WTO and anit-piracy issues), the phrase IP as used in this paper connotes ownership of inventions and generally refers to the legal protection codified in the Patent Law of the Russian Federation.

36 Pratt and Whitney (P&W) is reportedly interested in various transactions with high tech air craft manufacturing enterprises in Perm. But the transactions have reportedly been delayed, pending resolution of the IP ownership issue. Similarly, it has been reported that Tupelov entered into a joint venture to produce a new generation of airplanes. In return for the use of "its" IP, the state took an ownership stake in the JV. However, the investments required to commercialized Russia's potential stock of IP will be hobbled until the state clarifies when it will demand an ownership stake for use of IP created with budget funds and what precise IP objects are subject to this state ownership provisions.

37 Many other aspects of IP, including piracy, WTO accession, and TRIPs are important features of the Russian IP landscape. However, they are not the dominant focus of the Government economic reform program and, therefore, of this paper. Nevertheless, Annex 1 provides a description of the IP-WTO issues, including the improvements in the IP protection system that will be required to ensure compliance with WTO practices. It is interesting to observe the almost total disconnect between the focus of the debate in Russia (who owns IP created in whole or in part with budget resources) and the IP issues that are uppermost in the minds of foreign multinationals (how can Microsoft, Sony, etc. protect their intellectual property from piracy in Russia).

(i) Pre-1992: The pre-1992 period and the Soviet Union approach to IP ownership. This time frame is important since the vast majority of budget funded IP was created during this period. To a large extent, the debate over the ownership of budget-funded IP in the post-soviet period is an attempt to eliminate or correct the ambiguities created when Soviet era IP legal and organizational concepts were combined with a Western system of private property, privatization and intellectual property.

(ii) 1992-1998: The post-1992 period characterized by the adoption of Russian Federation IP legislation covering the full gamut of topics from patents to copyrights, trademarks, and microchip typologies.

(iii) 1998-Present: The period from 1998 to the present when the ownership of budget funded IP seems to have become a major focus of discussion.

A. Intellectual Property Laws In the Soviet Union

Patents, or IP, as the term is commonly used in Western legal systems, is the right to prevent someone from using an invention without the permission of the inventor or patent holder, usually expressed in the form of a license granted in exchange for royalties.[38] It does not grant the patent holder or licensee the right to use the invention. For example, someone holding a patent on a chemical compound can prevent someone else from selling or using that compound. But the patent holder or licensee cannot necessarily use the compound, say for pharmaceutical purposes, until the appropriate national regulatory authorities authorize the sale and use of that compound.

In the Soviet Union, by comparison, inventions were state property and, in theory, freely available for anyone to use without special permission, licenses or royalty payments, provided that such usage was deemed to be in the interest of the state.[39] Under the Soviet system, an inventor received public recognition in the form of an Authors' Certificate (AC or *avtorskoe svidetel'stvo*). In addition to ego gratification and patriotic recognition, the inventor might expect to receive a small one time monetary bonus and, perhaps, some special privileges – a bigger apartment, a longer vacation, employment, promotion, etc. Under no circumstances, however, did the AC grant the inventor the exclusive right to the

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[38] This report does not purport to provide a description of basic intellectual property concepts and legal practices. For a layman's guide to these issues, see Jeffrey I. Auerbach, "Patent Law Basics," November 1994, available at the web site of the Association of University Technology Managers http://www.autm.net

[39] This discussion draws heavily on Andrei A. Baev, "Protection of Intellectual Property Rights in Russia, in David Bernstein (ed.), Cooperative Business Ventures between US Companies and Russian Defense Enterprises, Center for International Security and Arms Control, Stanford University, 1997. Baev notes, for example, "The Soviet ideology that a discovery or creation was made for the good of the whole people and thus owned by all of the people placed the overwhelming bulk of intellectual products into the 'public domain.'" Another excellent summary of the IP regime during the Soviet Period is available in Glenn Schweitzer, From Swords Into Market Shares: Technology, Economics and Security in the New Russia, John Henry Press, 2000, Chapter 5.

invention, including the right to charge others for the privilege of using the invention and also provided the legal basis on which to file for patent protection.

Civilian inventions covered by AC's were thus placed in the public domain. Soviet enterprises had the right to use these inventions at their discretion, without special permission or licenses. In addition, the State, rather than the inventor, had the exclusive right to control the use of these inventions outside the USSR by entering into license agreements or applying for foreign patent protection. One result of this system is that individual scientists rarely concerned themselves with IP issues – filing patents, issuing licenses, generating royalties, or even seeing to it that a particular invention was used. Everything belonged to the state, which handled these tasks as part of the overall planning function. In addition, a research institute's recognition and flow of annual budget resources was not related to the use of its inventions – i.e., how many were utilized/commercialized – but rather, by how many inventions were created and registered via ACs.

Patents, however, were theoretically available under limited circumstances in the Soviet Union. As in other countries, Soviet patents granted the patent holder the exclusive right to license the use of the invention and to collect royalties. However, three factors discouraged the use of patents by ordinary Soviet scientists and inventors.[40] First, unlike AC's which were virtually free, Soviet patents were costly to apply for and maintain. Second, by opting to apply for a patent instead of an AC, an inventor could not be certain that the patent would be granted. But the inventor was almost certainly forgoing the valuable social benefits accruing to holders of AC's and, possibly, exposing himself to retaliatory measures for preferring personal enrichment at the expense of the "good of the whole people." And finally, Soviet law stipulated that the State owned all inventions created (i) in the course of an inventor's employment at a state enterprise or research institute, (ii) via the use of property belonging to the state, or (iii) with budget resources appropriated by the State.[41] In these cases, which constitute the vast majority of inventions created during the Soviet period, inventors were eligible only for AC's.

Melding the Soviet Union's AC system with a modern patent system has proven to be more difficult than expected. As the next section will show, RF IP legislation, adopted in 1992 and 1993, is modern and up-to-date, covering most of the major IP issues and complying with most international norms, treaties, and international conventions. The difficulty, therefore, is not related to legal drafting per se. Rather, it relates to sorting out IP ownership issues in the midst of a rapid transition in ownership which raises a number of complex questions that have yet to be resolved.

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[40] According to Baev, p. 270, most Soviet patents, as opposed to ACs, were issued to foreigners seeking to protect products licensed or sold to Soviet entities.

[41] The concept that the intellectual property rights to inventions created in the course of employment belong to the employer rather than the employee is fairly standard in most western legal systems. For an interesting discussion of various US court rulings on this subject, see Stanley H. Lieberson, "Relevant Concepts in Determining Difficult Disputes Over Ownership," Journal of the Association of University Technology Managers, Vol. 10, 1998.

B. Intellectual Property Legislation in the Russian Federation[42]

Following the dissolution of the Soviet Union, the Russian Federation enacted a series of laws defining and protecting various forms of intellectual property, including patents, trade marks, and copyrights, among others.[43] Experts seem to agree that in all important respects Russian IP legislation complies with Trade Related Aspects of Intellectual Property Rights (TRIPS) requirements for entry into WTO. As one observer noted recently, "The soundness of the 1992/1993 legislation is reflected in the likely acceptance of Russia into the WTO. Membership requires that national legislation on intellectual property rights meets an international standard of acceptability."[44]

Pursuant to this legislation, ownership rights to the results of government funded IP were assigned to the institutions where the work was conducted. An important feature of the legislation is that ownership rights could be assigned only to legal entities – research institutes, manufacturing enterprises, and innovative firms, etc. – that made the discoveries. Ownership rights could not be assigned directly to the ministries that had funded those activities or under whose auspices the work had been conducted.

When Russian IP legislation was adopted, this was a distinction without a difference. Russia had not yet embarked on its privatization program. Consequently, the vast majority of research institutes, manufacturing enterprises and innovative firms that received IP rights were all state owned. Thus, irrespective of whether the IP rights were delegated to a ministry or to an enterprise or institute, the state directly or indirectly remained the owner of budget funded IP.

Privatization changed these arrangements. Suddenly, it appeared that the rights to government funded IP would be assigned to newly privatized, entities – a situation that

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[42] Excellent summaries of the entire array of intellectual property legislation in the Russian Federation including patent laws, copyright laws, etc. is available in Improvement Of The Policy And Regulatory Framework For Small And Medium Enterprise Development: Part D, Patents and Intellectual Property Rights Development, A Report by KKP Partners, June 2000. Another excellent, comprehensive summary can be found in Part I of Creation of Legal, Organizational and Economic Conditions for Innovation Activity as a Factor of Activation of Effective Modernization of Branches of Industry: Analysis Of The Status Of The Innovation System Of The Russian Federation, Report prepared under Contract N ERB IC15-CT98-1002, stage N 1, May, 1999, by the International Institute of Applied Technology, Transtechnology, ANVAR Innovation Agency, and Moscow State Aviation Technology University.

[43] In fact, the drive to modernize the intellectual property protection began during the last months of the Soviet Union with the passage of the Civil Code of the Soviet Union, the USSR Law on Inventions, and other related legislation. Many of these laws were in effect for only six months. For details, see Creation of Legal..., p. 7-12. A complete list of the legal acts of the Russian Federation (in Russian and English) in the field of legal protection and commercialization of intellectual property, with abstracts and complete texts can be found in the web site (funded by the British Council and the Russian Foundation for Assistance to Small Innovative Enterprises) http://www.ipr.inage.ru

[44] Quoted in Schweitzer, op. cit., P. 118. See 1, below, for a more detailed discussion of the compliance of Russian IP legislation with TRIPS requirements as well as for a discussion of anti-piracy issues in Russia.

was never contemplated when the IP laws were passed.[45] This led one observer to declare, "The consequence has been the spontaneous redistribution of rights to such results, the ineffective use of research results, the development of many undefined and contentious relationships and the violation of the legal rights of patent and copyright owners. These developments highlight the need to examine the entire set of issues associated with the creation, legal protection, and introduction into the economy of the results of scientific-technical activity and to formulate the basic position of the government on the questions of intellectual property arising in the scientific-technical sphere."[46]

C. The Status of Budget-Funded IP

There is a widely shared view in Russia that the existing stock of government financed IP is rapidly becoming obsolete before much of it can be commercialized. Rather than let this potentially valuable resource go to waste, the Government hopes to find ways to "introduce the results of IP into the economic turnover." While there is a strong consensus about the importance of commercializing this IP, there is less agreement about either how to do it or who should do it. Simultaneously, there is a squabble over dividing the spoils of commercialization. Even before anything has been commercialized, various groups within the government and research establishment are debating who should own the IP, who should get royalties and license fees from successful commercialization efforts, and how to levy property taxes on any IP that is assigned to private enterprises.

While these are all important questions, the attention devoted to these issues is diverting attention from a more important and meaningful policy debate: specifically, what government policies will most effectively support commercialization of both the existing stock and new flow of IP. And in addition, how can Russia's existing S&T assets -- both IP, human resources, universities, research institutes, and enterprises -- support the restructuring and revival of Russia's economy.

The current debate is framed around the question of who should own IP that was financed with budget resources. Although the discussion does not always distinguish between the two, this includes the existing stock of budget financed IP as well as the new flow of budget financed IP. To recapitulate, prior to 1992/1993, all IP belonged to the state. Russia's patent laws and related IP legislation were designed before the full scale revolution in property rights had occurred. Therefore, when the legislation assigned ownership of a particular piece of IP to the institution that had created it, by implication,

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[45] Russian IP legislation was modeled after US and European legislation. Thus, the legal framework implicitly assumed the existence of a functioning market economy with well-defined, stable property relations. Neither the IP laws of Europe, the US, or Russia were designed to accommodate such a sudden, large scale shift in property relations.

