ISTC 2012: Toward Sustainable Global Security

By: **David V. Gibson and James E. Jarrett**

Date: June 23, 2003

Abstract:

Review of the programs and activities of the International Science and Technology Center (ISTC) in Moscow, Russia, with recommendations. ISTC is an organization that facilitates commercial occupations for Russian scientists formerly working on weapons of mass destruction.

Keywords: economic development; nuclear non-proliferation; Russia; Russian Federation; technology commercialization

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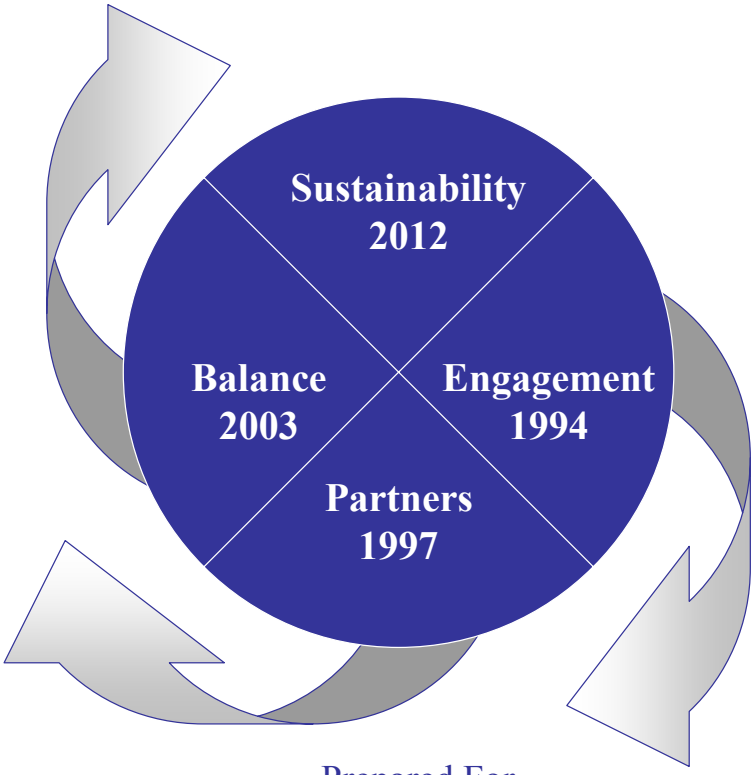
IC2 Institute

The University of Texas at Austin

& International Collaborators from EU, Japan, Korea

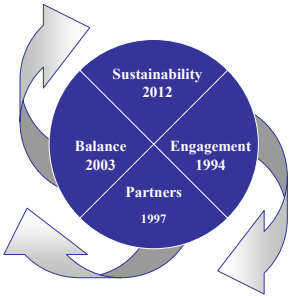


Prepared For

International Science and Technology Center

Moscow, Russia

www.istc.ru



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By
IC2 Institute
The University of Texas at Austin, USA
& International Collaborators from EU, Japan, Korea and Russia:

Dr. David V. Gibson, Project Director, USA

European Union

Professor Manuel Heitor
Dr. Robert Hodgson
Professor Peter J. Idenburg
Professor Giorgio Sirilli

Japan

Professor Kiyoshi Niwa

Korea

Professor Tae Kyung Sung

Russia

Dr. Leonid Gokhberg
Professor Nikolay Rogalev
Dr. Alexander Sokolov

USA

Dr. Eliza Evans
Dr. James Jarrett
Dr. J. Bruce Kellison

Prepared For
International Science and Technology Center
Moscow, Russia
www.istc.ru

June 23, 2003

Dedicated to the talented and hardworking
management and staff of the
International Science and Technology Center,
Moscow, Russia.

Acknowledgements

We thank Lawrence Wright, International Science and Technology Center, Deputy Executive Director, Partnering and Sustainability, US for his oversight of this research project and report. And we thank Randall Beatty past Deputy Executive Director, US and Maria Douglass past Senior Technology Implementation Manager, US with whom we launched this research project in early 2002. The continued support and advice of Maria Douglass, Project manager and Irina S. Roslova, Technology Implementation Officer was critical to facilitating the International Research Team's data collection, workshops, interviews, visits to RF/CIS institutes, and report writing throughout this research project.

The authors of this report are especially grateful to our Expert Advisors: Jean-Pierre Contzen, EU Member of ISTC's Scientific Advisory Committee and past Chairman of ISTC's Governing Board and George Kozmetsky, founding director of IC² Institute, The University of Texas at Austin. Dr. Contzen was especially diligent in reading and critiquing this reports evolving drafts and in making useful and insightful contributions based on his long association with ISTC and his broad and deep knowledge of scientific policy and practice worldwide. Dr. Kozmetsky provided valued insights in terms of the global importance for science and technology as a resource for building and sharing wealth and national security worldwide.

We thank key representatives from ISTC's Funding and Recipient Parties including Eun-Chul Choi, Director, Technology Cooperation Division I, Ministry of Science and Technology, Korea; Dr. D.J. Gambier, Principal Administrator, European Commission Directorate Geenral Research, Brussels; Andy A. Hood, Senior Coordinator for Science Centers Program, Department of State, US; Lyubov M. Kondratenkova, Ministry of Atomic Energy, Moscow; and Hisashi Michigami, Director, International Science Cooperation Division, Ministry of Foreign Affairs, Japan.

This report is, to a great degree, based on the insights and information provided by ISTC management and staff, some relatively new to ISTC and some who have spent years working to accomplish ISTC's mission and objectives. At ISTC we thank Executive Director Dr. Michael Kroening and Deputy Executive Directors for Science Department, Dr. Uwe Meyer, EU; Technology Department, Michiaki Okubo, Japan; Partnering and Sustainability, Lawrence Wright, IV, US; and Operations Department, Sergey A. Zykov, RF. In this regard we also thank the following Senior Technology Implementation Managers: Anne Marie Dalgaard, EU; Maria Douglass, US; Byung Sam Kang, Korea; Motoi Sakamoto, Japan.

During our year-long data collection and report writing the International Research Team interviewed many ISTC and RF/CIS Institute managers and staff and these include: Alexander V. Artykhov, Program Manager; Karen S. Bunyatov, SPM; Konstantin N. Evstyukhin, Project Officer; Peter Falatyn, Senior Advisor; Dr. Tatiana A. Gremyakova, SPM; Helen Huet, Chief Contracting Officer; Fatima Khadnova, SPM; Fedor G.

Kiryutin, Translator; Bill Komashko, SPM; Dr. Yuri B. Kondratenkov, Consultant on Special Matters; Dr. Gennady G. Kulikov, SPM; Eric A. Kunsman, SPM; Dr. Yuir I. Malakhov, SPM; Vladimir M. Matyushechkin, Deputy Chief Contracting Officer; Ekaterina V. Pankratova, Program Manager Seminars; Diana D. Pobedimskaya, SPM; Ekaterina V. Pankratova, Program Manager; Dave Rich, Commercialization Programs Group; Patrick Russo, SPM; Tatiana A. Rybakova, SPM; Elena Simakova, Public Information Officer; Edward L. Stephen, SPM; Tero T. Varjoranta, Division Manager, Sustainability Programs; Dr. Vladimir M. Urezchenko, Training Program Group. Several of ISTC contributors provided repeat interviews, support documents, and ongoing valued advice and these individuals include Leon Horowicz, SPM; Morgan D. Libby, SPM; Dr. Gill Won Shu, SPM; and Robert M. Teets, Jr. Senior Project Agreement Officer.

We appreciate the insights provided by Project Managers interviewed at 12 select institutes within the RF/CIS as follows: Alexander G. Trifonov, Joint Institute of Power and Nuclear Research, Minsk; A.S. Kotosonov, NIIGrafit, Moscow; Stanislav A. Lavkovsky, Lazurit Joint-Stock Company, Nizhne Novgorod; V. Vyshinsky, TsAGI; Yuri Tairov, St. Petersburg Electrotechincal University; Nina P. Khuchua, Tbilisi State University; Nikolai A. Mezentsev, Budkler Institute of Nuclear Physics; Sevan Paruirovich, State Engineering University of Armenia, Yerevan; Yuri Volkov, MIFI; Sergei Karabashev and Yakov Mukovskii, MISIS, Moscow; Suren O. Mirumyants, State Institute of Applied Optics, Kanan, Tatarstan; and Dmitry Gorbenko, VNIIEF, Sarov. And we thank the 63 ISTC corporate partners from the EU, US, and Japan who provided valued responses to our Partner Survey either over the phone or though email.

The International Research Team was also fortunate to interview and collect data from public and private knowledgeable informants from Russia and abroad. In this regard we especially thank Dr. Christian Besson, Research Director, Schlumberger, Moscow; Dr. Arie Cohen, Sr. Program Manager, Corporate R&D, Dow Chemical Company; Dr. Mikhail I. Fedorov, Senior Researcher, A.F. Ioffe Physico-Technical Institute, St. Petersburg; Dr. Leonid Gokhberg, Director, Institute for Studies of Information Economy, Higher School of Economics, Moscow; Dr. Vladimir V. Kaminski, A.F. Ioffe Physical Technical Institute, Russian Academy of Sciences, St. Petersburg; Dr. Natalia N. Karpova, Graduate School of International Business, Academy of National Economy, Moscow; Dr. Alexandrov Konstantin, Russian Academy of Medical Science, Joint-Stock Company, Moscow; Professor Igor S. Lyubutin, Deputy Director, Institute of Crystallography, Moscow; Professor Michail V. Kovalchuk, Corresponding Member of RAS Director, Institute of Crystallography, Moscow; Dr. Abgar L. Orbeli, Deputy Director, A.F. Ioffe Physical Technical Institute, St. Petersburg; Dr. Nikolay Rogalev, Moscow Power Engineering Institute; Dr. Alexander Sokolov, Deputy Director, Center for Science Research and Statistics, Moscow; Dr. Sergei A. Tsyganov, Head of Innovation Department, Russian Foundation for Basic Research, Moscow; Dr. Al Watkins, World Bank; Professor Andrei G. Zabrodskii, Vice Director, A.F. Ioffe Physical Technical Institute, St. Petersburg; Dr. Vladimir G. Zinov, Director, Center for Technology Commercialization, Academy of National Economy, Moscow.

***In contrast to military intervention, ISTC provides an alternative model* for dealing with the threat of proliferation of weapons of mass destruction while at the same time supporting global R&D and prosperity sharing. ISTC is an important and forward thinking example of how to organize and implement a multilateral consortia of scientific, political, and business interests that represent developed and developing regions to foster global security and wealth and job creation through the civil use of science and technology.**

***Regardless of** whether Saddam Hussein had actual chemical or biological weapons, it is known with absolute certainty that Iraq had a large and well-trained cadre of scientists and technicians capable of producing such arms. The US record is not strong when it comes to finding and working with those responsible for Iraq's weapons of Mass Destruction. Fortunately there is another approach active in the science centers in Moscow and Ukraine that serves as a model to employ scientists in civilian research and redirected away from Weapons of Mass Destruction.*

"Find and Employ Iraq Scientists" (adapted)
Jon B. Wolfsthal, Carnegie Endowment's Nonproliferation Program, *Los Angeles Times, June 17, 2003*

***We are all** internationalists now, whether we like it or not!*

"Building a New Multilateral World"
Tony Blair, Prime Minister, Britain
Business Week, April 21, 2003

***Rogue states** and terrorists organizations usually do not have the ability to build their own weapons of mass destruction. Therefore, if we target our efforts at nonproliferation programs we are more likely to thwart efforts of the next madman seeking to acquire such weapons.*

Representative Curt Weldon, US Congress
Quoted in "Bill Seeks to Lessen Threat From Former Soviet Nukes"
By Jason Embry, Washington Bureau, April 11, 2002

***In the long** run, as I have seen repeatedly across the globe, human life moves forward, not though war, but through the painstaking work of people like those at the International Science and Technology Center. .*

Science Center Provides Successful Model of Cooperation
G. Geyer, Universal Press Syndicate, March 11, 2003

***Technology** continues to shrink the world. There is no choice other than to participate in the global community. Science and technology is to precious a resource to be restricted from drawing the world together. That is what the 21st Century is all about.*

Dr. George Kozmetsky
Founding Director IC2 Institute
1917-2003

Preface

The International Science and Technology Center (ISTC) began operations in Moscow, Russia in 1994 as a multilateral organization founded through an intergovernmental agreement between the Russian Federation, the European Union, Japan, and the United States of America. ISTC's central mission was and continues to focus on redirecting Weapons of Mass Destruction (WMD) research to peaceful purposes thereby minimizing if not preventing the threat of nonproliferation. ISTC's programs and activities focus on Former Weapons Scientists within the Russian Federation (RF) and Commonwealth of Independent States (CIS) including Belarus, Kazakhstan, Armenia, Georgia and Kyrgyzstan. ISTC is also charged with the preservation of the science and technology (S&T) research potential of the RF/CIS, and with establishing links with international S&T communities and market economies. This report:

(1) Reviews ISTC programs and activities in meeting established and evolving objectives focused on nonproliferation and sustainability

(2) Analyzes challenges and reflects on program metrics

(3) Recommends programmatic initiatives and suggests opportunities and initiatives for accelerating success

ISTC 2012: Toward Sustainable Global Security observations and recommendations are based on twelve months of qualitative and quantitative data collection including interviews with over 50 ISTC management, staff and other knowledgeable informants, visits with Project Managers at RF/CIS Institutes, workshops with ISTC personnel, reviews of published documents and databases, and phone and email surveys of ISTC's Corporate Partners. Data collection, analysis, and report writing was accomplished by an international team of researchers and expert advisors from the EU, Japan, Korea, and the US.

ISTC 2012 reinforces the belief that sustainable nonproliferation is most economically and efficiently achieved through balanced partnerships leading to self-sustainable S&T and innovation systems. In this regard, the report is organized around the framework of "seven pillars" of sustainable S&T systems: Internationally Open and Networked; Research Excellence; Economic Value; Multi-sourced Financing; Attracting Young Talent; National Purpose; and Societal Value. The report describes how, over the past eight years:

(1) ISTC's programs and activities have contributed to each of the seven sustainability pillars in the RF/CIS, and suggests how

(2) ISTC's Secretariat can accelerate the transition toward balanced partnerships with public and private sectors regionally, nationally, and globally, including self-sustainable nonproliferation within the RF/CIS

ISTC 2012 concludes with key observations and recommendations for ISTC's Secretariat and for each of the 10 programs reviewed including Science Projects, Partner Programs, Business Management Training, Valorization Support, Workshops & Seminars, Patent

Support, Travel Support, Technologies Database, and Communication Support. Finally a Fast Track Action Plan is offered for select RF/CIS-based S&T institutes to become key regional and national "models of success" for accelerated regional technology-based growth and wealth and job creation including the attraction and retention of young talent and achieving balanced partnerships with public and private organizations within select regions of the Funding Parties.

ISTC is an important experiment on how to organize and implement a multilateral consortia of scientific, political, and business interests that represent developed and developing regions to foster wealth and job creation through the civil use of science and technology. In contrast to military intervention, ISTC provides and alternative model for dealing with rogue nations and the threat of terrorism while at the same time supporting global science and prosperity sharing. These are extremely important and challenging issues given the emerging realities of the early years of the 21st Century.

ISTC 2012:

Toward Global Security and Sustainability

Appendices (Under Separate Cover)

I S T C 2 0 1 2:
Toward Sustainable Global Security

1. Introduction

The ISTC has truly been an experiment, a successful one. For nations leaving behind the Cold War, it has demonstrated a new path. For newly independent nations, it has kept parties working together and has added new parties to the mix…it has provided an opportunity to build meaningful ties where there was once isolation.

Dr. Ronald F. Lehman
Chairman of the Governing Board
ISTC Annual Report, (adapted) 2001

This report was initiated and funded by the Secretariat of the International Science and Technology Center (ISTC), Moscow to:[1]

- Review programs and activities in meeting established and evolving objectives focused on nonproliferation and sustainability
- Analyze challenges and reflect on metrics
- Recommend programmatic initiatives and suggest opportunities to increase effectiveness that contribute to the ISTC's partnering and sustainability mandates. This includes an evolving strategy towards balanced partnerships and the revival of vigorous, viable national science and technology (S&T) systems for the

[1] Since beginning operations in 1994, ISTC has benefited from 2-year reviews and assessments of the organization's programs, activities, and objectives. The first review in 1996 led to the formation of ISTC's Partner Program, Business and Management Training Program, and Japanese Workshop Program. The second review in 1998 led to the Valorization Support Program and Technical Monitoring Experts Program. The third review in 2000 led to the EU and US Workshop Programs, the ISO 9002 Project, and the Data Collection Project.

Russian Federation (RF) and Commonwealth of Independent States (CIS) thereby fulfilling, in a sustainable manner, ISTC's central mission of nonproliferation.[1]

The ISTC was established in November 1992, as a multilateral organization, though an intergovernmental agreement between the Russian Federation, the European Union [The European Atomic Energy Community and European Economic Community], Japan, the United States of America.[2] The main motivation was, and continues to be, nonproliferation:

> To keep knowledge related to weapons of mass destruction (WMD) and their delivery systems out of the hands of rogue nations and terrorist groups by preventing a 'brain drain' of scientists and engineers from elite research institutes in the Former Soviet Union (FSU).

Since beginning operations in Moscow in March 1994, ISTC has instituted a range of programs and activities designed to provide crucial financial, programmatic, and technical support to former weapons scientists (FWS) in the RF/CIS[3] and to help redirect their research to peaceful purposes thereby minimizing if not preventing the threat of proliferation. ISTC's primary mandate is reflected in the Center's related objectives that include contributions to:

- The preservation of RF/CIS science and technology (S&T) research capabilities and the integration of FWS into the international scientific community
- FWS research transition to civil purposes and market-based economies

On the one hand, a decade after the collapse of the Soviet Union, it can be argued that the ISTC has made considerable progress in achieving these objectives under very

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[1] This report is **not** an assessment or policy review of ISTC's nonproliferation activities and objectives. It is understood that nonproliferation has been and continues to be the central mission of ISTC. And this report **not** about the sustainability of ISTC as an organization. The report **IS** about the sustainability of: nonproliferation programs and activities and the sustainability of S&T research excellence in the RF and CIS.

[2] In 1997 Norway became a Funding Party as did The Republic of Korea in 1998.

[3] Including Armenia, Belarus, Georgia, Kazakstan, and Kyrgyzstan.

challenging circumstances. On the other hand, the threat of proliferation of weapons of mass destruction – nuclear, chemical, biological, and other – remains an important international concern, indeed an increasing concern in the post 9/11 world with regards to the global war on terrorism. And while ISTC has achieved considerable progress concerning the transition of RF/CIS FWS to civil research and market economies, considerable challenges remain. Some of these challenges and opportunities are within the scope of ISTC's mandate and resources, many are not Figure 1.

Figure 1. Leveraging RF/CIS Science & Technology (S&T) Assets for Sustainable Nonproliferation Through Regionally-Based Wealth and Job Creation

The existence of considerable challenges for S&T sustainability and commercialization within the RF/CIS gives rise to the need to understand the interactive and non-linear nature of Knowledge/Technology Transfer (K/TT) and innovation, as well as the dynamic uncertainty that characterizes the development of S&T for established, emerging, and new-to-the-world markets. At the broadest level RF/CIS sustainable strategies need to be based on supportive policies and systems for:

- Education, science and technology excellence
- Systems supporting innovation, entrepreneurship, and business development
- The creation and diffusion of knowledge against a background of increasing internationalization, both inevitable and desirable, of RF/CIS S&T. This diversification is linked to the need to understand the complexity and diversity of the actors involved in innovation processes regionally, nationally, and internationally (Bozeman and Witmer, 2001; Conceição et al., 2001).

In keeping with the focus of this report, Alfred Watkins in "From Knowledge to Wealth: Transforming Russian Science and Technology For a Modern Knowledge Economy," argues that it is important for the RF to adopt and implement an internally coherent set of economic development policies to increase the knowledge content of the country's economic base. In this regard the RF (and the CIS) needs to pursue policies that (Watkins, 2002):

- Foster private sector development and improve the productivity and competitiveness of such "old economy" sectors as manufacturing and agriculture while stimulating the development of new technology-based enterprises
- Lead to commercialization of the output of the country's S&T system thereby converting knowledge to wealth
- Develop linkages between the country's SMEs and large national and international enterprises becoming part of the global value chain
- Encourage educated Russians to live, work, and invest in Russia.

SCIENCE, TECHNOLOGY, & SUSTAINABILITY

The mission of ISTC is directed to a part of global security risks – the proliferation of weapons of mass destruction. The year 2001 has shown the need for ISTC and the value of its organization as an international initiative of shared responsibilities. Moreover, the ISTC mission has evolved from an assistance program to a program of partnership between the ISTC member states – strengthening its political framework and programs

Dr. Michael Kroening, Executive Director
ISTC Annual Report, 2001

During 1994-1997, ISTC programs and activities emphasized the engagement and re-direction of Former Weapons Scientists, Figure 2. Stage 2 (1997-2002) focused on the transition of FWS through the initiation and evolution of programs and activities that encouraged government and non-government partner funding. In January 2003, after assessing its accomplishments and challenges the ISTC launched a major reorganization of the Secretariat and its staff with the goal of accelerating RF/CIS transition toward Stage III – Balance, and Stage IV – Self-Sustainability by emphasizing:[1]

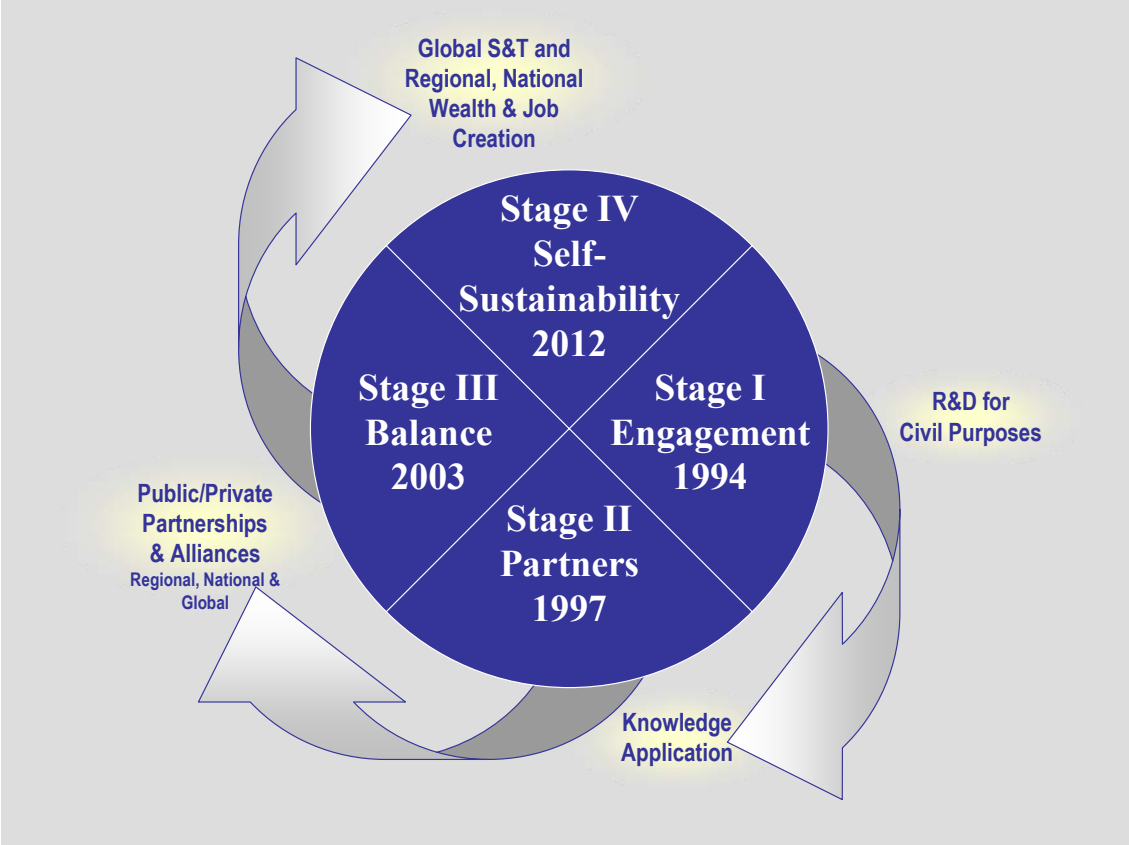
- Balanced division of activities between the Science Project Program and the Partner Program
- Evolution to Partnership (E2P) to encourage institutes to transition into business-scientific relationships independent of ISTC including:
  - The formation of "balanced partnerships" among public and private organizations where RF/CIS S&T institutes and their staff provide AND receive value-added services with Funding and Recipient Parties
  - Assisting researchers, institutes, and regions within the RF/CIS to be self-sustainable in wealth and job creation through the civil use of science and technology regionally, nationally, and globally

[1] "Ways to Partnership," ISTC paper approved by ISTC Governing Board at it's XXVII Session; "A New ISTC Organization," Governing Board Meeting XXIX-011, Attachment 1; and "Reorganizing the ISTC Secretariat and Implementing Change," Michael Kroning, January 2003.