[46] Yuri O. Lebedev, "Problems of Taxation and Technology Commercialization in Russia," Technology Commercialization: Russian Challenges, American Lessons (Washington, D.C.: National Academy Press, 1998), p. 51. For a similar analysis, see Vladimir Meshcheryakov, "Development of Legal Relations for Technology Commercialization in Russia" in the same volume.

ownership at least of the existing stock of government financed IP was assigned to the state or one of its agencies. Following the privatization, process, however, that was no longer the case. This revolution in property relations created a legislative void in IP ownership and raised a new question: In a world characterized by private enterprise, who should own the existing stock of budget financed IP that had been created in state-owned institutions with the use of budget funds?

This ongoing discussion is complicated by several additional factors. The first is the widely shared view that Russia's natural resources were privatized too cheaply. GOR is determined not to repeat that mistake with IP. This time it wants to make sure that the government is fairly compensated for its assets. The second is the perception that a sizeable portion of the existing stock of budget-financed IP is leaking out of the country. The most valuable portions are now being commercialized by foreign companies that hire Russian scientists in order to gain access to their "know how" or that purchase Russian high tech products from Russian enterprises which do not have clear title to the IP embedded in these products. In either event, neither GOR nor anyone else in Russia is receiving license fees or royalties for the use of this IP. Even worse, as long as the IP ownership issue remains murky, it is not clear who should be entitled to claim title to the royalties or defend the IP ownership rights against this form of "piracy."[47] The third is the tendency on the part of some participants in the discussion to view the existing stock of budget funded IP as a valuable antique that has been lost and forgotten in a musty attic. If it is "rediscovered" and put on sale, it can be a source of considerable revenue. All that is needed, in this view, is to take an inventory of the existing IP, assign ownership, and collect royalties for its use. In the case of military and dual use technologies, where Soviet technology and know-how is embedded in military or civilian products (e.g., rockets) that have a ready market, this perspective has a modicum of truth. But in the case of civilian inventions, or technologies that have not yet been embodied in commercialized products, this approach is less realistic. Nevertheless, the prospect of generating easy revenues has complicated the IP ownership discussion. Rather than focusing on what ownership system is most conducive to commercialization of innovations, the formation of new science-intensive enterprises, and the modernization of existing "old economy" enterprises so that they can become competitive in a global knowledge based economy, the debate has been muddied by questions of how to share the "pot of gold." This in turn has given rise to a series of conflicting decrees, State Concept Papers, proposed amendments to the Patent Law and proposed amendments to the IP sections of the Civil Code. As a result, the question of who should own government funded IP has still not been resolved.[48]

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[47] If these Russian inventions were not patented abroad, then the use of the invention abroad is perfectly legal according to international patent law and conventions. Therefore, some Russian policy makers have suggested that the Government should tax exports that contain a significant proportion of non-patented, budget-funded IP.

[48] This confusion is reportedly having a chilling effect on at least some promising technology commercialization programs. "The Russian legislation in the area of IP stipulated by the Law on Patents and other laws to this effect, with its certain merits for private patent owners, fails to take into account the interests of the State which has funded most of the results of scientific and technological activities. This incompleteness of the legislation happened to cause heavy losses in the scientific and technological potential not only for the State...but for private owners of these rights

On the one hand are those interest groups who argue that the government should own all the IP that was created with budget resources. If approved, the proposed draft amendments to the Third Section of the Civil Code would enshrine this view in the fundamental laws of Russia. In the meantime, and as a stop-gap measure, this view is reflected in two current government resolutions -- one passed in 1998 related to ownership of military and dual use technology[49] and the other passed in 1999 related to ownership of IP in general. But both seem to arrive at the same conclusion.

For example, the decree related to military and dual use technology declares that "the rights to such results of research and development and technological projects of military, special, and dual use designation (hereinafter referred to as "results of intellectual activities") as may have been obtained for the account of the RSFSR republican budget, the portion of the USSR state budget that represented the USSR budget, and the federal budget shall belong to the Russian Federation. (emphasis added).[50] The second resolution declares, "the rights to such results of scientific and technological activities as may have

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too. Foreign investors, mindful of the rigorous legislation of their countries refused to invest in the science intensive real sector because they had no confirmation that all issues concerning property rights had been settled." Yuri Yudintsev, "Intellectual Policy Calls for a State Policy," Intellectual Property, July 2000. A similar sentiment was expressed by Andrei Svinarenko, currently First Deputy Minister of Industry, Science and Technology. "The situation is aggravated by disorder in intellectual property rights law, particularly uncertainty about the ownership of industrial technology and scientific-technical knowledge from the Soviet period...During the Soviet era, all technology created in the defense sector belonged to the government, *de facto* but this ownership was never legally defined. The reorganization of government agencies in recent years, along with the increased independence of enterprises, has resulted in further indefiniteness. Foreign parterns are often completely puzzled: with whom should the conduct negotiations, when owners of a number of different organizations present themselves as the owners of existing "know how." Andrei G. Svinarenko, "Economic Policy and High Technology in Russia," presented in Russian Science and Industrial Policy: Moscow and the Regions, Conference Report, March 24-25, 1997.

[49] This debate has been complicated by rent seeking behavior. By contrast with civilian technology, a larger share of military/dual use technology has already been commercialized and is currently being exported in the form of weapons. Hence, some influential groups believe that ownership of this technology can generate "a pot of gold" for those ministries which funded the creation of this technology. This has led others to suggest that a similar pot of gold may also exist for civilian technology. Thus, the debate is not merely a question of what ownership structure will maximize commercialization but what ownership structure will maximize rents and what organization or individual should collect these rents. For a more detailed discussion of this rent seeking issue, V. Babkin, "Specifics of the State Policy of Introducing Into Economic Turnover Results of Research and Development Activities," Presentation at the Parliamentary Hearings on State Protection of Intellectual Property in the Russian Federation, May 23, 2000. Reprinted in Intellectual Property, July 2000.

[50] The military and dual use proposals are codified in a Presidential Decree and subsequent GOR implementing resolution. For the complete text see, Decree of the President of the Russian Federation # 556, On the Legal Protection of the Results of Military, Special and Dual-Purpose Research and Development, Engineering and Technological Works, May 14, 1998. Also see Resolution of the Government # 1132, On Priority Measures of Legal Protection of the State in the Process of Economic and Civil-Law Turnover of Results of Research-and-Development and Technological Projects of Military, Special and Dual-Purpose Designation, September 29, 1998.

been previously obtained for the account of the RSFSR republican budget, that portion of the USSR budget that represented the USSR budget, and the federal budget shall belong to the Russian Federation. (emphasis added). [51]

The alternative view suggests that the government should own only a portion of the IP created with budget funds. This view is not enshrined in any official laws or decrees. However, a draft State Policy Concept Paper (still awaiting approval via Government Resolution) observes[52], "Since the State at present does not have sufficient resources for commercializing all budget-funded IP, direct assignment of rights for budget funded IP to the State will not resolve the issue of IP commercialization." Therefore, the Concept Paper asserts, "The State, represented by federal executive bodies...shall secure for itself exclusive rights for only those scientific and technical activity results that are related to defense and national security, as well as the rights for those scientific and technical activity results in relation to which the State intends to promote development to industrial utilization and sales of finished products. In all other instances, the rights for scientific and technical activity results shall be transferred to corporate developers who would be responsible for effective commercialization of the above IP." [53]

The 1998 Concept Paper identifies critical technologies that merit various forms of government assistance. It goes on to identify the various ways that the government can help to commercialize these critical technologies – innovation insurance, state venture capital funds, tax policy, etc. But it does not explain who will actually own this IP. More importantly, neither the Concept Papers or the Decrees explain how the Government will manage the IP that it owns? How will it "introduce it into the economic turnover?" How will it ensure that this IP will be used to modernize the technological base of the Russian economy and fundamentally improve the competitiveness of domestic products."

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51 See Decree of the President of the Russian Federation #863, On the Public Policy of Introducing into the Economic Turnover Results of Scientific and Technological Activities and Intellectual Property in the Sphere of Science and Technology, July 22, 1998. Also see, Resolution of the Government of the Russian Federation #982, On the Implementation of Results of Scientific and Technological Activities, September 2, 1999.

52 The draft resolution is entitled, "On Priority Measures for Putting Scientific and Technical Activity Results Obtained at the Expense of Budgetary Funds into Use in the Economy." The companion State Concept Paper has the same title. Both documents were considered at a January 2001 meeting of the Government and are still awaiting final approval.

53 The Innovative Economy chapter of the Government's economic reform program echoes the sentiments of this Concept Paper. It states, for example, "It is advisable for the state to retain exclusive rights only to the results of scientific and technological activity related to the interests of defense and national security, as well as rights to the results of scientific and technological activity with respect to which it intends to independently take developments through to their industrial application and the marketing of finished products. In all other cases, rights to the results of scientific and technological activity should be turned over to the organizations that have developed a new technology and that will themselves deal directly with investors." Unfortunately, nowhere is it explained how the government will define defense and national security areas. The latter category could be exceedingly broad. For example, will the state define its intention referring to specific packets of IP, citing AC and patent numbers? Or, will it choose a broad area such as "composite materials and related technologies"? Rather than clarifying matters, the latter approach would inject even more uncertainty into the IP ownership discussion.

IV. Challenges For Russia: Next Steps

Russian policy makers are confronting a unique S&T/enterprise restructuring dilemma. For example, when Israel and Finland initiated their policies to promote science-intensive industrial development, it is doubtful that they faced a similar constellation of issues – (i) a large industrial base that has been shrinking almost continuously for ten years, (ii) a dire need for enterprise restructuring, (iii) the need to tackle vested interests in the process of restructuring a powerful S&T establishment, (iv) a large stock of existing IP that could represent either a potential pot of gold or an attic filled with obsolete technology, (v) malfunctioning or non-functioning financial and capital markets, and (vi) the impact on the R&D environment wielded by government institutions with no explicit responsibility for science policy, including the State Tax Inspection, the Ministry of State Property, and the State Customs Committee. Simply replicating policies adopted by Finland and Israel will likely not solve Russia's problems. But ignoring international lessons of experience is not a wise alternative either.

In designing an agenda for future policy initiatives, it may be helpful to keep the following in mind:

GOR has been extremely active in the field of S&T reform. They have produced myriad Concept Papers, decrees, resolutions, and proposed amendments to laws. In addition, GOR has established venture funds, Science Cities, Innovation Technology Centers, incubators, and a variety of other mechanisms ostensibly designed to stimulate technology commercialization and revitalize the S&T sector. Thus, whatever problems remain in the sector cannot be attributed to a shortage of Government attention, effort, and/or programs.

Government actions fall into two broad categories. First there are strategies without tactics -- broad general policy statements of a hortatory nature. For example, a draft decree approved at a January 18, 2001 Cabinet of Ministers meeting declares that the Ministry Industry, Science and Technology shall "determine procedures for commercializing IP, the rights for which are assigned to the Russian Federation, in accordance with the specifics of such IP." Nowhere is there a clear statement about how this general objective is to be achieved. Second, there are tactics without strategies -- a large number of micro policies which cannot be aggregated to deduce an overall strategy.

A. STRATEGIC DIRECTIONS

Recommendation #1. Define a series of realistic goals and objectives for Russian S&T policy and identify agencies to implement them. This would enable specific strategies and tactics to be measured against a clearly defined yardstick – namely, how well do they accomplish the goals and objectives.