- The emergence of a programmatic approach to enable "science and technology targeting" to more comprehensively address developmental needs in conjunction with national scientific and economic priorities including:
  - An emphasis on mission-focused programs having no national boundaries or allegiances

Stage IV 2012 will be realized with broad diffusion of regionally-based self-supporting programs and activities for sustainable world-class S&T, innovation, and full partnerships in global scientific and business communities. While it is clear that such broad-based excellence and sustainability cannot be achieved independently of regional and national policies and institution building, within the context of this report, guidelines will be proposed for ISTC's Secretariat to assess existing and suggested programs to accelerate the transition to self-sustainability.

Figure 2. ISTC Motivated RF/CIS Science and Technology Transition Stages From Engagement to Self-Sustainability



RESEARCH METHODS

Given that the ISTC is a multilateral organization with a broad range of international perspectives, activities, and metrics it was considered important to conduct this research project and report writing using an international team from the U.S., EU, Japan, Korea and the Russian Federation. This report benefits from the diverse perspectives of these researchers, expert advisors, and consultants whose professional careers include decades of work concerning science and technology, innovation processes and indicators, knowledge management, regional economic development, technology venturing (e.g., entrepreneurship, incubators), technology transfer, S&T policy, education and training, alliance building and more. (See Appendix C). The research team benefited from unfettered access to ISTC staff and activities as they employed a variety of quantitative and qualitative data collection methods including: reviews of ISTC documents, databases, and publications; phone and email surveys; interviews; focus groups and workshops; and observation. Data collection and analyses was conducted from February 2002 to March 2003. Research team members visited the ISTC, Moscow in February, April, June, July, September, and October of 2002 and March 2003 including field trips to research institutes in the RF and CIS. International Research Team members also met as a group in Kansai, Japan (August 2002) and Monterrey, Mexico (January and June 2003).

ISTC affiliated RF/CIS institutes and partner public and private organizations and their scientific, technical, and administrative personnel cover a broad range of evolving S&T and business expertise that is located in a variety of socio-economic and political environments. ISTC is itself a large, complex, and dynamic multilateral organization. Consequently, it is extremely difficult to "capture" at any one point in time a complete picture of existing operations. Data collection has, by necessity, been selective with the objective of including a variety of insights, observations, and recommendations to exemplify key points of discussion.

To sustain ISTC objectives – at regional and national levels – the International Research Team suggests that there needs to be certain characteristics present in S&T systems that

are reinforced by incentives and sanctions operating on the system. As defined in this report, these characteristics include, but are not limited to, seven Pillars of Sustainability, Table 1.[1]

Table 1: Seven Pillars of Sustainable Science and Technology (S&T) Systems

Sustainability Pillars	Rationale
Internationally Open & Networked	Internationalization of RF/CIS research institutes is of critical importance, knowledge sharing increases the knowledge base for S&T excellence
Research Excellence	Selectivity for excellence is key to sustainable development of world-class S&T
Economic Value	Research for improved competitiveness, wealth, and job creation through the involvement of corporate partners
Multi-sourced Funding	Multiple public and private funding sources are vital for the sustainability and independence of S&T systems
Attraction of Young Talent	Participation of young scientists is critical for the sustainability of S&T systems
National Purpose	R&D should contribute national purpose including: Environment and healthcare, critical infrastructures (water, energy, transport & communications), natural disasters and societal governance as well as new industry and market creation such as nano- and bio-technologies
Societal Value	Public spending on R&D should contribute to the well-being of citizens and nations world-wide by addressing 21st Century global challenges including health, the environment, water, energy and overall quality of life and security

1. Internationally Open and Networked – it is crucial to have unrestricted access to scientific peers in both public and private sectors worldwide to share thinking about research questions, findings and theories which are essential to ensure relevance and value-added contributions within regional and national S&T systems. This pillar should not be confused by ideas of uniformity and dominant fashion; unique and entrepreneurial approaches should be encouraged within free and open exchange.

2. Research Excellence (Contributing to New Knowledge) – the procedures guiding any nation's S&T system should result in needed resources (financial, intellectual, human and other) reaching the participants where excellence is being achieved while encouraging the aspirations of other elements of the system to achieve such excellence.

[1] This report focuses on the impact ISTC has had, and continues to have, on seven select Pillars of Sustainability; however, it is realized that while these pillars may be necessary they are not sufficient for sustainable S&T systems. Other important "pillars" would include educational excellence, economic and political stability, the rule of law and more. This report has chosen to focus on sustainability pillars most central to the nonproliferation mission of ISTC as defined by the Funding and Recipient Parties and enacted by the Secretariat through ISTC's various programs and activities.

3. Economic Value of R&D – for world-class S&T systems to be sustainable there needs to be a segment of S&T research that provides, directly or indirectly, an in-flow of financial resources to fund researchers, to provide up-to-date research equipment, and to recruit, grow, and retain talent. A transparent and effective system for protecting intellectual property rights is also central to this activity.

4. Multi-sourced Funding – an S&T system as a whole, and the majority of its component institutes, should seek multiple sources of income to sustain the work. This contributes both to independence from a dominant source and encourages relevance to multiple stakeholders. Typical sources will include a mix of national public budget, charities and foundations, international research programs, and domestic and international industry.

5. Attracting Young Talent – there is the need to ensure the continuing vibrancy that comes with new scientific talent and entrepreneurial energy attracted to work in what is judged to be important, exciting, challenging while providing appropriate rewards and motivation.

6. National Purpose – National and regional governments making better and more frequent use an S&T for economic value and creating new markets as well as societal governance and civil purposes. Such S&T systems should be relevant to a range of purposes that justify its use of national financial, human, intellectual and other scarce resources and would include:

- Defence and civil protection – as a contribution to regional and national security
- Health and quality of life – aging, disease and improve welfare for citizens
- Environment
- Critical infrastructures
- Economic competitiveness – contributing to wealth generation and economic success including new business formation and the development of regional

technology clusters, new industries in relation to both domestic and international markets

7. Societal Value – contributions to a world-wide sustainable knowledge-base for the 21st Century include:

- The funding of knowledge exploration for its own sake as a contribution to the human endeavour
- Dissemination of scientific methods and results
- Leverage regional and national institutions – Academic, Government, and Business – worldwide
- World-Class contributions to global scientific communities for the well-being of nations, peace and prosperity

These seven Pillars are considered crucial for sustainable nonproliferation as well as sustainable S&T excellence and economic development. They require support systems and incentives such as educational excellence, political stability, and the rule of law that take the following factors into account:

- **Time**: a relatively long-term perspective
- **Scope**: promoting national and international relationships, partnerships, and cooperation in science and technology
- **Context**: taking into consideration specific regional aspects within the RF & CIS, thus accommodating diversified environments
- **Value**: promoting market strategies and encouraging market-oriented technological cooperation, particularly through developing and funding "Programmatic S&T Initiatives" (e.g., nano-, bio-, and environmental) and fostering the development of innovation clusters within key sectors of the national and global economy

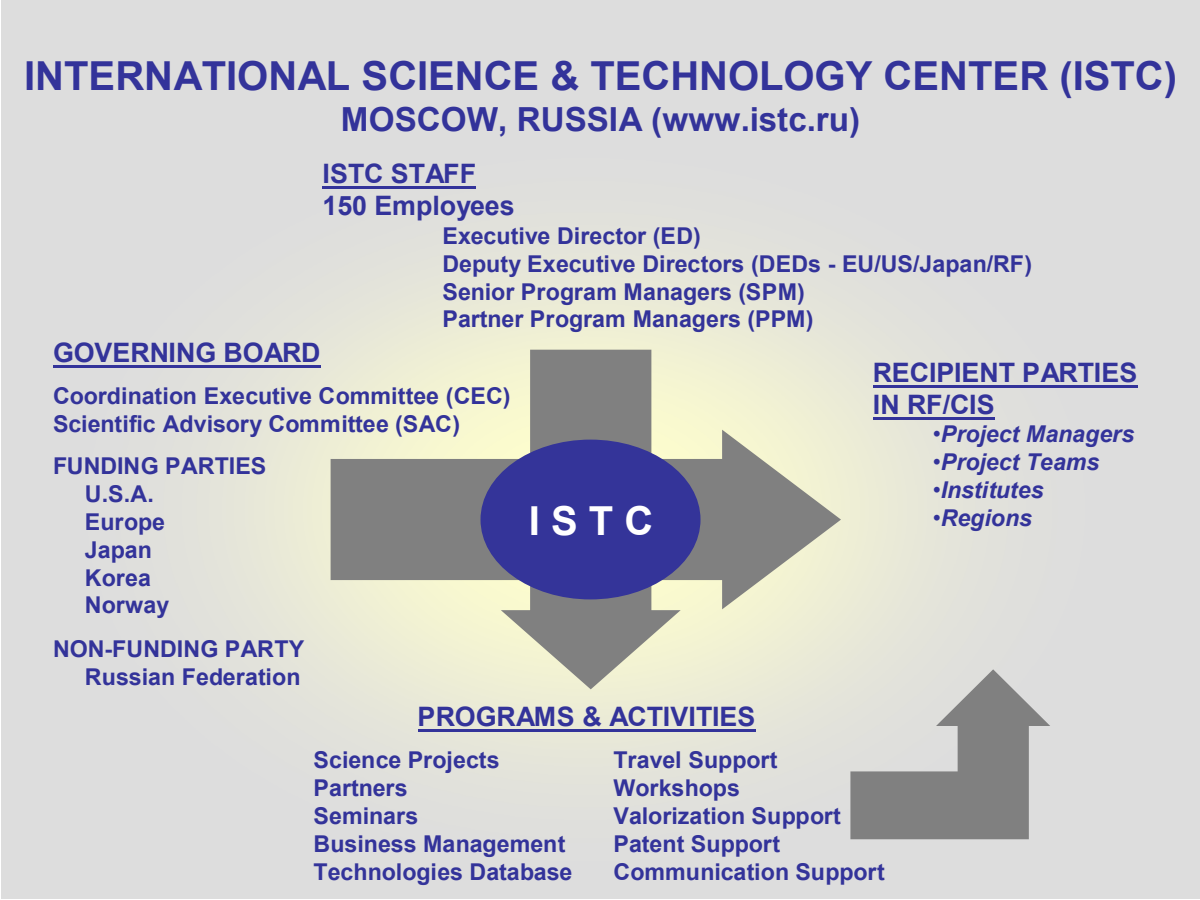
It is recognized that definitions of sustainability as well as related metrics and indicators are varied and complex. Furthermore, consideration needs to be given to the extent to which ISTC has the desire and mandate to broaden or transition its programs and activities. This is a task for Funding and Recipient Parties and it has been addressed in

ISTC Secretariat document "A New Organization" (GOV-XXIX-011) and "Reorganizing the ISTC Secretariat and Implementing Change" (January 2003) both of which will be referenced throughout this report. We limit our analysis to a discussion of existing and recommended strategies for building and maintaining self-sustainable nonproliferation and global security for the RF/CIS as well as Funding Parties. Accordingly, for the present research project self-sustainability is defined as long-term or permanent reorientation of defense sector RF/CIS professionals from military to civil R&D independent of the ISTC.