The task of preparing and agreeing these goals and objectives may not be simple or obvious. The choices facing Russian science and technology policy makers are fraught with trade-offs, ambiguities, and contradictions. Determining the optimal series of

objectives in this policy environment will demand analysis and evaluation of complex trade-offs.

For example, one of the most important issues facing Russia policy makers is whether to place priority on policies that foster the production of knowledge by Russian scientists or the consumption of knowledge by Russian enterprises. Put differently, at this stage in its development and competitive position in the global knowledge economy, should Russia emphasize its role as a producer of global knowledge or its need to consume knowledge produced outside Russia? And if Russia is going to be a producer of knowledge, should it focus on internal or external sources of demand? On basic, fundamental research or on more applied, commercially-oriented research?

Russian policy makers have not yet addressed these issues in a satisfactory, comprehensive fashion. For example, most Russian policy makers would argue that at a time when technology is a leading factor of production and the primary source of national wealth and economic growth, Russia should use its vast S&T assets as a resource for domestic economic growth. But what does this mean in practice and how can this be accomplished in reality?

At first glance this objective would appear sensible, logical and self evident. Russia has an abundance (an over abundance according to the 1993 OECD analysis) of trained scientists. So it stands to reason that these human resources should be used to revive the domestic economy. But how will this be accomplished? Despite the economic upturn of the past few years, there is still no or very low internal demand for science. Many Russian enterprises still do not have the financial resources to finance new plant and equipment, not to mention large scale R&D programs. As a result, one could argue that much of the future demand for Russian science will most likely come from outside Russia. This, in turn, would suggest that if Russia hopes to remain a world class producer of knowledge, both its research and commercialization programs should be more deeply integrated into the global economy. Accomplishing this objective will require a greater emphasis on the search for strategic partners who can help to shepherd Russian R&D projects from the laboratory to the market, strategic partnerships with foreign firms who are active in complementary R&D fields, a search for high tech, sophisticated customers who would be likely to purchase the output of Russia's R&D establishment, and foreign direct investment within Russia by both traditional high tech firms (e.g., Intel, Microsoft) and such old economy firms as Boeing, Pratt and Whitney, and General Motors.

A complementary (or perhaps alternative) approach, which would appear to be favored by Russian policy makers, would be to increase the internal demand for Russian science. But this approach, however desirable in theory, is fraught with numerous problems and practical implementation challenges. For example, Government policy may need to need to place a greater relative emphasis on applied research, thereby reducing the emphasis on "prestige" basic research. To date, Russian policy makers have been reluctant to

embrace this reform. Indeed, recent statements by top Russian officials would even seem to suggest that they are placing renewed emphasis on basic research.[54]

Moreover, the success of any program that emphasizes domestic demand for S&T will be critically dependent on the behavior of domestic enterprises. How will they modernize and improve their competitiveness? Will they rely on Russia's homegrown S&T resources or will they chose instead to rely on imported machinery and capital goods with embedded foreign knowledge, science and technology? Anecdotal evidence suggests that most Russian enterprises are reviewing such factors as quality, reliability and technical sophistication and selecting imported equipment rather than Russian-made equipment. That may be a wise choice from a corporate investment perspective. But if so, it may also suggest that, if Russia remains on its current policy course, the task of upgrading domestic enterprises and the task of relying on domestic demand to improve the market orientation of domestic S&T resources may be independent processes. Is this independence sustainable? Is it wise? Is it the best way to proceed? Should these trends be encouraged? Are there market-friendly policies that can create greater linkages between Russia's S&T resources and the domestic enterprise sector?

In drafting their goals and objectives, Russian policy makers need to sort out these priorities and address these questions. To date, however, they seem to be skirting these issues. For example, as noted in Section IIc, above, the chapter of the Government's economic program dealing with the development of an innovative economy begins with the dubious observation that "Russia has the potential to develop in practically every area of scientific and technological progress." In other words, fundamental choices and priorities are not necessary. Russia can do everything. The chapter observes that "the question of whether Russia will be a state with a powerful economy and high-technology industry, whether it will restore a strong science, and whether Russian scientists will regain their positions in the world scientific community is more urgent that it has ever been." True enough. But what policies will the Russian government adopt to meet these challenges? The report describes a ten year, three-phase program purportedly designed to convert Russia from a predominantly natural resource exporting economy to a producer of world class, research intensive products that can be sold on both domestic and foreign markets. This process is supposed to culminate in 2007-2010 with the appearance of a vaguely defined "innovation-based stage of development."

The mechanisms for generating this transition are rather ill defined and too general to be of any practical use to policy makers. They consist of such policy recommendations as (i) orient innovations "toward the modernization of existing production facilities ... and toward the improvement of products' attractiveness to consumers," (ii) "establish production facilities that employ state-of-the-art technologies and enter domestic and foreign markets with world-class research-intensive products;" (iii) "concentrate resources in breakthrough areas of scientific and technological development and form new production and technological entities;" and (iv) "attract considerable financial

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[54] "Annual Message of the President of the Russian Federation to the Federal Assembly," April 3, 2001 as quoted in Irina Deshina and Loren Graham, "Russian Basic Science, Changes Since the Collapse of the Soviet Union and the Impact of International Support" Paper presented at the Royal Society, London, October 22, 2001.

resources – first and foremost, from the raw-materials sector, as well as from the sale of military equipment" and establish mechanisms to transfer those funds into the "innovation-based track of economic development."

For the most part, these policies can be described as "logical wishfulness." Over long historical epochs, market economies have evolved from primary production to the production of more science and knowledge intensive products. And in the process of getting from the starting point to the finish line, production facilities have been modernized, state of the art production facilities have been established, and financial resources have been directed toward high tech investments and away from resource extraction. But these developments are the result and consequence of the transition to a modern, knowledge intensive economy; they are not the actual mechanisms used to generate the transition.

Two recent studies highlight some of the complex challenges that Russian policy makers and business executives will have to overcome if Russia is to move from a predominantly raw material exporting economy to a high tech, knowledge intensive economy. The first study examines the "institutions and economic policies supportive of high rates of economic growth in the medium term" and ranks 75 countries on the basis of a Growth Competitiveness Index (GCI).[55] The GCI utilizes three major sets of variables: (i) an economy's capacity both to innovate and absorb technologies generated by other innovative economies, (ii) the quality of its public institutions and (iii) the quality of its macroeconomic environment. According to this methodology, Russia ranks 63rd out of 75 economies, on a par with Venezuela, Bulgaria, and Indonesia and below every transition economy included in the study except Ukraine. Russia's ranking on all three sets of variables is uniformly low.

However, even more interesting than the rankings is the report's discussion of the challenges facing an economy as it moves through three stages of economic development starting with resource extraction, then proceeding to the stage of investment in which economic growth is driven by the process of harnessing global technology to local production and culminating in the emergence of an innovative economy in which growth is driven primarily by the development and sale of new technologies and innovative products on global markets. In the first, place, as the authors point out, each stage has its own unique set of challenges and policy requirements. During the "Factor Driven," resource extraction phase, the main challenge is the establishment of policies that are conducive to the organization of efficient markets for land, labor and capital and the establishment of a business climate that supports capital accumulation. During the "Investment Driven" stage, the main public policy task is the integration of the national economy into the global division of labor. And during the "Innovative Driven" stage, public policy must foster the rapid and repeated development and commercialization of new technologies.

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[55] Michael E. Porter, Jeffrey D. Sachs, et. al., The Global Competitiveness Report 2001-2002, Oxford University Press, 2002, p. 16. For complete details of the rankings, GCI methodology, and components of the GCI, see Chapter 1.1. For supporting studies on National Innovative Capacity, Economic Creativity, and the technology composition of economic trade, see Chapters 2.2-2.4.

The authors also note that "many of the failures in economic development in recent years involve countries getting stuck at critical junctures of economic transition: between Factor Driven and Investment Driven or Between Investment Driven and Innovation Driven stages....The shift from one phase of development to the next often requires new ways of organizing governments, markets and enterprises so it is not altogether surprising therefore that many countries fail at making appropriate transitions or even fail to recognize that such a transition is needed....Ironically, old strategies become new weaknesses."

A second study describing how firms innovate and use knowledge evaluates enterprises on the basis of nine key dimensions of technological capability.[56] These variables encompass such factors as a firm's ability to develop a coherent technology strategy to support the business, acquire and absorb technologies, form and exploit linkages with networks of suppliers and collaborators, plus several other core competencies. Firms are then placed in one of four categories depending on their level of technological capability. At the lowest level are firms that have absolutely no capacity for technological change. At the highest level are firms such as Intel, Boeing, or Microsoft which have the capacity to absorb technologies from around the world, innovate, and produce leading edge high tech products. None of the leading Korean firms are in the top tier. Firms such as Hyundai, LG, and Samsung are only in the third category. They can produce and assemble high tech products using technology imported from abroad, but they cannot innovate or generate their own leading edge technologies.

As both studies imply, making a ten year leap from a resource extraction economy to a global innovator may be overly ambitious. Russia's factor markets are just getting organized, Russia has very few enterprises that can compete with a Samsung or Hyundai in the production of globally competitive mass produced consumer or capital goods, most Russian enterprises do not have the high levels of technological capability required to compete with other globally competitive innovative firms, and the Russia innovation system, if no longer on the verge of collapse, is far from being in robust good health. Remedying these problems will require major policy, institutional and organizational changes that go far beyond the issue of redistributing financial resources from one sector to another – although given the lack of an efficient banking system and domestic capital market, even this limited objective may be beyond reach. Russia's mission statement should take these organizational complexities and difficulties into account. There is nothing wrong with ambitious goals, provided realistic measures are envisioned to achieve those objectives.

Recommendation #2. Audit a large, representative sample of Russian enterprises to assess their technological absorption and development capacity. Based on international lessons of experience, develop specific policies to help Russian enterprises at each stage in the development process to improve their technological capabilities and attain higher levels of sophistication. As the preceding discussion

[56] World Bank, Korea: How Firms Use Knowledge, Part A: Firm Level Innovations in the Korean Economy, 2002.

suggests, Russian enterprises will have to improve their technical capability if the Russian economy is to have any chance of making a successful transition from a Resource Extraction phase of development to an Investment or Innovation Driven stage of development. Researchers have developed a fairly simple audit tool to assess the technical capability of enterprises. Russian policy makers should utilize this audit tool to assess the strengths and weaknesses of a large representative sample of Russian enterprises. Based on the weaknesses revealed by the audit and international lessons of experience, they should develop specific targeted strategies that would help enterprises improve in areas where they are deficient and achieve higher levels of sophistication.

Recommendation #3. Review the factors responsible for Russia's poor performance on the Growth Competitiveness Index and develop policies to correct the critical weaknesses. The GCI is composed of numerous variables. Although Russia's overall score is low, even with the technology related cluster of variables there are pockets of strength (notably areas related to patenting and higher education), areas where GOR is already addressing areas of relative weakness (e.g., use of ICT and the internet which is a major focus of the eRussia and e-Education programs), and areas of serious deficiency (variables related to the ability to absorb technology from abroad and integrate it into domestic production processes, establish strategic alliances, etc.) Similar patterns of strength and weakness are evident in the public institutions and macroeconomic stability portions of the index. GOR should examine the revealed pattern of strengths and weaknesses, see which areas are not being addressed by current reform programs, and take steps to begin addressing these issues.