LINKING EXISTING ISTC PROGRAMS & ACTIVITIES TO THE SEVEN PILLARS OF SUSTAINABILITY

Since it's founding in 1992 the ISTC has initiated, supported, and evolved a range of programs and activities important to fulfilling the organization's mission of nonproliferation (See Appendix B for a review of ISTC programs and metrics for success). The Science Project Program and the Partners Program form the core of ISTC in terms of its mission, budgets, and staffing while eight other programs provide critical support activities. In addition to the focus on nonproliferation, it is the position of this report, that each of the 10 programs has also contributed to the initiation and maintenance of sustainable S&T systems in the RF and CIS. Figure 3 provides an overview of ISTC's main components including the Governing Board (Funding and Non-Funding Parties), ISTC Staff, Programs and Activities, and Recipient Parties.

Figure 3. Overview of International Science and Technology Center, Moscow [1]



ISTC Core Programs

- The **Science Project Program,** launched in 1994, is the most comprehensive nonproliferation activity conducted by the ISTC. With the assistance of SPMs, ISTC solicits scientific project proposals from Former Weapons Scientists throughout the RF/CIS. These projects are concurred by RF/CIS review and then reviewed for scientific merit by ISTC's Scientific Advisory Committee (SAC)

[1] In January 2003, the ISTC began implementing a major reorganization that included changes in the duties and responsibilities of the Executive and established four departments to be headed by each of four Deputy Executive Directors as follows: Science Department, Technology Department, Partnering and Sustainability Department, and Operations Department. These changes also impacted the new role of Senior Project Managers (SPMs) and Partner Project Managers (PPMs) as well as ISTC's various programs and activities. The discussion and conclusions of this report will reflect these changes ("Reorganizing the ISTC Secretariat and Implementing Change," M. Kroning, January, 2003).

and Funding Parties that decide which Science Projects to fund. A whole other group of Science Projects are initiated by the Funding Parties and targeted to certain FWS and Institutes and these projects also must proceed through host government concurrence, see Section 2, Figure 4, page 38.

- The **Partners Program,** launched in 1997, furthers ISTC objectives by expanding opportunities for collaboration with government and non-government organizations including private industry, foundations, and academic and scientific institutions. ISTC has Funding and Non-Funding Partners. Funding Partners represent both corporate and government interests. Non-Funding Partners are organizations that have an interest in and may have worked with RF/CIS institutes, but are not currently funding a research project though the ISTC.

ISTC Support Programs

- Since its inception, ISTC has encouraged RF/CIS researchers and scientific teams to develop their project proposals with the participation of international collaborators and organizations. The **Travel Support Program** (TSP) fosters such collaboration by reimbursing travel and related expenses for RF/CIS scientists to initiate and continue external technical consultations on their proposals and projects.
- The **Seminar Program** was launched in late 1994 to promote research exchange and collaboration among former weapons developers within the RF/CIS and researchers worldwide. ISTC organized S&T seminars are held throughout the RF/CIS and at times within the Funding Party countries.

1997

- Since beginning operations in 1994, ISTC has established networks and contacts in formerly closed and other research institutes and centers throughout the RF/CIS. Many innovative technical and research projects, were identified, either underway or planned, which conformed to ISTC nonproliferation objectives. Accordingly, in 1997 ISTC established the **Technologies Database Program**

(TDB - formerly the Promising Research Abstracts Database) to: (1) Establish and expand information exchange infrastructure concerning select research activities, (2) Promote the expertise of RF/CIS researchers and institutes, and (3) Facilitate cooperation between RF/CIS researchers and institutes and technical experts worldwide.

- As ISTC Science Projects began to reach their final stages it became apparent that some S&T being developed had potential for commercial applications. In keeping with the ISTC objective of facilitating the transition to market economies, the **Business Management and Training Program** (BMT) was launched in 1997 (1) to assist Former Weapons Scientists (FWS) in promoting the results of their work in international technology markets, and (2) to introduce FWS to market economy concepts including management and technology commercialization.
- Initially financed by the Science and Technology Agency (STA) of Japan, the Japanese ISTC **Workshop Program** was introduced in June 1997. In 2000 the EU and RF also began offering workshops as did the US and CIS in 2001. The program sponsors travel for RF/CIS scientists to participate in international workshops on important scientific issues and to facilitate networking with potential technical and industry partners.
- Launched in late 1997, the **Valorization Support Program** (VSP) was formed to support a variety of activities to be undertaken by ISTC staff including technology and market assessments, funding publications, new initiatives, and outsourcing select projects. A great deal of VSP effort was directed at ISTC Science Projects whose results were considered to have exceptional commercial potential capable of producing long-term support for FWS and their institutes.
- The **Patent Support Program** (PSP) was launched in March 1997 to review RF/CIS patent applications and to provide initial financial support to project grant recipients to cover the costs of obtaining RF/CIS patents.

2000

- The **Communications Support Program** (CSP), launched in 2000, is centered on improving the telecommunication infrastructure of institutes where current capabilities inhibit the successful accomplishment of ISTC programs and activities including the development of partnering opportunities.

It is the view of this report that, over the years, each of ISTC's programs and activities has directly and indirectly positively impacted the Seven Pillars of Sustainability. However, as indicated below select ISTC programs are considered to have had a more central impact on each of four pillars and are designated with an "H" in the appropriate matrix cell. We discuss each of these ISTC program within the context of the specific pillar as follows (Table 2):

- Internationally Open and Networked: Travel Support, Workshops and Seminars, and Communication Support
- Research Excellence: Science Projects
- Economic Value: Business Management Training, Valorization Support, Patent Support
- Multi-Sourced Funding: Partner Program and Technology Database Program

It is recognized that these are not, and should not be, isolated activities. The presence or absence of an "H" or "X" in Table 2 does not constitute an absolute, binary-type indication of effect. For example, the Sustainability Pillar of Internationally Open and Networked benefits from Science Projects, Business Management Training, Valorization Support, Patent Support, Technology Database, and Partner Programs as well as Travel Support, Workshops & Seminars, and Communication Support. Furthermore, each of ISTC Programs is considered to have had significant indirect impact on the following three Sustainability Pillars of:

- Attracting Young Talent
- National Purpose
- Societal Value

Table 2: ISTC Programs and Activities Mapped to Seven Sustainability Pillars[1]

	Int'l Open & Networked	Research Excellence	Economic Value	Multi-Sourced Funding	Young Talent	National Purpose	Societal Value
Science Projects		H			X	X	X
Partner Projects				H	X	X	X
Travel Support	H				X	X	X
Workshops & Seminars	H				X	X	X
Technical Database				H	X	X	X
Business Mgt Training			H		X	X	X
Valorization Support			H		X	X	X
Patent Support			H		X	X	X
Communication Support	H				X	X	X

H = High Impact

Global Challenges to Sustainable S&T and Innovation Systems

Worldwide sustainable S&T benefits innovation systems that facilitate and accelerate technology-based growth through:

- Knowledge/technology transfer (K/TT) across institutional boundaries (e.g., academia, business, and government)
- Entrepreneurial success
- Small and mid-sized enterprises (SMEs) including spin-out and start-up fast-growth companies
- Wealth and job creation

[1] This matrix serves as a roadmap to both (1) the document (under which pillar does the reader find the most complete description of an ISTC program), and (2) an innovative conceptual framework for considering ISTC programs and activities in terms of sustainable nonproliferation and sustainable S&T systems.

In the discussion of sustainable S&T systems for the RF/CIS, it is important to realize that fostering and accelerating technology-based growth is also a very challenging task for the Funding Parties concerning their own home-based S&T institutes, laboratories, and universities. In short, achieving successful K/TT, innovation, entrepreneurship, and accelerated wealth and job creation is a continuing challenge within the EU, US, Japan, Korea, and Norway despite these countries advantages of:

- A history of operating within market economies
- Lab directors, researchers, and technicians who have been educated in, and have lived their lives in, market economies
- Research activities that are relatively well funded and operate in stable political and socio-economic systems with regional innovation support systems including capital (business, banks, venture, angels) and know-how networks of professionals (e.g., lawyers, managers, accountants, marketing, supply chain)
- A mix of large, mid-sized, and small firms
- Established and emerging industries which are able to sell their products and services in large domestic markets
- Successful regional and national role models

Like the ISTC – most, if not all, US, EU, Japanese, and Korean publicly funded labs and research institutes and universities continually struggle with such issues as how best to:

- Facilitate cooperation among R&D labs and universities and private industry
- Encourage effective partnering and knowledge/technology transfer (K/TT) with industry especially with SMEs
- Accelerate technology-based regional economic development
- Manage intellectual property issues at individual and institutional levels of analysis
- Effectively promote entrepreneurship, start-up, and spin-out activity
- Partner with global science and commerce

As a further qualification, while this report is focused on RF/CIS science and technology it is NOT focused solely on high-tech including computer and information technology

(CIT) or nano- and bio-tech. The DotCom Society has recently demonstrated the limitations of High-Tech. The economic development and sustainability of the RF/CIS requires a strong primary sector including the chemical sector and manufacturing industry and other sectors that will also benefit from excellent and sustainable S&T.[1]
In summary, realistic expectations on the part of Funding and Recipient Parties are needed for both short- and longer-term objectives concerning S&T commercialization, balanced partnerships, and self-sustainability of RF/CIS institutes. RF/CIS industry-science partnerships for innovation need to be considered in light of current institutional frameworks which often remain dependent on traditional modes of behavior (e.g., dependence on central government) and outdated regulatory frameworks (e.g., complex and ambiguous intellectual property laws).

ABOUT METRICS

Metrics and accountability have always been important to ISTC's Funding and Recipient Parties and these metrics have evolved over the years. This report is, in part, motivated by the desire to assess program metrics from the perspectives of ALL the parties and to suggest new metrics that reward and motivate within the RF/CIS:

- Balanced partnerships leading to "graduation" from ISTC support
- Vigorous and viable national S&T systems
- Self-sustainability

We offer a framework of three levels of metrics reflecting an evolution from an almost complete focus on measuring the engagement of Former Weapons Scientists (FWS) to concerns of sustainable nonproliferation and regional development. These metrics include a mix of qualitative and quantitative data as follows:

- **Level I –** is most focused on counting the basics as is number of FWS funded, number of trips to visit collaborators, number of workshops attended and number of contacts generated, number of ISTC partners and amount of their funding,

[1] This paragraph reflects email correspondence with Jean-Pierre Contzen, EU Member of ICTC's Scientific Advisory Council, October 19, 2002.

number of international patents. Level I metrics are usually the easiest to quantify and they offer important indicators of volume of activity. They have, in general, been the focus of data collection by ISTC since 1994 and are cited in Secretariat meetings and in ISTC's annual reports.

- **Level II –** is most concerned with return on investment (ROI) including gains in knowledge as well as profit. Level II includes more qualitative data such as which network contacts led to follow-on activity that produced value-added lessons-learned or S&T commercialization, number of partners satisfied with the deliverables of their funded projects, and amount of income generated from a patent or technology license.