B. LINKAGES AND INCUBATORS

High tech, science intensive enterprises do not thrive and prosper in an economic vacuum. They thrive and prosper only as part of a much larger regional, national or global value chain. Fostering these critically important linkages requires at least two critical preconditions. The first is a prosperous (local, regional and/or national) large enterprise sector that produces high value added products with inputs from Russian enterprises.[57] The second is a group of enterprise managers who understand the nature and importance of these value chain linkages and who are driven by the desire to move to a higher position on the value chain. Neither prerequisite is present to any significant extent in the Russian economy. As noted above, Russia does not yet possess a truly dynamic core of large enterprises – similar even to those which exist in Korea -- with the capacity to absorb technology and generate strategic linkages with sophisticated suppliers and customers. And most Russian enterprises do not have close linkages to healthy foreign enterprises. Moreover, most Russian enterprise managers do not yet see the need

[57] An interesting question is whether former Financial Industrial Groups (FIGs), now renamed Industrial Business Groups (IBGs), can play this dynamic role in the Russian economy. Two interesting articles with an optimistic assessment of the potential positive role of IBGs can be found in Alexander Dinkin, Integrated Business Groups: A Breakthrough Toward Modernizing The Country, unpublished ms, 2001; and Al Breach, "The FIGs' Return – Emphasis on 'Industrial' This Time," Goldman Sachs Emerging Market Economics Analyst, May 18, 2001.

for establishing these linkages. A truly vibrant enterprise sector will not emerge until these deficiencies are remedied.[58]

Moreover, the workforce of many Russian high tech SMEs currently consists of semi-skilled workers with screw drivers and soldering irons assembling high tech gadgets that were designed and invented by a scientist owner-manager. These so-called screwdriver assembly firms are a high tech version of the industrial revolution. For these scientist-entrepreneurs, merely surviving over the past ten tumultuous years was a victory and an achievement worthy of note. Having won the battle for survival, many of these science-intensive enterprises are content to compete for a share of the CIS or emerging country market. They explain that the quality of their products is 80% of the quality available from western manufacturers but at a price that is 30% or 40% of the western price. All in all, they believe that they are delivering value for money. And indeed they are. But they also know that their firms are not competitive on the global stage. Serving the CIS and emerging markets is an excellent short term, crisis survival strategy. But is this strategy and are these emerging market customers a stepping stone to a higher position on the on the value chain or a dead end? Will these markets slowly disappear as these customers get wealthier and start consuming higher quality goods? Will Russian firms use these sales revenues to invest in additional R&D and to upgrade their production quality so that they can meet the higher quality demands of their existing customers and to attract new customers? Or are they merely surviving by selling their inherited stock of intellectual capital. In other words, is the CIS market niche a stepping stone to more sophisticated markets or a dead end destination? Unfortunately, most Russian high tech enterprises do not yet have the skills, strategic linkages, and business contacts needed to use the CIS market as a stepping stone to higher value added niches.[59]

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[58] The Russian operations of Boeing, Ikea, Pratt and Whitney, and McDonalds would appear to be exemplary in this regard. Boeing reportedly helped several Russian firms meet the international quality standards required to supply material and parts for international airliner production. Similarly, Ikea, Pratt and Whitney and McDonalds have developed local SME supplier networks. Via its Backward Linkages program the IFC is hoping to develop similar supplier networks in conjunction with its investment in Ford's Russia operations. In each case, the local SMEs are trained to meet the exacting quality standards of a dynamic, multinational corporate customer. In effect, these local SMEs have found a niche in the global value chain. Dynamic Russian enterprises with links to the global economy could offer similar benefits to Russian suppliers. Whether these enterprises will emerge and play this role is still an open question.

[59] For example, a recent study of research institutes in Novosibirsk reports that even though the institutes are exporting successfully, they are not on a long term sustainable development path. They are exploiting their inherited intellectual capital, which is another form of brain drain and which does not lead to long term renewal of their physical or intellectual capital stock. This was a reasonable defensive strategy at the beginning of the transition period, but it has become a dead end strategy ten years later. For example, one firm is producing what are now viewed as low tech computer chips. They've survived by moving down the value chain. Another firm is producing a cutting edge, high tech equipment for the Russian market. Unfortunately, most Russian customers cannot afford this particular piece of sophisticated equipment and the local enterprise does not have neither the financial or managerial capacity nor the reputation for quality and service that are required to compete successfully in international markets with western multinational firms.

By comparison, recent studies of Intel's impact on Costa Rica suggests that when Intel located a major manufacturing facility in Costa Rica, it didn't merely produce goods and services in Costa Rica. It also procured local goods and services from firms in Costa Rica and Central America. But Intel is a

The lack of linkages, in turn, is a deterrent to the emergence of a dynamic venture capital industry in Russia. Indeed, Russia is facing a classic chicken and egg dilemma in terms of venture capital. Many venture capitalists argue that Russia has a shortage of "bankable deals." By this they mean enterprises with solid marketing prospects in Europe, North America and Japan and a vision for forming the sort of marketing, technology and long term developmental alliances that an enterprise needs to develop if it is to become the sort of world class technology enterprise that venture capitalists find attractive. At the same time, many Russian high tech enterprises are looking to venture capitalists to provide the strategic direction and vision that will help them find a higher value added niche on the global value chain. Thus, venture capitalists argue that Russia does not have the strategic vision which venture capitalists are seeking in a prospective investment and Russian enterprises argue that they need venture capitalists precisely to provide this absent strategic vision.

Recommendation #4. To break this vicious circle, GOR should support the establishment of commercially oriented technology incubators that will nurture promising high tech enterprises and make them suitable candidates for venture capital financing. Most of the existing incubators in Russia provide custodial care. They are primarily controlled work spaces designed initially to help fledgling firms survive in the midst of a hostile environment – one in which land is difficult to rent, utility connections are difficult to organize, and petty harassment (or worse) from bureaucratic inspectors is an unfortunate but common fact of life. Once a firm enters one of these incubators, it is under no pressure to leave. Many Russian high tech SMEs have remained in these incubators for ten or more years. These custodial incubators may have served a useful purpose during the early phase of the transition process. But today, their custodial function is best served by eliminating the administrative barriers hampering the emergence of new SMEs and the growth of existing SMEs. This sort of incubator, in other words, should be supplanted by the rule of law and clear, transparent and sensible business regulations.[60]

At the same time, Russia should support the development of the type of commercially oriented incubators found for example in Israel, Europe and the US. These incubators can be defined as "A location in which entrepreneurs can receive *pro-active, value-added* support, and access to critical tools, information, education, contacts, resources and capital—*that may otherwise be unaffordable, inaccessible or unknown.* A technology incubator's management team facilitates the interaction between each business and these resources, and coaches each business through a development process such that the

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demanding customer. It insisted on high quality production and on time delivery. Intel helped local SMEs in Costa Rica and Central America upgrade their production facilities so that they could meet Intel's demanding quality standards. Many of these firms are now able to serve Intel as well as other global high tech firms. Their linkage to Intel enabled them to generate additional linkages to other world class firms. This sort of virtuous circle/ upgrading process seems to be missing in Russia.

[60] Comprehensive recommendations for improving the business climate can be found in the Government's economic reform program as well as in Administrative Barriers To Investment Within Subjects Of The Russian Federation, Report of the Foreign Investment Advisory Service, a joint service of the International Finance Corporation and the World Bank, September 2001.

resulting venture provides all participants with an acceptable rate of return on their investment."[61]

More specifically, a well structured incubator provides (i) links to industry, universities and research institutes, (ii) business support services to enhance and develop business, (iii) daily hands-on managerial mentoring (general management, finance, accounting, marketing, production, R&D), (iv) technological advice and assistance with intellectual property protection, (v) financial resources for R&D and initial marketing expenses, (vi) access to potential private investors and strategic partners, and (vii) training and coaching so that entrepreneurs have a better understanding of how to deal with potential foreign investors and strategic partners. By the end of the incubation period, the enterprise should be able to raise additional funds from investors and continue operating the project independently.[62]

These incubators operate under a rigorous selection process. Not all firms that apply for entry are accepted. An entrant typically pays for the incubator's services by giving the incubator operator a predetermined share of equity in the new venture. Finally, incubators operate under a rigorous "up or out" procedure. Firms typically remain in the incubator for no more than two years. At the end of that time period, they are either a commercial success, and therefore no longer eligible to remain in the incubator, or a commercial failure, in which case they are obliged to leave the incubator in order to make room for more promising candidates.

As part of their long term relationship-building processes, these new-style Russian technology incubators could use internships and marketing arrangements to establish links with incubators promoting similar technologies in the US, Europe and Asia. In addition, these Russian incubators could be encouraged to establish linkages with leading venture capital funds in Asia, Europe or the US that specialize in the development of related technologies. These venture capital funds are typically supporting a portfolio of firms that need to solve complex technological problems before they can bring a technology to market. Russian firms can offer to conduct contract research or other high tech services for those firms under the tutelage of US or European venture capitalists. Over time, these lower level commercial research relationships might result in the creation of strategic alliances or second generation joint ventures which could be funded by the venture capitalists. The objective, in other words, would be to ensure that Russian high tech enterprises develop the relationships and linkages with demanding customers that the Russian enterprise needs if it is to move to progressively higher levels on the global value chain.

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[61] Technology Innovation Centers: A Guide to Principles and Best Practices, Report prepared for the US Department of Commerce by Claggett Wolfe Associates, December 1999, p. 1.

[62] Adopted from Timo Hokkannen, unpublished IFC manuscript, November 2001.

C. GOVERNMENT PROGRAMS

Government spending on science, technology and research declined dramatically for most of the past ten years, both in real absolute terms and as a percentage of GDP and total government spending. Nevertheless, government spending still accounts for nearly 50% of total science and technology spending in Russia, a much larger share than in other OECD countries where business spending is the predominant source of R&D spending. Given the relative paucity of business spending and the relatively large share of government spending, it is more important than ever to ensure that scarce budget resources are expended in ways that contribute to the evolution of a modern, knowledge intensive, high tech economy.

Unfortunately, a recent analysis of federal expenditures on R&D noted that a substantial portion of budget expenditures do not contribute to this objective. On the contrary, the report explains, existing Government R&D spending supports prestige basic research over more commercially relevant applied research, subsidizes existing research institutions irrespective of whether their research agenda is congruent with national priorities and objectives, promotes the institutional status quo, fosters the continued separation of research institutes from enterprises, does little to promote private R&D spending, and allocates only a small percentage of total funding on the basis of competitive standards of merit. For example, the report notes:[63]

> "[U]sing the need to maintain the competitive strength of the economy as a reason for government interventions in the R&D sector implies not so much the support of fundamental research but incentives for the applied science and innovations.... [T]he existing budget classification virtually precludes planning and control of expenditures both from R&D regulation purposes and objectives' perspective and from the standpoint of scientific and technological policy priorities as set by the government.... A strongest case for government intervention in the civil science and R&D sector from the standpoint of the economy is to ensure a stronger competitive edge of the national economy within the framework of international division of labor. However, the above objective of state aid provision to science in Russia has not been yet formulated as a government priority or government policy objective. Moreover, to a certain extent it runs counter to the proclaimed priority of the fundamental research support over aid to applied science....Government financing of R&D to a larger extent aims to maintain the existing infrastructure of scientific organizations rather than to obtain scientific results."

Thus, whether intentionally or unintentionally, Government R&D expenditures, would appear to be promoting and preserving the least effective features of the Soviet S&T system. The following recommendations are designed to increase the likelihood that

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[63] Fiscal Policy Center, ANALYSIS OF FEDERAL EXPENDITURES ON R&D, MOSCOW-2001, prepared under U.S. Agency for International Development Contract OUT-PER-I-00-99-00003-00, p7, 16, 45, 48 of the English translation.