- **Level III –** focuses on balanced partnerships and self-sustainability where strategies for cooperation and collaboration are created and maintained. Here there is a greater appreciation for value-chain development such as the amount and type of learning gained by the Project Manager and his research team. At this level of analysis there is a greater appreciation for developing win-win scenarios that support increasing value-added, long-term partnering.

It is not suggested that ISTC has the time and resources needed to measure all levels of metrics, but it is suggested that there be an evolution toward, and a greater appreciation for, what metrics best capture key components of sustainable nonproliferation. Collecting data on metrics at Levels II and III can be extremely difficult and time consuming under the best of circumstances (such as a highly controlled and homogeneous environment). Complexity increases dramatically when there are concerns of data comparability across different cultures and organizations, a broad range of personal motivations, considerable time-lag to assessing key outcomes, and a variety of important contextual and other intervening variables. Still, it is suggested that it is good strategy for ISTC to consider and explore, perhaps learn-by-doing, how best to measure the performance of its various programs as they contribute to balanced partnerships and self-sustainable nonproliferation. Indeed, if actively engaged in such a program of

processes and metrics ISTC could become an important contributor to establishing "best indicators and measurement techniques" for S&T, innovation systems, and sustainability within complex multilateral environments.[1]

[1] In 1983 the U.S. launched its first for-profit R&D Consortia, The Microelectronics and Computer Technology Corporation (MCC), to better compete with Japanese in software and computer information technologies. About $50 million was spent/year on leading edge software and semiconductor research, but almost no human or financial resources were devoted to studying knowledge and technology transfer processes for successful return-on-investment (ROI). In short, the MCC wasted a valuable opportunity to use its own activities as a "experiential learning laboratory." In 2001, after about 400-500 of the nation's best and brightest software engineers and technicians spent close to $800 million, MCC closed it doors largely as a result of ineffective knowledge/technology transfer leading to poor ROI for the over 22 shareholder companies (R&D Collaboration on Trail, D. Gibson and E. Rogers, Harvard Business School Press, 1994.)

2. Internationally Open & Networked

National and international research and industry contacts are important for Russian scientists – they need to connect with scientific peers and with industry for application of their results and to keep abreast of industry advancements and needs in the RF and abroad.

Professor A. Zabrodskii
Vice Director
Ioffe Institute, St Petersburg
Interview, Summer 2002

INTRODUCTION

All national science and technology (S&T) systems, no matter how large, are only part of a larger global effort. It is important to be in communication with one's scientific peers worldwide to leverage success and to avoid non-productive streams of research especially given 21st century science complexity and cost as well as the rapid pace of discovery and the accumulation of knowledge. In short, a key characteristic of sustainable RF/CIS S&T systems is the capacity of the researchers to be internationally open and networked.

Relationships between the creation, distribution, and use of knowledge for regional, national and global Public Interest and National Purpose (including economic development) and Societal Value are important areas of international research (Smilor, Kozmetsky, and Gibson, 1988; Kozmetsky and Yue, 1997; Burton, 1998; World Bank, 1998; Conceicao, 2002). For example, Saxenian (1994) describes how the preeminence of Silicon Valley, CA as a world-leading wealth-generating technology center can, in part, be attributed to the encouragement of experimentation, collaboration, and collective learning within and across public and private research networks: regionally, nationally, and globally.

While all of ISTC's programs have had important and positive impacts on the sustainability pillar of being Internationally Open and Networked, the Science Projects and Partner Programs have provided the basis for RF/CIS multilateral cooperation and

the opening RF/CIS science and technology to the world. Since 1994, The Science Projects Program has enabled FWS scientists to continue their research and to collaborate with scientific peers worldwide. Since, 1997, The Partners Program has facilitated the transition these research activities to civil purposes and commercial applications.

It is important to remember that forming effective and efficient knowledge/technology transfer (K/TT) partnerships and alliances across western R&D facilities (e.g., universities and government laboratories) and the private sector in market-based economies is an on-going and challenging task (Gibson and Rogers, 1994; Segil, 2000). Even within market economies it has been a challenge to have Federal Labs be "open and networked" with regional firms, especially if they are mid-sized and start-up enterprises (Gibson and Jarrett, 1976). Challenges increase exponentially when including different national governments, cultures and values, modes of operation, and metrics for success as well as great physical distances. Additional challenges for ISTC being internationally open and networked include working with RF/CIS scientists where, up to the early 1990s, "closed cities" and extreme secrecy were the established and enforced norms behavior. So, it is a significant accomplishment that since 1994, ISTC has been able to achieve considerable success in:

- Transitioning FWS and institute administrators from advocating "total secrecy" to being open and networked, and
- Transferring RF/CIS science to commercial and public applications worldwide.

After 8 years of operation, ISTC has become an important component of global, multidisciplinary, and virtual S&T networks that encourage and support the integration of RF/CIS weapons scientists into international scientific communities as well as the linking of RF/CIS science to civil and commercial applications. As ISTC moves into its second decade of operation, this multilateral, global organization needs to do more to provide young and older RF/CIS researchers with additional value-added Internationally Open and Networked opportunities for forming and maintaining international partnerships and for transitioning research to civil and commercial purposes. Accordingly, ISTC's programs and activities that support this fundamentally important sustainability pillar to

accelerate the flow of codified and tacit knowledge among RF/CIS researchers and scientific peers worldwide to speed knowledge creation, dissemination, and use.

ISTC PROGRAMS & ACTIVITIES

The following pages will discuss four supporting programs that have also made significant contributions to RF/CIS researchers being internationally open and networked:[1]

- Travel Support Program
- Workshops and Seminars Programs
- Communication Support Program

Travel Support Program (TSP)

As stated by Professor A. Zabrodskii, Vice Director, Ioffe Institute, St Petersburg (Interview, Summer 2002): [2]

> ISTC research funding and travel support in 1994-1996, was crucial to assisting Ioffe Physico-Technical Institute retain key scientists and research capability and to re-establishing and strengthening international research networks. So that currently international research projects and funding with some of the world's leading universities is providing significant support for the institute and allowing us to contribute to global science.

There are many management strategies and computer and information technologies for facilitating the creation, dissemination, and use of knowledge. None is completely satisfactory. They range from the more passive to interactive (Table 3), but in the end most scholars of the topic argue for the importance of face-to-face communication and the building of relationships that facilitate the timely exchange of tacit as well as codified knowledge. Even within the Internet and Web-based global scientific community, it is

[1] The Science Projects and the Partners Programs will be discussed in the following Sustainability Pillars of Research Excellence and Multi-Sourced Funding.

[2] As noted in the Introduction, due to time and budget constraints IC² Institute researchers were limited to the number of excellent RF/CIS institutes that could be visited. Based on criteria of the usefulness and generalizability of results certain institutes such as Ioeff were selected for visits, also please refer to Appendix B.

still important to encourage the mobility of researchers to promote understanding and trust across national and global scientific networks to:

- Foster the transfer and use of cutting-edge knowledge
- Encourage collaborative institutional relations
- Leverage scarce human and financial capital
- Stimulate scientific development in the context of continuous change and the increasing internationalization of the world's scientific base

Table 3. Passive to Interactive Modes of Knowledge Transfer

Passive Mechanisms
Non-proprietary and proprietary technical reports
Refereed journal articles and other professional publications
Newsletters
Videotaped overviews/demonstrations
Technology directories
Computer and Information Technology (CIT) Mediated Mechanisms
Databases
Video conferencing
E-mail
Internet and the web
Exchange of computer-based models and concepts
Interactive Face-to-Face Mechanisms
Professional meetings and trade shows
Program Advisory Committees
Science and Technical Requirements Panels
Visiting researchers
On-site-demonstrations
Parallel (shadow) research projects
Researcher/User face-to-face collaboration and joint research projects

Research collaborations have been found to be most effective in facilitating knowledge/technology transfer to commercial and process applications (Gibson and Rogers. 1994) and four variables are considered key to effective knowledge/technology transfer and application across organizational boundaries (Gibson and Smilor, 1988):

- High understanding of the environments where knowledge/technology is created and where it is to be applied
- High motivation (e.g., appropriate reward systems) on the part of both knowledge generators and users to be actively and positively engage in knowledge/technology generation, exchange, and application
- High understanding of goals and objectives at different stages of knowledge transfer to minimize obstacles and contextual differences
- Frequent and interactive communication using the range of passive to interactive modes, but emphasizing the importance of face-to-face communication

As Gokhberg (2002) concluded in his survey of PMs in RF/CIS institutes:[1]

> "…it is possible to draw a conclusion that there exists a connection between the intensity of international S&T cooperation and sustainability of research teams. The teams that had maintained only formal relations with [foreign] collaborators have worse indicators of sustainability than those that had sufficiently active contacts. The most successful research teams for practically all indicators were those that had planned, together with collaborators, promotion of results of the project and their commercialization (especially for indicators of commercialization and patenting), as well as the teams in whose activities collaborators had taken active part at all stages of the project implementation (especially with regard to a non-commercial use of results).

Recommendations

The use and assessment of appropriate metrics for ISTC's Travel Program is an especially important task as PPMs and SPMs:

(1) Move from being "proposal to transition advocates"

[1] At several instances in this report we cite results from ISTC's "Sustainability Data Collection Project," conducted by L. Gokhberg and A. Sokolov, Center for Science Research and Statistics," Moscow (2002).

(2) Focus more attention on the use of RF/CIS S&T for governmental and commercial applications within Funding and Recipient Parties

As noted in a recent ISTC two-year review,

> "….simple measurements to evaluate the success or usefulness of the Travel Program are not applicable. Rather, ISTC must rely on the collective sense gathered from Parties, CIS scientists, and Secretariat staff to determine the program's impact."

Appropriate metrics are key to effectively motivating and evaluating important travel and related activities so it contributes to achieving balanced partnerships and sustainable nonproliferation. In the past, Travel Support metrics reflected what was easiest to count (e.g., number of trips, cost and length of trips). A more through evaluation of the value-add of such trips would include an assessment of the relationships formed and maintained and the importance of the knowledge shared across these networks such as:

- Increased communication and learning how to collaborate, research has shown that early and frequent communication among researchers and science/knowledge users is crucial to successful transfer and commercialization
- Learning about a range of needed skills such as best practices for regional and international salesmanship and presentation of S&T, marketing, networking, forming and maintaining relationships
- How best to access needed support services (e.g., intellectual property rights) for successful commercialization of competitive technologies
- How best to account for small incremental S&T/knowledge transfers that add value to the science and/or commercialization effort but often do not produce impacts that can be easily measured
- How best to assess the value of learning what <u>not to do</u> in a research or commercialization project

Given the above considerations, it is suggested that additional funds and personnel be provided for the Travel Support Program as needed for:

- More frequent travel within the RF/CIS and internationally for PPMs/SPMs and RF/CIS researchers - currently, only about 1 in 3 travel requests are funded (with the exception that all party-requested travel is approved). Examples abound in R&D organizations where large amounts of funds were dedicated to S&T development but adequate funds and time allocations were denied key personnel for travel that would have dramatically benefited the research project in terms of improved science or commercial applications (Gibson and Rogers, 1994).
- Longer trips--currently travel is permitted only for the dates of a conference and/or meetings and not several days on either side of the specific events which are important for less structured networking. Informal networking at conferences, professional meetings, and company visits is often where there the most important value-added knowledge is exchanged and partnerships formed.
- The allocation of funds and personnel time for (1) the preparation of more detailed trip reports by travel grant recipients, and (2) more detailed analyses of trip reports for assessment of potential impacts, follow-up activities and outcomes. Currently such evaluations focus more on compliance with travel stipulations and regulations
- Follow-up activities after the travel is completed --- business cards can be exchanged and networks initiated during travel, but it takes considerable effort and skill in he use of a variety of communication-based activities to maintain, grow, and leverage distant networks

Metrics for Travel Support

The Travel Support Program (TSP) was launched as the Project Development Grants Program to assists FWS and their research colleagues to meet with international collaborators and organizations to help develop Science Project proposals that met global standards. RF/CIS scientists are also granted travel funds to attend international conferences and/or visit foreign institutes and laboratories. The number of ISTC funded trips has increased over the years from:

- 143 in 1999
- 153 in 2000

- 186 in 2001

Average trip costs are $2,500-$3,000 for trips to the USA and Japan, and $1,500 to $2,000 for trips to Europe, please refer to Appendix B for an overview of Travel Support Program.

The Science and Technology Center of the Ukraine (STCU), which is considerably smaller than ISTC, funded 24 trips in 2001-2002 under four categories of travel: Partner Support, Partner Links, Restricted Proposal Development, and Project Proposal Preparation. These categories allowed STCU staff to determine travel priorities and project managers (PMs) to sharpen the focus of their visits.[1] STCU's travel grants are restricted to those who previously worked on completed STCU projects or have current projects with no remaining travel funds.

This report suggests a range of quantitative and qualitative metrics for ISTC Travel Support as well as travel for Funding and Recipient Parties. Three levels of metrics include:

- Counting the Basics
- Valuation of Knowledge/Return on Investment
- Balanced Partnerships and Sustainable Nonprolifereation

Level I – Counting the Basics

- Number of RF/CIS researchers/scientists sent abroad by ISTC and costs/trip
- Number international scientists received in RF/CIS institutes as a result of ISTC research programs and other activities (e.g. SAC Seminars)

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[1] At the STCU, funds allocated to each category are based on management priorities as follows:

- 50% of funds are allocated for Partner Support—Up to $3,000 can be allocated for detailed discussions and negotiations with existing partners on finalizing a project partner agreement, on future technology commercialization, or on establishing a small/medium business. In addition, cost-sharing from the partner is expected.
- 30% for Enhancing Partner Links—Up to $2,000 can be allocated to discuss NEW business leads and potential new partner projects. Cost-sharing from the partner is expected.
- 15% for Restricted Proposal Development—This allocation is only for trips within the four party countries. There is a 5-day duration maximum and 1 trip is allowed per scientist for the development of new proposals.
- 5% for Project proposal preparation—Up to $1,500 is allocated for previous STCU grantees to meet and discuss with international contacts and collaborators. Cost-sharing from collaborator is expected.

- Number of personal contacts initiated from the above travel:
  - Nationally (within the RF/CIS) and internationally
  - Across academic, business, and government sectors

Level II – Valuation of Knowledge/Return on Investment (ROI)

- Number of personal contacts established and results of these relationships
- Number of projects initiated or augmented (by research group and/or by institute) as a result of the visits within and outside the RF/CIS
- Relationships strengthened or problems resolved after face-to-face meetings
- Useful entrepreneurial role models and case examples located and leveraged

Level III – Balanced Partnerships and Sustainable Nonproliferation

- Lessons learned from travel concerning improving the research project, technology transfer, marketing, presentation effectiveness and other "best practices"
- Value-added partnerships maintained and increased over time, e.g., where RF/CIS researchers are moved up the learning curve as a result of the partnership
- Building trust for enhanced regional and international cooperation and transfer of knowledge for enhanced S&T research and commercialization

Seminars and Workshops

The ISTC organizes seminars and workshops in Recipient and Funding Party countries to:

(1) Advance national and global science

(2) Highlight S&T topics of global significance

(3) Facilitate the development of project proposals and the inclusion of partners and collaborators in ISTC activities

Generally seminars are held in the RF/CIS and workshops are held in the Funding Party countries.

Seminar Program

ISTC's Seminar Program was launched in late 1994 to promote research exchange and collaboration between FWS and their research peers worldwide. In March 1997, ISTC's Governing Board decided to hold annual seminars on important global S&T related

issues and that ISTC's Scientific Advisory Committee (SAC) would organize these seminars. This decision resulted in the following seminars:

- June 1998 at Arzamas-16 - "Spent Nuclear Fuel and Pu Dispoosition"
- June 1999 at VNIIEF - "Large Scale Area Remediation"
- June 2000 on the Volga River - "Towards More Efficient Utilization of Research from RF/CIS Institutes.

Two most recent examples indicate how these SAC Seminars facilitated RF/CIS researchers being "internationally open and networked:"

- In April 23-27, 2001 SAC seminar on "Basic Science in ISTC Activities," in Akademgorodok, Novosibirsk. Co-Organizers of the seminar were the Siberian Branch of Russian Academy of Sciences and Budker Institute of Nuclear Physics. The scientific advisory committee included representatives from the Institute for Environmental Science, Japan; Geological Survey of Japan; Ministry of Science and Technology, Portugal; Los Alamos National Labs, US; Princeton University, US; Department of Histology and Cytogenetics, Paris University; and VNIIEF Russia.
- In May 27-29, 2002 SAC seminar on "Nanotechnologies in the Areas of Physics, Chemistry, and Biotecnoloogy," in St. Petersburg, Russia that was co-organized be the Ioffe Institute, St. Petersburg. As stated in the seminar program, "International competition and cooperation in this area of research are key in all countries in which S&T play a key role." This SAC Seminar focused on:
    - Synthesis and assembly
    - Biological approaches and applications
    - Dispersions and coatings
    - Large surface area materials
    - Consolidated materials and nanocluster-based materials

Through August 2002, SAC has helped organize over 28 science and technical seminars. In 2003 SAC seminars are scheduled for Berlin, Germany and St. Petersburg, Belarus, Arzamas 16, Tomsk, and Moscow, Russia.

In support of the Open and Networked Pillar objectives of SAC Seminars include:

- Supporting S&T conversion from WMD to civilian activities relevant to the general objectives pursued by ISTC
- Heightening the awareness of RF/CIS scientific potential worldwide leading to an integration of RF/CIS scientists with the international S&T community
- Initiating and helping to maintain international scientific cooperation between foreign and RF/CIS scientists and with global technology users, industry, and markets
- Adding value with respect to other scientific meetings by facilitating RF/CIS cooperation with international S&T and supporting organizations and programs worldwide while focusing on themes not otherwise covered

Workshop Program

ISTC's Workshop Program began in June 1997 with the support of the Science and Technology Agency (STA) of Japan. The first two workshops were on biotechnology and materials science with the objective of having RF/CIS scientists introduce important scientific concepts and technologies to Japanese industry. Currently ISTC helps organize Japanese, EU, and USA workshop programs with a total annual budget of about $380,000. Over the past years, ISTC has helped organize increasing numbers of workshops in Funding Party country locations as follows:

- In 2000 there were nine workshops: 4 in Japan, 4 in EU, and 1 in RF
- In 2001, there were18 workshops: 6 in Europe; 5 in Japan; 4 in the Russian Federation; 2 in the CIS; and 1 in the USA

L. Gokhberg's (2002) survey of Program Managers in the RF/CIS found that:

> "In the search of financing for the continuation of projects, including non-commercial ones, the most active teams were those that had sent a summary of promising projects, participated in the program of patenting support, and (or) in workshops in Japan, the United States or Europe."

ISTC supported seminars and workshops have also had an important impact on facilitating "inter-institute researcher" communication among CIS/RF researchers whether the meetings are held within the RF/CIS or abroad. Prior to the early 1990s the Former Soviet Union's Cold War mentality and "closed cities" did not encourage even the national networking of S&T researchers. And what networking that existed was pretty much disseminated after the collapse of the FSU. Being nationally open and networked for sharing knowledge and the leveraging of limited talent and resources is a significant added benefit of ISTC's seminars and workshops.

Recommendations: Seminars and Workshops

Primarily because of financial and staff limitations, potentially useful quantitative and qualitative data collection has not occurred on workshop and seminar operations, results, and impacts including follow-up participant tracking. Given concerns of balanced partnerships and sustainability, additional metrics might consider contributions to global commerce as well as science. More complete and systematic post-seminar and workshop follow-up is considered important both to determine satisfaction with current methods and to better assess and direct future act ivies.

Seminars. Because of the variety of topics held at different locations within and outside the RF/CIS, ISTC Seminars are disseminating knowledge about RF/CIS scientific and technical capabilities to a range of Funding and Recipient Party clients as well as helping to link RF/CIS S&T to national and global S&T and business networks. Metrics on these activities need to be collected. And it is emphasized that it is important to have SAC Seminar Program Committees be truly representative of the broad base of national and international experts and that they work to include a brad range of national and international S&T experts for enhancing the selectivity and impact of these seminars.

Workshops. Post-workshop metrics need elaboration in terms of both the Funding and Recipient Parties ROI. Despite examples where specific workshops have led to useful knowledge exchange, partner recruitment, and new partner projects, what is currently unknown is the full extent of direct and indirect impacts of these events. Only modest

follow-up activities and data collection is occurring, in part, because of considerable resource and time constraints placed on the ISTC staff that are organizing and managing these events. Additional qualitative and quantitative data collection might include:

- "Technology Brokers" might be selected from RF/CIS or host country where the workshop is being conducted to best represent and champion RF/CIS technologies and to provide follow-up activities and act as a communication "bridge" after the RF/CIS scientists have returned to their institutes. This is a role currently performed to varying degrees by ISTC SPMs and STIMs.
- Better identification and use of "ideal type" presenters for "selling" the business application of RF/CIS S&T --- whether the presenters are from an RF/CIS institute or ISTC or a "Technology Broker" --- but someone who can effectively speak English (or the native language of the industry participants) and "sell" the problem solving capacity of the technology
- Better assessment of "ideal type" workshop attendees who have the organizational resources and clout needed to champion the technology in the potential partner company. A successful workshop is more than filling attendee seats. The best attendee might be product development and sales personnel rather than local research experts that may have more of a "not-invented-here" bias. (Gibson and Rogers, 1994).

An increase in staff and funding would allow time for workshop and seminar program organizers to be engaged in additional pre-planning and follow-up activities both with presenters and attendees and with sponsors while experimenting with different types of seminar and workshop formats and settings. Exit surveys could be conducted to determine:

- Presentation effectiveness of RF/CIS scientists from the point of view of science/knowledge exchange as well as linking to a potential commercial partners or applications

- Recipient and Funding Partner satisfaction with the seminars and workshops in terms of different national locations, types of participants, and potential scientific and commercial outcomes
- Specific ideas about potential new science and commercial collaborations and follow-up research activities
- Satisfaction with the type of event and format. For example, "road shows and field visits" to company locations with presentations by PPMs and interested company participants from different technology and functional areas
- Potential new partner projects and contacts acquired by participating in a workshop or seminar

Levels of Metrics for Seminars and Workshops

Level I – Counting the Basics

- Number and location or seminars and workshops
- Number of RF/CIS Participants; from which institutes/organizations
- Number of international participants; from which institutes/organizations

Level II – Valuation of Knowledge/Return on Investment (ROI)

- Assessment of quality of presentations and content for both scientific and commercial applications
- Number of science and/or commercialization projects extended/augmented and new projects initiated

Level III – Balanced Partnerships and Sustainable Nonproliferation

- Amount and quality of co-sponsorship of event
- Quality and amount of national and international members on the conference organizing committee
- Quality of conference/workshop attendee
- Requests to be a workshop/seminar sponsor and host

Communications Support Program

In 1999 the ISTC established the Communications Support Program (CSP). The main objective of CSP is to improve the telecommunication infrastructure of RF/CIS institutes

where lack of adequate CIT equipment and capabilities inhibited, if not prevented, researchers from participating in ISTC projects or from engaging in commercial opportunities. CSP is considered essential for the growth and maintenance of the internationally open and networked pillar to the benefit of sustainable nonproliferation.

Concerns of nonproliferation, the global war on terrorism, and threat reduction would seem to increase when RF/CIS WMD researchers have limited communication --- computer and information technology (CIT) --- capacity with the ISTC or with possible national and international collaborators in Science Projects and with Funding Partners. RF/CIS Institutes that are isolated because of great physical distance and inadequate CIT cannot be expected to be very effective customers of the broad range of ISTC programs and activities that are dedicated to transforming WMD research to civil purposes and they are blocked from building and maintaining balanced partnerships and self-sustainability. As reported in the Gokhberg (2002) survey of PMs in RF/CIS:

> Eighty-Six percent of the surveyed research teams participated in some ISTC programs and the least active teams were the groups whose managers had no Internet access.