Government R&D spending supports the emergence of a new, more productive market oriented S&T system that will help Russia emerge as a leading player in the global knowledge economy:

Recommendation #5. Establish a clear set of priorities for Government R&D spending. As the preceding quote suggests, Government R&D spending is an amalgam of programs without clear priorities and objectives. Thus, before any meaningful reform can be implemented, representatives from the Government, Duma, Presidential Administration, scientific research community, universities, small high tech enterprises and large industrial enterprises should discuss and agree a mission statement for Government R&D spending. The mission statement should identify **limited, mutually consistent, and specific** goals and priorities for Government R&D spending. For example, is the goal to preserve existing scientific research institutions irrespective of the quality of their research? To support basic research and prestige science? To develop a limited number of "centers of excellence" that will focus on critical research priorities? To foster Russia's emergence as a leading player in the global knowledge economy? To support the emergence of new high tech/science intensive SMEs? To help the private sector commercialize innovations funded with budget resources? To strengthen national defense? To help existing old economy enterprises restructure, modernize their plant and equipment and, in light of Russia's approaching membership in the WTO, become more globally competitive? Something else?

Recommendation #6. Align Government spending to the agreed goals and priorities. Once new goals and priorities have been established, it is likely that existing R&D expenditure patterns will have little or no correlation with the new goals and priorities. Therefore, GOR and the Duma should examine R&D spending on a line item by line item basis to see what goal or objective, if any, each item serves. Items that do not promote the new goals and objectives should be phased out rapidly or canceled outright. New items should be funded only if they serve a priority objective.

In addition to reviewing the goals and objectives of Government spending, GOR should also realign the actual spending mechanisms. The following recommendations provide some suggestions for improving the efficiency of spending mechanisms.

Recommendation #7. Establish a clear timetable for increasing the portion of the Federal R&D budget that is allocated on a competitive basis. Develop clear, transparent peer review procedures, utilizing both national and international experts, to evaluate competing proposals. Only 7% of public spending is allocated on a competitive basis, with clear transparent rules of the game, peer review of applications, and a clear, definable link between government goals, priorities and spending. By all accounts, this portion of the budget is well spent and should be expanded. Examples of government programs based on competitive funding allocations include the Fund for Assistance to Small Innovative Enterprises (FASIE), the Foundation for Basic Research, and the Saint Petersburg Fund for Science and Technology Development. The Foundation for Basic Research, for example, establishes basic research priorities corresponding to the government's priority research agenda, has an open tender for proposals to define and implement specific research projects designed to further the priority research agenda, and funds only those projects that have been approved by a

rigorous peer review panel of national and international experts. Institutes within the Academy of Sciences are eligible to compete for funds, alongside other private and public research institutions, universities, and private enterprises. The key point is that funding is allocated on the basis of competitive merit, rather than to selected institutions on an entitlement basis (e.g., where funds are allocated to every research institution that meets certain eligibility criteria such as membership in the Russian Academy of Sciences, irrespective of the quality, priority, and utility of their research).

Recommendation #8. To foster the transition from entitlement funding to competitive funding, GOR should conduct a performance review of those Russian funds which operate on a competitive funding basis and compare their operating procedures with those used by analogous funds and research institutions in OECD countries (e.g., the National Institute of Health or National Science Foundation in the US, the Academy of Finland, etc.) On the basis of these lessons of experience, GOR should develop a time bound action plan to convert progressive shares of government spending from an institutional entitlement basis to a competitive funding basis.

Recommendation #9. Develop spending mechanisms that foster linkages between research institutions, educational institutions, and enterprises and catalyze private research spending. Current Government R&D spending programs tend to reinforce the old Soviet practice of separating research institutions and enterprises. Moreover, these spending programs do little to catalyze or leverage private sector resources. All too often, government funded civil research priorities are established and government funded civil research is conducted with little regard for whether there is any need or effective demand for the eventual research results. This excessive concern with the supply of innovation and basic research should be balanced with more regard for demand.[64]

Recommendation #9A. One option for solving this problem would be to establish a tripartite Government-industry-research advisory council to recommend a limited number of basic research priorities for government funded research. The actual research would be financed on the basis of the competitive funding recommendation outlined above.

Recommendation #9B. A second, complementary approach, focused more on applied research, would be to develop matching grant R&D programs. Under the terms of these programs, research or educational institutions would receive government support for research projects provided that they are able to attract co-

[64] This problem is not unique to Russia. A recent World Bank report on the Korean innovation system observed, "Firms also feel, rightly or wrongly, that Korean universities and government-funded research institutes are not "in tune" with their short, medium, or long term needs. In particular, in government policies for more "basic research" in the public sector, industry felt that this mis-specified or over-generalized real needs....Equally, policies to encourage more basic research within industry were also criticized for being out of touch. Firms felt that the real needs were for nearer-term, more focused and applied research which supported their strategy of moving towards new product development." Korea: How Firms Use Knowledge, Part A: Firm-Level Innovation in the Korean Economy, Unpublished World Bank Manuscript, 2002, Para. 4.8 - 4.9.

financing from private enterprises. This would have several beneficial effects. First, it would leverage federal and enterprise R&D resources. Second, it would foster greater communication and interaction between the research community and the enterprise community. Third, it would help to stimulate private sector R&D spending, which in Russia is far below the OECD average. Fourth, on the margin it would encourage large Russian enterprises to purchase more R&D from domestic R&D enterprises and institutes. And finally, by ensuring that federally funded R&D is channeled in directions that are of greatest interest to Russian industry, it would help to ensure that Russia's R&D resources help to modernize and improve the competitiveness of Russia industry.

Recommendation #10. Develop concrete mechanisms to foster the commercialization of government funded R&D. At least three separate policy initiatives could be undertaken to achieve this objective.

Recommendation 10A. Bridge the Innovation Gap. Government support in Russia (and other countries as well) for basic research stops before commercialization is feasible. As noted in a recent OECD report on Russia's innovation system, "The Government's role in market economies should remain simple, namely: aim to diminish the innovation risk for the concerned parties. Governments must use market forces to stimulate innovations. In doing so, they reduce the probability of technical and commercial failure in the innovation process and increase the rewards for all involved, typically academia and industry. Academics and businessmen have different interests in the process. Academic scientists generally have no resources, no stimuli to continue research beyond the point at which it is reasonable to expect publication in a scientific journal. Industry finds this point in the research process still fraught with risks, for the knowledge available at this moment is still very remote from being able to be assessed in market terms, i.e., to be able to calculate any rate of return on the probable investments. Bridging this gap, the so-called 'innovation barrier,' should be a primary objective of Government R&D spending."[65]

There are a number of ways to accomplish this objective. For example, the Small Business Innovation Research (SBIR) program sponsored by the US Small Business Administration (SBA) is one interesting approach to bridging the innovation barrier. (Brief descriptions of how the French and Finnish governments help bridge the innovation barrier are available in Annex 3 and Annex 4 respectively.) SBIR, which was established by the US Congress in 1984.[66] has several major objectives. First, it provides high tech entrepreneurs

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[65] Baruch Raz, "National Frameworks for Encouraging Cooperation Between Science and Industry: The Case of Israel," Paper presented at the at the Helsinki Seminar on "Innovation Policy And The Valorisation Of Science And Technology In Russia," March 1 –2, 2001 available at the web site address http://www.oecd.org/dsti/sti/

[66] For details of the SBIR program and results of recent evaluations see R.T. Tibbetts, "The Importance of Small High-Technology Firms to Economic Growth – and How to Nurture Them," Proceedings of the Conference on Technology Transfer and Innovation, Commonwealth Institute, London, July 2000.

with the start up capital they need to explore the commercial feasibility of high risk research ideas. Venture capitalists traditionally have little interest in providing this early stage financing. Second, it fosters the commercialization of government funded R&D. Third, it establishes productive, commercial linkages between high tech SMEs and Government-funded research priorities. And finally, "graduates" of the SBIR program are an excellent source of deal flow for venture capitalists.[67]

Pursuant to the SBIR program, the Department of Defense, National Institutes of Health, NASA, Department of Energy, National Science Foundation, Department of Transportation, Department of Commerce, Department of Education and Environmental Protection Agency provide detailed descriptions of all the non-classified research taking place in that department or agency. Each agency also publishes comprehensive instructions for newly established or existing SMEs to submit proposals to explore the commercial potential of government funded research taking place in participating departments or agencies. Each agency sets aside 1.25% of its research budget to finance these commercial feasibility studies. Each agency reviews its proposals on the basis of their technical merit and potential commercial application.

Proposals that pass the review process receive Phase I funding of up to $100,000 to cover 100% of eligible costs for six months. In effect, Phase I funding can serve as the seed capital for a newly established SME, if the SME has access to equipment and facilities to conduct the required research. The objective of Phase I funding is to determine the scientific and technical merit of a proposed research idea. Phase II funding provides an additional $750,000 of seed capital to cover 100% of eligible R&D expenses for an additional two years. The objective of Phase II funding is to demonstrate the commercial feasibility of a research idea. Only 40% of the proposals that receive Phase I funding are selected for Phase II funding. By the end of Phase II, a proposal is expected to have demonstrated sufficient technical and commercial feasibility to attract private funds to finance the remaining steps to successful commercialization. The private enterprise receiving Phase I and Phase II funding has full commercial rights to all the profits, IP, and research data.

Recommendation #10B. Transfer ownership of government-funded IP to the research institute or university where it was created . As the discussion in

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Also see, David Audretsch, "The Dynamic Role of Small Firms, Evidence from the US," World Bank Institute Working Paper, 2001. Applications and official SBIR program details are available on the US Small Business Administration's web site at www.sba.gov. The SBIR program was renewed by Congress in 1996 with no dissenting votes. Among the firms that received early stage financing from SBIR are Apple Computer, Chiron, Intel and Compaq. A description and summary of several evaluations of the SBIR program is available in Wendy Schacht, "Small Business Innovation Research Program," Congressional Research Service Report for Congress, December 28, 2000.

[67] Russia is hoping to attract additional venture capital flows, but venture capitalists generally complain that there is not sufficient deal flow to make Russia a profitable, worthwhile market. A program such as SBIR could contribute to the solution of this particular problem.

Section III indicated, ownership of IP funded in whole or in part with budget resources remains unclear. This murky ownership status hampers commercialization, deters foreign investments and leaves Russia's intellectual resources open to unauthorized duplication in the West and elsewhere. Moreover, matching grant programs, SBIR, or other programs designed to bridge the innovation gap and catalyze private research funding cannot succeed as long as the ownership of the IP generated by these collaborative arrangements remains in doubt. Thus, clarifying IP ownership is not only essential to improve the quality of government R&D spending. It is also essential to facilitate more productive linkages between SMEs and larger domestic and foreign enterprises, attract venture capital, commercialize Russia's existing stock and new flow of innovations, and generally facilitate Russia's transition to a more productive position in the global knowledge economy. The OECD experience suggests that transferring ownership of government-funded IP to the research institute or university where the innovation was created is the most effective way to eliminate these ambiguities and uncertainties and generate successful government-industry R&D collaboration and IP commercialization programs.

Four critical factors determine the success of these OECD collaboration and commercialization programs. The first is the replacement of uncertainty with clarity in terms of actual ownership. The second is the establishment of clear commercialization rules of the game – e.g., who is responsible for commercialization? How are the financial returns of technology commercialization divided between the inventor, the organization bearing the financial risk of commercialization, the owner of the IP, and the Government, if it is not the owner? The third is the establishment of effective organizational arrangements to manage and implement the commercialization process, starting with the filing of domestic and international patent applications and ending with the collection and distribution of royalties generated by successfully commercialized innovations. And the fourth and final is the development of clear mechanisms to promote the growth of new, science intensive SMEs and to ensure that innovations are used to improve the global competitiveness of domestic enterprises in general.