CSP's evaluation processes define an Institute's communication profile in terms of such characteristics as Internet capability, security, site network, local area networks, office software suite, e-mail capabilities, and scanning and phone/fax capabilities. This evaluation is incorporated into work plan instructions for the Institute to

- Identify challenges needing to be resolved
- Answer fundamental questions including
  - Interconnect topology and speed
  - Network hardware and services provided
  - Number of buildings/floors to be connected

In 2000, CSP implemented plans at 8 research institutes: 6 in the Russian Federation and two in Kazakhstan and completed technical support assessments at two additional institutes. In 2001, CSP implemented plans for high speed Internet access, websites, and

IT equipment purchases at 13 research institutes: 10 in Russia, two in Kazakhstan, and one in the Kyrgyz Republic. In 2003 CSP completed its first Partner funded project, began its first jointly funded (EU-USA) project, and provided Internet service to four institutes. Institute initiated projects were also rejected and in 2003, as two projects with a combined value of over $300,000US, were not funded. In summary, since, 2000 a total of 22 projects have been funded for CSP to assess and to provide needed CIT service to institutes in Russia, Kazakhstan, Armenia, and Georgia. Seven of these projects have been completed.

Recommendations

ISTC's Communication Support Program is currently facing three important challenges that would seem to gain increased importance as the Secretariat moves from engagement (funding former weapons scientists) to Balanced Partnerships and Sustainable Nonproliferation.

1. Staffing and Equipment. The limited CSP staff (one Senior Program Manager and ½ time project officer) is challenged to effectively identify, analyze, and implement needed and desired IT technologies for the broad range of RF/CIS Institutes located over great distances. In addition to the challenge of maintaining adequate CIT equipment and training, is the challenge of providing reliable and continued IT connectivity. Many RF/CIS institutes are not capable of paying IT connection fees that are about $1,500/month. To meet the above noted challenges, this report recommends:

- Outsourcing --- placing contracts with existing domestic companies to provide needed CIT support services for the ISTC Secretariat and for RF/CIS institutes[1]
- Employ the services of additional "informatics" SPMs
- Have Science and Partner Projects budget for projected IT connectivity costs

[1]Recently a technical service contractor was signed to provide needed consulting services for CSP management and clients. The objective is to reduce the time spent on negotiating individual service contracts. In addition, a reputable equipment supplier is now providing preferred service and prices that have resulted in significant cost savings.

2. CIT uniformity. A second CSP challenge is to find appropriate ways to encourage a more uniform IT strategy that encourages standardization and uniformity across RF/CIS institutes. In addition, some institutes do not have adequate CIT security, an issue that would seem to have direct implications for nonproliferation. ISTC is uniquely challenged in this regard given the traditional autonomy of research institutes, the Center's multi-language environment, and the broad range of technological, cultural, and management activities across extensive geography. In short, ISTC's Secretariat is challenged by IT "communications that don't communicate" and institutes that use software without the appropriate licenses.

To meet these challenges CSP is pursuing the use of standardized CIT and software as well as the remediation of specific CIT deficiencies. This report also recommends having CSP work with select champions (e.g., PPMs, SPMs, and PMs) and select FR/CIS institutes to implement more uniform IT strategies and to use these select examples as role models for success.

3. Tactical Communications. CSP's third major challenge concerns tactical communications and the reality that CSP personnel need to work in remote locations where communications services range from poor to non-existent including a total lack of telephone, fax, mobile phone, e-mail, or even public phones. As stated by the CSP Program Manager,

> We cannot expect normal productivity and personal security to be retained in the absence of basic communication services. Achieving a basic service connection at an institute can take time. While this activity is being accomplished CSP personnel are often out of contact with ISTC and the institute cannot participate in ISTC activities."

Basic assessment and connectivity procedures for an institute take time and extended delays can result in lack of institute cooperation and CSP frustration with meeting proposed objectives. Accordingly CSP has developed two integrated equipment and software packages to lessen these tactical challenges.

- The "Road Warrior" technology package was developed by CSP to solve communications challenges of CSP personnel when traveling to distant locations to assess and enhance the CIT capabilities of select RF/CIS Institutes. Road Warrior includes a laptop, satellite cell phone, and mapping software that allows CSP personnel to communicate with ISTC Secretariat, IT vendors, and other important contacts while working in isolated locations.
- "Fast Start" is designed to solve an Institute's immediate communication challenges by using a satellite dish and rack mounted receiver that are supportable in remote locations.

The objective is to have the Road Warrior and Fast Start technologies be used and re-deployed as select RF/CIS institute CIT capabilities are met and others are included on the list.

Levels of Metrics for Communications Support

Level I – Counting the Basics

- Number of institutes that have had a CIT needs profile
- Number of institutes that have had their CIT needs improved and level and quality of connectivity

Level II – Valuation of Knowledge & Return on Investment (ROI)

- Assessment of quality of CIT capability at lab
- Assessing how well the institutes and PMs use CIT to be internationally open and networked to more effectively
    - Participate in ISTC Programs and Activities
    - Communicate with Science Project Collaborators
    - Communicate with Partner Programs
    - Conduct market and competitive analyses

Level III – Balanced Partnerships and Sustainability

- Meeting CIT staffing, training, and equipment needs for RF/CIS Institutes in a sustainable way
- Finding effective ways to move toward greater CIT uniformity among RF/CIS Institutes and Funding and Recipient Parties

- Meeting tactical concerns of how best to effectively and efficiently provide needed CIT to especially isolated RF/CIS Institutes

SUMMARY

ISTC Travel Support, Seminars and Workshops, and Communications Support Programs have been critically important to (1) initiating and maintaining the sustainability pillar of "Internationally Open and Networked," and (2) promoting sustainable RF/CIS science and technology and nonproliferation. It is important to support the national and international mobility of researchers through the Travel Support Program as well as to provide RF/CIS researchers with conference and workshop venues and with CIT capabilities needed to promote the internationalization of labs. Besides lessening the isolation effects of research teams and networking them to international science, developing science-based networks encourages the creation and dissemination of new knowledge to stimulate technology development in the context of continuous change and increasing internationalization of the scientific base. Furthermore, being Internationally Open and Networked is critically important to balanced partnerships and sustainability through S&T commercialization.

3. Research Excellence –

Contributing to New Knowledge

History has shown that the damaging effects of even temporary financial or institutional crises can be long lasting if not permanent for a nation's Science and Technology capabilities. Going back to the initial state of competence takes far longer than the crisis period and requires more extensive effort than required to sustain the S&T system before the crisis.

Thanks to the resiliency of the Russian S&T community in facing their severe adversity in the early 1990s damage has been limited. But if strong and timely measures were not implemented the crises could have become irreversible. Today, any temptation to lower standards of scientific quality for the purpose of accelerating recovery would be short-sighted. Scientific excellence must remain an absolute requirement.

Jean-Pierre Contzen
EU Member of ISTC's Scientific Advisory Committee
Past Chairman of ISTC's Governing Board
Interview March 22, 2002

SCIENCE PROJECT PROGRAM

ISTC's Science Projects Program was the first and most comprehensive nonproliferation activity conducted by the ISTC. This program of "engagement" directly targets the funding of Former Weapons Scientists (FWS) through the solicitation of project proposals. FWS serve as Project Managers and on project teams and are provided with funding support to transition their research activities to civil purposes. In keeping within ISTC's founding mandate, all Science Projects should have at minimum of 30% FWS.[1]

[1] The identification of FWS is an important topic of discussion. If Former Weapons Scientists are defined as being linked to the Former Soviet Union then, as some advocate, concerns of nonproliferation will diminish with time and age. However, whether we are considering older or younger scientists and technicians, clearly there are degrees of how much a researchers expertise is directly linked, or could be directly linked, to weapons of mass destruction. And such labeling becomes increasingly complex as nonproliferation concerns move from the possibility of building nuclear bombs to weapons of mass destruction based on chemical-, nano-, and biotechnology. The Sustainability Pillar of "Attracting Young Talent" discusses these issues in more depth (see Section 6).

During ISTC's initial years of operation, early to mid-1990s, the Science Project Program, working in consort with the Travel Support and Seminar Programs, provided crucial financial and networking capability to key FWS and their respective research institutes. For example, According to Professor A. Zabrodskii, Vice Director, Ioffe Institute, St Petersburg (Interview, Summer 2002):

> During the mid-1990s funding from ISTC was crucial to Ioffe Institute being able to retain our scientists that formed the core of our areas of research expertise. Through travel grants, seminars, and seed funding for research projects, ISTC was important to assisting Ioffe re-establish contacts in the West and East. Currently, Ioffe has important research and funding contacts with research institutes and universities worldwide. [1]

During the Former Soviet Union (FSU) Russian weapons scientists, due to powerful incentive mechanisms, represented the nation's scientific elite. A current and continuing challenge for RF/CIS S&T systems is how best to:

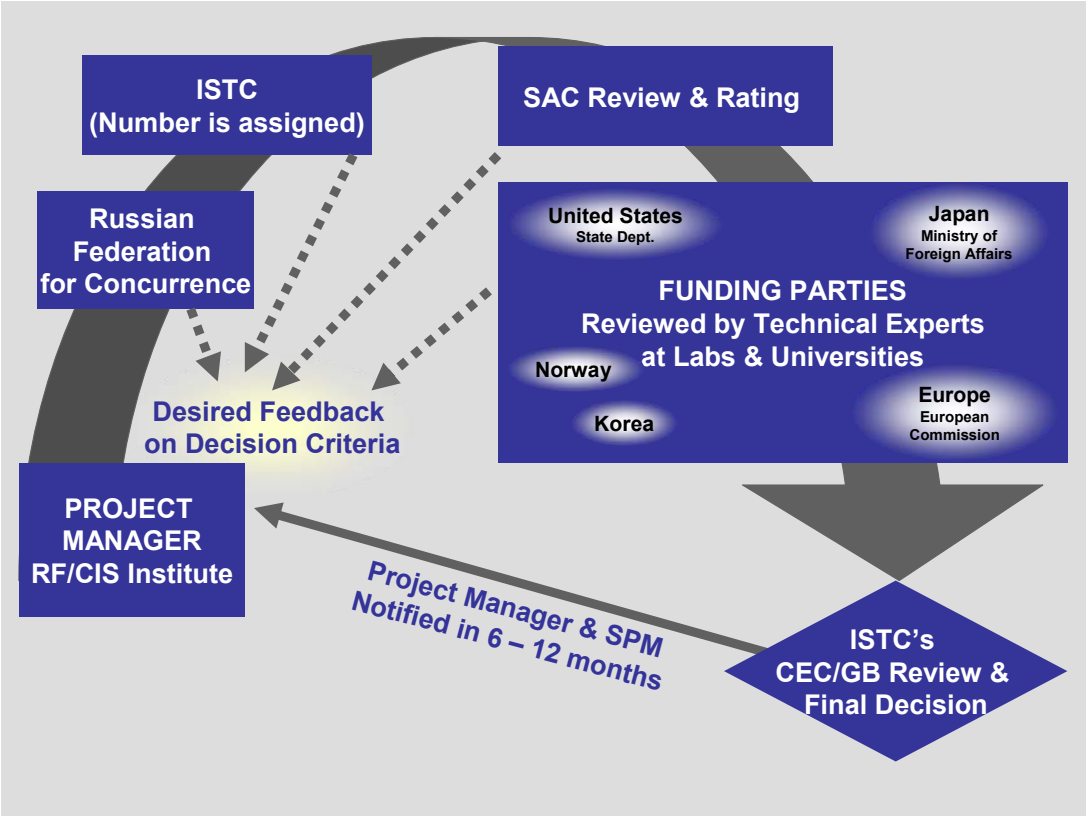
(1) encourage the flow of research funds to where research excellence is being achieved, and
(2) fund systems and organizations that recruit, educate, and retain the most talented scientists to do their best work.