None of these factors and mechanisms presently exist in Russia. There is an active discussion of who should own government funded IP, how to value government-funded IP for property tax purposes, and how to prepare a comprehensive inventory of past Government funded IP. For all practical purposes, this is destined to be a dead end exercise with no tangible benefit for the economy unless GOR establishes a comprehensive system, not only of IP ownership, but of IP commercialization.

For example, the US Government operates a large number of government funded defense and civilian research programs, maintains a large number of government owned laboratories and federal research facilities, and is generally recognized to have one of the most successful IP commercialization programs in terms of clarifying ownership, converting inventions into products and industrial processes, and developing new, dynamic SMEs. These programs rest on two

critical pillars. The first is the recognition that the Government was not and could never be an effective owner of IP. Therefore, the US Government transferred ownership of government funded IP to the university or institute where it was created. The second pillar was the development of rules and regulations specifying the university or research institute's rights and responsibilities for commercializing the government-funded IP and the establishment of institutions dedicated to technology commercialization at institutes and universities. Annex 2 describes these arrangements in greater detail.

Recommendation #10C. Establish Technology Transfer Offices at Russian universities and research institutes and train the management cadre that will operate these centers. Transferring ownership of government funded IP to the university or research institute where it was created is a necessary, but not sufficient step toward the creation of an effective technology commercialization system. To bridge the so-called "exploitation gap," – i.e., the gap between the number of inventions that are created and the number that are actually put to commercial use -- many countries found that it was also essential to establish specialized institutions with trained personnel dedicated to licensing this IP to those foreign and domestic enterprises who will invest the time and resources required to develop commercially viable products based on this IP. These specialized institutions -- Technology Transfer Offices (TTO) as they are known in the US and Industrial Liaison Offices (ILO) as they are known in the United Kingdom -- generally perform the following range of functions: apply for domestic and foreign patents, pay the necessary patent application and annual patent maintenance fees, license the patented IP, enforce ownership rights against alleged infringement, collect royalties from license holders, and distribute royalties according to a pre-determined formula between the TTO (to cover administrative expenses), the institute our university where the IP was invented, and the inventor(s).[68] Although TTOs are not designed to be self-supporting profit centers, US experience suggests that they can eventually become self sustaining within approximately 10 years. In most successful Technology Transfer Office, gross royalties and licensing fees generated by the TTO generally amount to between 0.5% and 2% of the institute's or university's annual research budget.[69]

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68 TTOs have the added advantage of being decentralized institutions. Rather than one central government agency attempting to commercialize the entire stock of government funded IP, each university or institute in the US establishes its own TTO dedicated to commercializing the technology generated in that institution. Experience indicates that rather than breeding wasteful duplication, this decentralized approach generates innovation, competition, experimentation and success. Moreover, a well functioning TTO can be a tool to help attract investors to a region and establish partnerships between local and foreign business on the one hand and the university on the other. In this respect, a TTO can be an important ingredient in a comprehensive regional development program.

69 As this data suggests, the real economic value of establishing TTOs and clarifying IP ownership has little connection to the ensuing licensing fees. On average, these fees are rather meager. Rather, the economic value to the government and society is derived from the economic activity generated by the commercialization process itself. This includes the establishment of new high tech SMEs, the

To help establish TTOs as an integral feature of the Russian S&T sector, GOR should provide matching grants to finance (i) a portion of the initial start up costs and first few years of operating costs to support the creation of a decentralized system of TTOs in different regions of Russia. The TTOs should be established at both universities and major research institutes that both appear to have technology with potential commercial applications and are willing to bear part of the cost of establishing and operating TTOs; (ii) a portion of the cost of conducting expert technology audits at the selected institutes and universities. The purpose of these audits would be to ascertain what technologies and innovations, if any, have potential commercial application;[70] (iii) a portion of the cost of applying for and maintaining foreign patents. Not every innovation identified by the audit will be eligible for patent protection or worth the cost of patent protection. Therefore, GOR should establish some sort of transparent, competitive, expert evaluation system for selecting which innovations would be eligible to receive foreign patent protection grants. (iv) training personnel in the legal, financial and technical aspects of establishing and operating a TTO. Training could include such topics as case studies on how TTOs operate in different countries, the mechanics of conducting a technology audit, how to market innovations and search for licensees, different strategies for managing IP, and different strategies for linking the TTO to the institute's overarching research and innovation mission.

Finally, OECD experience suggests that institutions such as TTOs should not be seen as an isolated component of the national innovation system. Instead, to maximize their effectiveness, they should be linked, both institutionally and in terms of policy initiatives to complementary activities to bridge the innovation barrier (Recommendation 10a, above) and establish incubators to help nurture the development of promising high tech SMEs.

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creation of well paying, skilled jobs and the additional tax revenues generated by this additional economic activity. To the extent that participants in the IP ownership discussions in Russia are fighting over imagined royalties, they are bound to be disappointed. To the extent that the fight over royalties detracts from the creation of an effective IP commercialization system, the Russian economy will lose not only royalties, but jobs, new businesses and taxes.

70 The audits recommended here differ substantially from much of the technology audit activities currently underway in Russia. Those audits are designed primarily to identify innovations so that they can be taxed (even before they have been commercialized) or the state to claim ownership. Either way, these audits create a clear incentive for institutes to hide their innovations. By comparison, the audits recommended here would be undertaken as part of a comprehensive commercialization program that would include transfer of ownership to the institutes or universities where the innovation was created, the establishment of a rational tax policy (based on best practice examples gleaned from the OECD) with respect to IP that has not yet been commercialized, and the establishment of a decentralized system of TTOs.

Annex 1
Russia's Intellectual Property Laws and the WTO

By all accounts, existing Russian legislation in the area of patents, trademarks, copyright, etc. is fully compliant with Trade Related Aspects of Intellectual Property Rights (TRIPS) and WTO requirements. The main weakness with Russia's IP laws lies in compliance and enforcement, but not the laws themselves. This Annex provides a brief description of the WTO and TRIPS related aspects of Russia's intellectual property laws and a brief description of the compliance and enforcement weaknesses highlighted by most analysts.

TRIPS and the WTO

Russia expects to become a member of the World Trade Organization. As a WTO member, it will be required, *inter alia*, to bring its national IP legislation in compliance with the provisions of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement).

The TRIPS Agreement was developed during the 1986-94 Uruguay Round of trade negotiations under the WTO umbrella at the initiative of developed countries and became binding on all WTO members in early 1999. While The TRIPS Agreement builds on pre-existing international IPR conventions, it is by far the most sweeping agreement on intellectual property rights to date.

The TRIPS Agreement stipulates that member countries must apply the principles of most-favored nation (MFN) and national treatment of intellectual property protection to all participating members. Under the Agreement, all forms of IPRs are to be protected: copyright and contiguous rights; trademarks; use of geographic names; industrial patterns; patents; microchip topology, and trade secrets.

For each form of IPR, the "Agreement defines the main elements of protection, namely, the subject-matter to be protected, the rights to be conferred, and permissible exception to those rights. For the first time in an international agreement on intellectual property, TRIPS addresses the enforcement of IPRs by establishing basic measures designed to ensure that legal remedies will be available to title holders to defend their rights. The Agreement also makes disputes between WTO members with respect to their TRIPS obligations subject to the WTO's integrated dispute settlement procedures."[71]

In assessing Russia's compliance with the WTO IPR requirements, it is not sufficient to consider only the quality and content of the existing legislation. Equally important is the quality of the enforcement regime. The consensus of most observers inside and outside Russia is that while Russia's laws on the protection of intellectual property are generally

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[71] Carlos A. Primo Braga, Carsten Fink, and Claudia Paz Sepulveda, *Intellectual Property Rights and Economic Development.* World Bank Discussion Paper No. 412, March 2000.

well drafted and meet international standards, the enforcement procedures are weak and in need of upgrading to ensure full compliance with TRIPS obligations.

A. Legal Framework

With respect to Russia's legal framework, the World Intellectual Property Organization (WIPO) has appraised Russia's legal base governing intellectual property and found it to be in general compliance with the TRIPS provisions. Russia's domestic legal protection framework is quite extensive and covered by over 100 legal acts[72]. In addition, Russia is a signatory to a number of earlier International Conventions in the field of intellectual Property Rights[73] which predated the TRIPS Agreement.

Nevertheless, Russia still needs to make some adjustments to bring its national legislation into full compliance with TRIPS. For example[74]:

- Industrial Patterns. The Patent Law on protection of industrial patterns is in general compliance with the TRIPS provisions with the exception of the norms related to the criteria of eligibility of patterns for protection. Article 25 of TRIPS on "Conditions of providing protection" stipulates that protection be given to all independently created new and original patterns. The Russian Patent Law, by comparison, stipulates that, to be eligible for protection, a pattern must not only be new and original, but also industrially applicable through its multiple replication by way of manufacturing of the appropriate articles.

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72 The Constitution of the Russian Federation (Article 44,) the Civil Code (Articles 128, 138, 139 etc.,) the Criminal Code (Articles 146, 181 etc.,) the Law "On Copyright and Contiguous Rights," the Law "On Legal Protection of Computer Software and Databases," the Patent Law, the Law "On Trademarks, Service Marks, and Denomination of Place of Origin of Goods," the Code of Administrative Offences, and a number of the other laws and regulatory acts. A complete list of legal acts in the field of legal protection of IPRs is available at the web site http://www.ipr.inage.ru

73 Eurasian Patent Convention, World Copyright Treaty, World Intellectual Property Organization, Paris Convention for the Protection of Industrial Property, Patent Cooperation Treaty, Berne Convention for the Protection of Literary and Artistic Works, and Geneva Convention for the Protection of Producers of Phonograms Against Unauthorized Duplication of Their Phonograms. For a description of these international conventions and treaties and Russia's obligations therein, see Improvement of the Policy and Regulatory Framework: Small and Medium Enterprise Development, Part D, "Patents and Intellectual Property Right Development," unpublished ms., Moscow, June 2000.

74 A more detailed description of the technical amendments that will be required to bring Russia's IP legislation and enforcement procedures up to TRIPS standards, see Improvements of the Policy and Regulatory Framework, op. cit., and Chapter 1 of Natalia Zolotykh et. al., Creation Of Legal, Organizational And Economic Conditions For Innovation Activity As A Factor Of Activation Of Effective Modernization Of Branches Of Industry, Report On The "Analysis Of The Status Of The Innovation System Of The Russian Federation" Prepared Under Contract N ERB IC15-CT98-1002, stage N 1, 1999.

- Inventions. Provisions of the Russian Patent Law on protection of inventions and patterns are in general compliance with the provisions of the Paris Convention and the TRIPS Agreement with the exception of the TRIPS norms regarding the use of invention without the permission of patent holder ("forced licensing"). Article 31 of TRIPS on "Other uses without the permission of patent holder" significantly restricts the use of protected patent without the holder's permission, and allows usage only under a number of limited specific conditions (forced licensing terms). The current Russian legislation, by comparison, allows the use of protected patent without holder's consent in many more circumstances.

B. Enforcement Practice

However, the real challenge and reform agenda in Russia today with respect to IPRs lie in the improvement of the enforcement practice. The scale of violations and infringement of intellectual property in Russia has been the subject of much concern, notably amongst Western governments and manufacturers in the face of their increased losses in sales, royalties and markets shares.[75] IPRs most frequently subject to piracy in Russia are products of the music business (about 75%), video products (about 85%), computer software (97%), and products of the publishing business (45%). In recent years, Russia has become a major distributor of counterfeit goods, servicing not only its domestic market but increasingly exporting pirated merchandise to Eastern Europe, the FSU, Turkey, Israel, etc. The Russian Anti-Piracy Software Association (RAPSA) even reported one instance in which the coding and design of a new computer game had been stolen from Western manufacturers at an early stage of product development. Pirated copies, with technical improvements introduced by the pirates, were released in Russia before non-pirated copies were available in the West.

Despite the presence of strong, comprehensive IPR legislation, IP protection and enforcement in Russia is cumbersome and often unreliable owing notably to the inexperience and reluctance of the judicial and investigative systems. As one observer noted recently, "Investigators are not ready to investigate infringement of intellectual property rights either psychologically (e.g., a violation of intellectual property rights is not comparable to murder or robbery and, therefore is considered a less serious crime), or procedurally (e.g., there are no agreed methods on how to investigate such cases and collect evidence)." In addition, judges seem to lack expertise in IPR issues which has often resulted in what Western observers consider to be miscarriages of justice and arbitrary dismissals of complaints regarding violation of IPRs by Russian courts[76].

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[75] For example, the US Government reported recently that "Russia's record on the actual protection of intellectual property has been inadequate at best in the past decade, and the country is on the [US Government's] 301 watch list for IPR infringements." For details see, Svetlana Kuzmichenko, Protection Of Intellectual Property Rights (IPR) In Russia And In Russia's Primorsky Krai, BISNIS, US Department of Commerce, May 2001.

[76] For example, in 1997, the Russian Commercial Courts accepted over 340,000 lawsuits of which only 121 were connected with the protection of intellectual property rights. A survey of Commercial courts in nine jurisdictions found 172 IPR cases in 1998. Of those filed by foreign plaintiffs,

In view of the poor enforcement record of the Russian system, private manufacturers and distributors have sought to organize themselves and create several associations to assist them in the protection of their intellectual property rights through daily work with and technical assistance to local police, courts, customs, and other governmental authorities[77]. Among other activities, these organizations are pushing for reforms to strengthen Russia's legal and enforcement framework against piracy. Two items are high on their agenda. First, they are lobbying for an amendment to Article 146 of the Penal Code. Article 146 currently specifies that criminal sanctions are applicable only if the IPR violation causes "substantial damage." Russian courts, however, have ruled that even millions of dollars of damages may not be substantial when measured against the balance sheet of such firms as Microsoft or Sony. The proposed amendment would allow criminal sanctions to be applied whenever damages exceed some absolute threshold – e.g., $10,000. Second, current law states that a complaint can be filed only if the complainant is physically present in the Russia. However, many firms that have been damaged by piracy are represented by distributors. Because they do not have an official legal presence in Russia, they do not have the legal standing to file a complaint. And the courts and police will not act unless an official complaint is filed. A second proposed amendment would correct this perceived deficiency by allowing complaints to be filed even if the complainant is not a legal resident of Russia.

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approximately half were successful. The Moscow Prosecutor's Office had over 30 criminal cases on infringement of intellectual property rights in 1998, of which only 11 claims reached Russian courts; the rest were rejected, and there were only 3 verdicts of guilty.

[77] For example, there are four anti-piracy associations in Moscow alone: the Russian Anti-Piracy Organization (RAPO) (which coordinates actions involving motion pictures), Business Software Alliance (BSA), International Federation of Phonographic Industry (IFPI), and Russian Anti-Piracy Software Association (RAPSA).

Annex 2
Commercializing IP: The US Experience

Several countries have developed different models ranging from transfer of ownership of all government-funded IP to the private sector (US) to a system in which the state retains some ownership rights and actively promotes commercialization of government funded S&T (UK, France, Germany, Japan). Despite their differences, these systems all work reasonably well. Thus, the real question is not "who owns" government funded IP but rather how government-funded IP can be introduced into the economic turnover. This Annex will describe the US approach, in part because the US model is generally recognized as an example of international best practice and also because this is the approach which many in GOR say that they wish to emulate.

The US approach to ownership and commercialization of government-funded IP is codified in two major pieces of legislation – the Bayh-Dole Act (P.L. 96-517) and the Stevenson-Wydler Act (P.L. 96-418), both approved in 1980. Both laws are designed to encourage the commercialization of R&D that was funded by, or developed by the government. Bayh-Dole pertains to the ownership of patents resulting from government-funded R&D that was performed in non-government facilities – e.g., universities, non-profit research laboratories, etc. Stevenson-Wydler pertains to the ownership of patents resulting from cooperative research efforts between government research laboratories and outside partners where there is no direct federal funding to the outside partner.[78]

Both laws were based on the premise that simply funding more basic research would not solve the US technology commercialization problem. On the contrary, technology commercialization is not a linear process in which more basic research inputs automatically generate complementary applied research, development, commercialization, and diffusion of the results into the economy. The problem with the US in the 1980s was that despite its overall strength in basic research, other countries were commercializing the results. A second related premise was that the US government had not been an effective owner of the IP which it had already created and funded. At the time both laws were passed, the USG owned approximately 28,000 patents. But fewer than 5% of these inventions were licensed for commercial use.[79] The remainder lay idle.

The reasons for this low level of commercialization are complex. First, and perhaps foremost, not every invention is commercially viable. Markets simply do not exist for every interesting invention. Second, studies indicate that research accounts for approximately 25% of the cost of bringing a new product to market. USG agencies have

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[78] For details see Wendy Schacht, "Patent Ownership and Federal Research and Development (R&D): A Discussion of the Bayh-Dole Act and the Stevenson-Wydler Act, (Congressional Research Service: The Library of Congress, December 11, 2000). Note: CRS reports are not generally available to the public although they can occasionally be found on the internet or obtained via Congressional offices. CRS reports cited in this note were obtained directly from the CRS.

[79] U.S. Government Accounting Office (GAO) Report to Congressional Committees entitled "Technology Transfer: Administration of the Bayh-Dole Act by Research Universities, May 7, 1998.

neither the mandate nor the capability to finance the remaining 75% of the costs of commercializing inventions or determining which inventions have commercial potential. Simply stated, the government was not well suited for the venture capital business. Last but not least, prior to the passage of these laws, the Government refused to relinquish title to federally-funded inventions. Instead, it retained title and granted non-exclusive licenses to anyone who wanted to utilize the invention. Since companies could not obtain ownership of the patent or exclusive licenses to exploit government-funded inventions or inventions developed in government laboratories, they were unwilling to go through the expense and effort of developing new products based on these inventions.

Bayh-Dole and Stevenson-Wydler were designed to clarify ownership of government funded IP, but more importantly, to ensure that government funded inventions were put into economic circulation. They explicitly encourage cooperation between research institutes, universities, laboratories conducting fundamental research, and domestic industry to ensure that the fruits of research are not locked in the laboratory but are actively used as an economic resource to promote growth and the competitiveness of US industry. This has proven to be especially useful for defense-oriented research.[80] Rather than keeping the research bottled up in defense products, Bayh-Dole and Stevenson-Wydler protect US national security interests while simultaneously providing incentives for private industry to use these inventions for the widest possible range of civilian applications.

At least in this limited respect, the problem facing the US in 1980 and Russia in 2001 are similar. In both countries, inventions were sitting idle and were not being used as a resource for wealth generation. But at least for the US, the solution to this problem was not just a question of ownership rights. Indeed, prior to the passage of Bayh-Dole and Stevenson Wydler, the ownership status of these US inventions was already clear – these inventions belonged to the US government. Rather, as the discussion below of Bayh-Dole will illustrate, the solution was much more about creating economic incentives and mechanisms to foster the commercialization than about clarifying ownership.

A. Bayh-Dole

Bayh-Dole is based on a simple premise: although budget funds were financing the development of inventions, taxpayers were not benefiting from the economic development (and financial return to the government in the form of increased tax revenues) that would result from the successful manufacture and sale of products produced as a result of these inventions. In passing Bayh-Dole, Congress decided that the public interest would best be served if title to budget-funded inventions were passed to those institutions -- universities, small businesses or non-profit research institutes – where the inventions were created. But there was a caveat. These institutions could retain title only if they diligently promoted commercialization by licensing the

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[80] As one analyst observed recently, "While the major portion of total federal R&D spending has been in the defense arena, government-financed work has led or contributed to new commercial products and processes including, but not limited to, antibiotics, plastics, jet aircraft, computers, electronics, and genetically engineered drugs." Cited in Wendy Schacht, op. cit., p. 7.

innovations for use by commercial enterprises. The institutions would earn licensing fees and royalties (generally ranging between 3% and 6%), thereby giving them a strong incentive to promote commercialization. The enterprises would receive an exclusive license to use the invention, thereby giving them an incentive to use corporate funds to commercialize the invention. The USG would not share in the license fees or royalties (especially since universities are non-taxable institutions and therefore would not pay taxes on the royalties earned and were under no other obligation to share royalties with the government). Nevertheless, the government would profit from the new jobs and increased taxes eventually generated by the increased economic activity spawned by government-funded inventions. As the Bayh-Dole Act declares:

> It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally-supported research and development; ... to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise, to promote the commercialization of public availability of inventions made in the United States by US industry and labor; [and] to ensure that the Government obtains sufficient rights in federally- supported inventions to meet the needs of the Government and to protect the public against nonuse or unreasonable use of inventions.[81]

To achieve these objective, the Bayh-Dole Act along with subsequent amendments and implementing regulations[82] provide for the following:

- The provisions apply to all inventions developed in the course of a federal grant, contract, or cooperative agreement. The provisions apply even if the federal government is not the sole source of funding.

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81 Cited in Appendix B, "Excerpts from the Bayh-Dole Act," in Technology Commercialization, op. cit.

82 An excellent summary of the Bayh-Dole Act is available in "The Bayh-Dole Act: A Guide to the Law and Implementing Regulations," Council on Government Relations, September 1999, (web site: http://www.ucop.edu/ott/bayh/html Also see Mark W. Crowell, "Commercializing University Technology" in Technology Commercialization: Russian Challenges, American Lessons, op cit.; Wendy Schacht, "Patent Ownership and Federal Research and Development (R&D): A Discussion of the Bayh-Dole Act and the Stevenson-Wydler Act," (Congressional Research Service: The Library of Congress, December 11, 2000) and Wendy Schacht, "R&D Partnerships and Intellectual Property: Implications for US Policy," (Congressional Research Service: The Library of Congress, December 6, 2000) (web site http://www.cnie.org/nle/st-19.html . Final rules for implementing the Bayh-Dole Act were published on March 18, 1987 and codified at 37 CFR part 401.1-401.16. According to the Council on Government Relations brochure cited above, "these regulations...specify the rights and obligations of all parties involved and constitute the operating manual for technology transfer on a national basis." This portion of the Code of Federal Regulations can be accessed at the web site http://www.access.gpo.gov/nara/cfr/waisidx_00/37cfr401_00.html

- Each university, small business or nonprofit organization (hereinafter, university) may retain title to inventions made as a result of government-funded R&D.[83]

- The university has an obligation to disclose each new invention to the funding agency within two months of its discovery.

- Within two years after disclosure, the university must decide if it wishes to retain title to the invention.

- If the university determines that it wishes to retain title to the invention, it must file for a US patent within one year. Within ten months of the US filing, the university must indicate if it will file for foreign patents. If it chooses not to, the US government can file for foreign patents in its own name.

- If the university retains title, it must provide the government with a non-revocable license to use the invention.

- Any company holding a license to a patent that involves sales of product in the US must substantially manufacture the product in the US unless it can be shown that this is not economically feasible.

- In marketing inventions to licensees, universities must give preference to small business firms (less than 500 employees) provided that these firms have the resources and capability of commercializing the invention.

- If the invention was not commercialized within a reasonable period of time, the federal government can compel the university to grant a license to a third party or the government can reclaim title and grant licenses itself. (These are the so-called "march-in" rights.)

- Universities must share royalty and license income from the invention with the inventor. It must use the remaining income to cover the cost of maintaining a university technology transfer office and to support scientific research and education.[84]

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[83] Bayh-Dole allows universities, small business, and nonprofit organizations to own inventions developed with budget funding. However, a Presidential Memorandum issued by President Reagan on March 18, 1983 extended the benefit of Bayh-Dole to large for-profit organizations as well as small businesses. That Memorandum is still in effect and is codified in the Code of Federal Regulations cited above.

[84] Excellent descriptions of university technology licensing procedures and the operation of university technology management offices can be found in University Technology Transfer: Questions and Answers, Council on Governmental Relations, November 30, 1993 (available at the web site http://www.cogr.edu/qa.htm . Another excellent source of information is available at the web site of the Association of University Technology Managers http://www.autm.net

Bayh-Dole had a major impact on the commercialization of government-financed inventions. For example, in 1980, approximately 25-30 universities were engaged in technology transfer. Between 1974 and 1984, 84 universities applied for 4105 patents and received 2944 patents. Licensing income reported by 112 universities in 1986 amounted to $30 million. By comparison, in 1999 alone, 190 universities, hospitals and nonprofit research organizations reported[85]:

- Approximately $41 billion of economic activity, supporting 271,000 jobs was attributed to the results of academic licensing;
- Adjusted gross license income was $862 million;
- 5545 US patent applications were filed and 3661 patents were issued;
- 3914 new licenses were issued and 18,617 licenses were outstanding. Almost 2/3 of the new licenses were issued to small businesses;
- The business activity associated with the sale of licensed products is estimated to generate approximately $5 billion of federal, state and regional tax revenue.

B. Stevenson-Wydler

Whereas Bayh-Dole concerns the ownership and commercialization of government-funded inventions created in universities, Stevenson-Wydler addresses the ownership of inventions created in the course of cooperative research ventures between private enterprises and government laboratories. The basic rationale for the legislation was an attempt to create closer linkages between federal laboratories conducting basic research and private industry, on the grounds that this would generate significant benefits for both parties. The basic building block of Stevenson-Wydler is the cooperative research and development agreement (CRADA), which defines the terms and conditions of the cooperative venture between a federal laboratory and private enterprise.

Pursuant to Stevenson-Wydler, the work performed by a federal laboratory under a CRADA must be consistent with the laboratory's basic mission. Both parties to the CRADA may share personnel, services and property. However, the federal government may not provide any direct funding to the private partner. Although Wydler-Stevenson does not mandate any specific disposition of IP created in the course of the CRADA, it permits the federal laboratory to transfer ownership of the resulting IP to the private enterprise. As with Bayh-Dole, the federal government must be given a non-exclusive, irrevocable, paid up license to use the technology throughout the world.

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[85] 1999 data are from The Association of University Technology Managers, Inc., report entitled, AUTM Licensing Survey, FY 1999: A Survey Summary of Technology Licensing (and Related) Performance for U.S. and Canadian Academic and Nonprofit Institutions and Patent Management Firms.

Annex 3
Public Sector Support To Innovation: The Case Of France

With only about half of its R&D investment financed by the private sector, France is below OECD average of 2/3 private financing. The Government of France believed that too many valuable ideas from Government-funded research remained underutilized and thus decided to take action. With that in mind, France developed a variety of support mechanisms for innovative activities. These include *inter alia* the following:

A. ANVAR

ANVAR (Agence Nationale de Valorisation de la Recherche) - a Government Agency – was set up in 1979 to promote and finance innovation in French industry with a particular focus on SMEs. Anvar operates under the auspices of several ministries in charge of industry, research and SME development and has an annual budget of approximately 215 million euros. Since its creation, Anvar developed a number of different products and offers the following services:

- Financial support: Anvar provides financial support to innovative enterprises, research labs and start-ups for innovative projects. Financial support can take one of 2 forms: (i) interest-free loan for up to 5-6 years, repayable if the project is successful, covering up to 50 % of the expenditure related to the innovation or technology transfer project or (ii) in some specific cases grant financing for up to 38 000 euros. Financing can be used for several purposes including to: (i) prepare or complete innovation programs (market survey, design, patents); (ii) facilitate the establishment of innovative companies ; (iii) enhance the technology level of SMEs (by hiring researchers, scientific and technical information, etc..); and (iv) encourage SMEs to become more involved in European technological cooperation projects within Eureka (seeking partners and drawing up formal cooperation agreements) or other similar regional or international initiatives.

  Projects are evaluated by Anvar regional officers and selected on the basis of their technical, economic and financial merits.

- Partnership building, "matchmaking" and information support: ANVAR uses its 24 regional offices and European network to collect and disseminate information. It also seeks to facilitate partnerships and interface between research, SMEs and financial providers through a variety of means including a daily radio program aired on Frances' most famous information channel (France-Info) where SMEs can advertise their projects and financing or technological needs.

It should be noted that the Russian Foundation for Assistance to Small and Innovative Enterprises (FASIE) was organized on a similar model. FASIE and ANVAR have developed close ties and are currently working on a cooperative program designed to foster linkages between Russian and French high-tech SMEs.

According to ANVAR, from 1981 to 1999, the agency provided support to 22,000 companies and laboratories and supported over 34000 technological innovation projects for a total aggregate budget of 3,13 billion euros. An Anvar representative indicated that, on average, 40% to 50% of the credits provided by Anvar are repaid.

B. Public Sector Venture Capital

In the late 1990s, the French Government set up several venture capital funds as instruments of its state innovation policy to stimulate the development of new technologies and the growth of new innovative enterprises in sectors suffering from shortage of private finance. This initiative was modeled after a similar yet broader European initiative[86]. Targeted sectors include life sciences, information technologies, electronics, new materials and environment.

There are mainly 3 public venture funds registered and supervised by the French Stock Exchange Regulator. These funds are so called "funds of funds", i.e., instead of investing directly in companies, they finance and leverage existing funds whose aim is to invest directly in innovative companies. The total aggregate size of these funds is approximately 300 million euros.

- Fonds Public pour le Capital-Risque created in 1998: 91.5 million euros invested from the French State budget.
- Fonds BEI-CDC pour le Capital-Risque also created in 1998: 45.7 million euros invested by the European Investment Bank. These two first funds intervene simultaneously and invest equal amounts in each fund.
- Fonds de Promotion pour le Capital-Risque created in 2000: 150 million euros contributed in equal parts by the European Investment Bank and the Caisse des Dépôts et Consignations.

These funds take equity participation in existing FCPRs (Fonds Communs de Placement à Risque - the French legal entity for venture mutual funds). Eligible mutual Funds must be committed to investing more than half of their portfolio in French innovative companies which are less than 7 years old and 75% of their portfolio in European companies. Maximum stake in one single fund must not exceed 30% of the total capital under management or 12 million euros.

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86 **European Investment Fund (EIF):** One of Europe's objective formulated by the European Union is to foster an innovation-based and knowledge-based society. The European Investment Bank is participating in this effort through the European Investment Fund (EIF). EIF is EIB's venture capital specialized subsidiary focusing on high potential innovative SMEs. EIF operates as a fund of funds and intervenes in the early stages of creation where it seeks to act as a catalyst, i.e., send early signals out of to the investment community. By mid 2001, EIF's investments amounted to 1.2 billion euros spread amongst 116 venture capital funds. EIF also operates EIB's SME loan portfolio guarantees which works with over 70 banks and financial institutions in the European Union. With a capital of 2 billion euros, the overall leverage effect of the guarantee program has been evaluated to amount close to 20 billion euros.

As of end of June 2001, these 3 Funds had invested public funds in 18 FCPRs which had in turn invested in 267 firms. Global capitalization of those firms amounted to about 5 billion euros. The average investment in a company was about 1,2 million euros. Companies operating in the field of life sciences, new materials, industrial processes or communication and information new technologies represent 83% of all invested funds and 78% of the number of financed companies.

Annex 4
Finland's National Innovation System

1. Context

Prior to 1991, half of Finland's exports went to the Soviet Union. The collapse of the USSR combined with the global recession of the 1990s had a major impact on Finland whose unemployment rate soared from a low 3.5% in 1990 to a high 20% in 1993. To address this situation, in 1994 the Finnish Government developed a new economic program which set out to develop Finland as a globalized information society. To achieve this objective, the Government designed an integrated and highly interactive National Innovation System placed under the direct patronage of the President of Finland.

2. Key Features of the National Innovation system

- Objective: The objective of the innovation system was to strengthen the competitiveness of basic industry while developing new high-tech industries. The system was designed to provide support for all stages of innovation and business development starting from R&D or pre-incubation to production and linkages to global markets.

- Structure: Key organizations included in the innovation system are: the Academy of Finland, the National Technology Agency (TEKES), Public and private R&D organizations; Technology transfer agencies and capital providers. Together, these organizations provide the following comprehensive set of services:

    1. R&D/ Technology support
    2. Risk financing including equity, soft loans and grants
    3. Access to International market
    4. Training and development of entrepreneurial and technical skills
    5. Advice on optimal organizational models, and
    6. International linkages

A brief description of the specific functions of each organization is provided below.

Academy of Finland: its main function is to ensure the excellence of basic research in Finland through competitive funding mechanisms and to participate in the formulation of Finland's science policy.

TEKES (National Technology Agency of Finland): was created in 1983 under the Ministry of Trade and Industry to promote the technological competitiveness of Finnish industry, expand and diversify industrial production and promote high tech exports. TEKES is the principal public sector implementing arm of Finland's technology policy. It provides grants and soft loans to innovative enterprises for high risk product development projects and provides financing to research institutes and universities for applied technical research.

Public R&D organizations: Public R&D organizations include universities and other higher learning institutions (totaling about 50), national research institutes and VTT (the Technical Research Center of Finland). Combined, these organizations represent about 30% of the total R&D national expenditure. In addition to public R&D, private sector R&D spending is also growing exponentially and amounted to approximately 2% of GDP in 1999. Overall, the Finnish innovation system is characterized by a strong interaction between the science base and businesses.

Technology Transfer: Finland' national innovation system is also characterized by its strong focus on regional development. The "Science Valley" of Kuopio in Central Finland is a product of effective technology transfer mechanisms and productive interface between science and business. Kuopio is a university town with a Science Park hosting over 70 high tech companies employing over 10,000 people specialized in IT, mechanical engineering, materials technology, biotechnology and medicine.

Capital Providers: Finland has a number of public and private capital providers for innovation which include SITRA (the Finnish National Fund for R&D), Start Fund of Kera, Hermia (an incubator and seed capital provider), Finnfund (specializing in international JVs) and the Foundation for Finnish Inventions. SITRA , created in 1967, is the largest public sector venture capital provider. Its funding is appropriated by the Finnish Parliament and is used to provide (i) start up capital for new technology firms (in 1999, SITRA was a minority shareholder in over 90 companies); (ii) services to match SMEs with business angels; (iii) funds for research projects in existing companies of any size; (iv) funds for training projects; (v) funds for technology transfer and (vi) funds for existing venture capital funds.

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