From the inception of the Science Project Program, the ISTC Secretariat and Scientific Advisory Committee (SAC) have worked to maintain and enhance RF/CIS S&T research quality and methods at international levels of excellence. Science Project Proposals come from RF/CIS institutes to ISTC for routing to the Russian Federation (Non-Funding Party) for "concurrence" that assesses the

[1] Ioffe Institute's fundamental discoveries were in the 1930s and the 1950s in solid-state effects and the generation of electrical energy including the first practical use of semiconductors. At the time, the Institute had extensive research contacts and exchange with the West and Asia, but in the 70s and 80s these international contacts decreased considerably (Semiconductor Thermo-elements and Thermoelectric Cooling, A. F. Ioffe's seminal book first published in 1956). As of Summer 2002, Ioffe had 16 funded ISTC Projects with total costs of $14,178,000 and 13 completed projects.

science/technology in terms of national security and political concerns, Figure 4. "Concurred" proposals are assigned a Project Number, given a preliminary assessment by the ISTC Secretariat, and are targeted for review by the Scientific Advisory Committee (SAC). The SAC meets 3 or 4 times/year to review rather large numbers – hundreds - of proposals at each meeting. The SAC is composed of eight members, each with a strong research background: Two from each of the Founding Parties, European Union, Japan, Russian Federation and United States. The SAC members assess each proposal and after internal discussion provide a rating based on scientific excellence, originality, relevance of the subject to ISTC goals, potential for sustainability, cost effectiveness and extent of foreign collaboration.

Figure 4. Path of Science Project Proposals from RF/CIS Institutes, to RF Concurrence and Funding Parties



The Science Project Proposals are then forwarded to representatives of all the Funding Parties: To the European Commission for the EU; the Department of State for the US; the Ministry of Foreign Affairs for Japan, to Korea, and to Norway.[1] Some proposals receive single (one Funding Party) or multiple Party funding and some are not funded. Funding decisions are based on a range of criteria including the SAC ratings, Funding Party reviews, and political concerns. Funded Science Project Proposals are reviewed for recommendation at ISTC's Coordination Executive Meeting and are then submitted to ISTC's Governing Board for final decision. The Project Manager is then notified of the funding decision and is assigned an ISTC-based Senior Project Manager (SPM) for oversight. The proposal process, from initial submission to notification of award takes from 6-to-12 months, Figure 4.

It is important to emphasize, that according to some SPMs and PMs, there is confusion and perhaps misperception as to why certain proposals are funded and why others are not funded. On the one hand, this lack of feedback from the various components of the review process has tended to de-motivate some ISTC staff and Institute-based PMs. On the other hand, increased feedback would provide SPMs and PMs with important knowledge to be able to improve their proposals and as suggested elsewhere in this report (Section 4, Economic Value) such feedback might also include informed opinions on potential commercial and governmental applications of the technology.

Since ISTC is a multilateral, political organization that operates under the mandate of nonproliferation, a range of criteria are used, and should be used, to evaluate and fund Science Project Proposals. On the one hand, this review process might be considered rather complicated and time consuming. On the

[1] Each Funding Party has its own review process. US Science Project Proposals are sent to the Department of State and then forwarded to appropriate technical experts at US Federal Labs and research universities. EU Science Project Proposals are sent to the European Commission in Brussels where they are, depending on the technology focus, sent to select and knowledgeable EU research/technology evaluators (usually based in universities) representing all the member states (the number of member states increased from 15 to 25 in May 2004).

other hand, such a multi-layered review is necessitated by important political and economic concerns of the RF/CIS countries including national security and the potential loss of valuable intellectual property involving premier S&T talent and facilities. The "knowledge capital" of the RF/CIS is considered fundamentally important to RF/CIS economic development and national security.[1] In addition the Funding Parties also have a variety of concerns including nonproliferation, fostering the civil use of S&T, and ensuring that RF/CIS scientific and research excellence that they fund is not used for dual purpose or weapons of mass destruction. An important advantage of such a front-end loaded review process, including multilateral concurrence, for ISTC's clients is that it minimizes the possibilities of downstream RF/CIS challenges to the transfer and application of S&T results to the Funding Parties.

In brief, there are considerable political and pragmatic realities to be accommodated with regard to funding FWS and to fostering continued Research Excellence throughout the RF/CIS. Host Country (RF/CIS) and Funding Party (US, EU, Japan, Korea, and Norway) concurrence reflects multilateral and multi-client objectives covering fundamentally important issues of national and global security. Furthermore, while ISTC and SAC have embraced the view that selectivity for research excellence is key to the development of world-class S&T systems, it is also recognized that there is a broad range of S&T capabilities at institutes throughout the RF/CIS. Accordingly, SAC has worked to enhance and reinforce excellence where it is found and to nurture excellence where it is needed.

Traditionally, ISTC's SPMs have been charged with assisting FWS in writing acceptable proposals as well as assisting with project management leading to successful project completion. Science Project Proposals are usually about 35 pages (in English) and are supposed to include:

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[1] Indeed the "knowledge capital" of the Funding Parties (e.g., R&D at universities, federal laboratories, research consortia) is also considered an important national and regional resource for research excellence and economic development.

- Contact information for all participants
- Summary and detailed project information and task descriptions
- Summary and detailed budgets for each participating institution
- Project locations and equipment for individual tasks
- Expectations of foreign collaborators
- Technical approach, methodology, and project flow chart
- Detailed technical schedule – quarter-by-quarter with individual personnel commitments
- Organizational structure
- Monitoring and Auditing Statement
- Intellectual Property Statement
- Expected results and their applications
- References
- Statement concerning the meeting of ISTC goals and objectives in terms of project oversight and of the transition of former weapons scientists to applying their research capabilities to commercial activities

To assist with project management and monitoring, most ISTC Science Projects have partner research institutes/academic institutions within the RF/CIS and research collaborators within the Funding Parties (US. EU, Norway, Japan, and Korea), see Appendix E overview of Science Projects at 12 Institutes. Ideally Science Project research excellence has been fostered by:

- ISTC/SAC proposal review processes
- On-going SPM project monitoring
- National and international research collaborators

As of January 2003, SPMs and PPMs (some SPMs are newly labeled as Partner Project Managers, PPMs) began transitioning from being "proposal advocates" to "transition advocates." The new focus is to evaluate Science Project Proposals against worldwide research criteria rather than spending time working with institute-based PMs on writing (and rewriting) these science proposals. SPMs/PPMs are to concentrate their efforts in science sectors where they "have acquired an expertise and familiarity in core competencies to provide consolidated analysis and coordinate networks of expertise….PPMs/SPMs will also provide an evaluation of each project's potential either in the research or commercial sector." This shift in focus is to encourage the Secretariat ("Reorganizing the ISTC Secretariat and Implementing Change," January 2003) to:

- Maximize the effort to move scientists quickly off dependence on ISTC funding and into their own successful, self-supporting careers
- Manage science in specific topic areas and to provide services to the beneficiaries demonstrating the added value of ISTC projects to the Parties
- Better support the identification and maintenance of long-term strategic partnerships in key areas of ISTC activities

FOSTERING & INCREASING Research Excellence

The achievement of quality and excellence in S&T programs worldwide is associated with mechanisms of peer review by informed scientists. Common international metrics used to assess S&T quality worldwide include:

- Publications in refereed scientific journals
- Bibliometric analyses of research citations
- Competitive national and international research grants and awards of recognition

While such performance appraisals are attractive to policy makers, there is a need to distinguish between important qualitative and quantitative differences and

statistical artifacts (Smith, 2001). It needs to be emphasized that there are limitations with all indicators of S&T productivity and quality. Indeed researchers have confirmed the need to consider such commonly used quantitative indicators as "entry points into discussions," due to their limited relevance and limited comparability (Barré, 2001).

For example, within the RF/CIS if a metric of research excellence relies on "the number of publications in prestigious refereed journals," one needs to consider that publishing in English in a Western journal might not be a feasible, or an attractive use of time, for a FWS Project Manager who is centered on locating and maintaining funded research with a partner either within or outside the RF/CIS. Furthermore, publication in quality Russian research journals might be considered more important to Russian researchers for peer recognition and career development despite the fact that Russian research publications might not get the same volume of reviews and citations as a Western publication.

As noted in the Gokhberg (2002) survey of PMs at RF/CIS institutes:

> Among the considered conditions of scientific productivity, a direct connection with a number of prestigious publications was established concerning the type of R&D (basic research), type of lead institute (higher education institutions), participation of supporting organizations, and the personal characteristics of project managers (having a scientific degree, or a medium-level administrator) and such considerations as having Internet access and being fluent in English.

ISTC research quality assessments ostensibly occur:

1. At the initiation of a project: As accomplished by ISTC's proposal review process that includes the SAC, Funding and Recipient Parties, scientific collaborators, and the CEC and GB reviews. A request voiced by interviewed SPMs (and which was echoed by the Institute-based PMs) is for increased feedback from the Funding Parties to SPMs and PMs on "criteria for selection" ---

why a particular proposal was funded, or not funded, whether it be for technical, proposal quality, political, or others considerations, see Figure 1. Such feedback, it is suggested, would enable PMs and RF/CIS Institutes being able to transition toward more effective proposal writing and to a more effective SPM, PPM, and PMs transition efforts.

2. At key points during the research project: As accomplished by ISTC's SPMs and PPMs as well as national and international research partners and collaborators. During project execution, quality assessments rely on the analysis of comments from collaborators and partner institutions. Such Science Project monitoring includes audit reports and yearly on-site visits conducted by Senior Project Managers (SPMs). Research quality is also ostensibly monitored through such activities as:

- Information exchange via email, phone, and fax
- Quarterly technical reports
- Cross-checking of obtained results
- Tests and evaluation of research equipment

An important challenge to fostering research excellence it the reality there has been great variety in the intensity and quality of effort in monitoring such excellence on the part of ISTC's international partners and research collaborators. While some do little more than fill out the required paperwork, others actively engage to bring value-added expertise and mentoring to the process.

3. At the completion of the project: As indicated by feedback from research partners and collaborators. Additional quality assessments occur through knowledge dissemination and peer review at CAS seminars, conferences, and workshops. Furthermore, in the context of this report toward fostering balanced partnerships and sustainable nonproliferation, end-of-project metrics should also include assessments of:

- Amount of follow-on research and/or commercialization activities and funding
- Attraction and retention of young talent
- S&T Contributions to National Purpose and Public Interest

- S&T contributions to Societal Value

RECOMMENDATIONS

On the one hand, a sustainable S&T system must have as one of its core principles the pursuit of research excellence that improves the chances of extending S&T boundaries and discovering knowledge that increases understanding of fundamental processes, i.e., Societal Value. At the most fundamental level, this activity alone legitimizes the claim of the scientific community on resources for its work and earns respect for its contribution. On the other hand, there are tremendous gaps in the value chain that flows from:

(1) The discovery and dissemination of new knowledge, to
(2) Return-on-investment (ROI) which centers on payback for the considerable intellectual and financial capital invested in S&T research and development.

While it is important to be aware of the considerable challenges confronting national and regional S&T systems within the RF/CIS, there remains an overriding need to promote research excellence that will:

- Establish and institutionalize processes of research monitoring and accountability
- Attract, grow, and retain young talent
- Promote balanced international cooperation

Against this background, any consideration of commercially "exploiting" S&T opportunities for the RF/CIS, must encompass the need for a "culture of rigor," fostering research excellence (e.g. Conceição et al., 2002).

In this report, with regard to the ISTC, it is suggested that for sustainable nonproliferation the value chain needs to benefit RF/CIS regions as well as Funding and Recipient Parties in contributing to: [1]

1. **Economic Value (see Section 4)**

   Although research excellence is not a sufficient condition for high rates of successful technology commercialization (Kroening, 2002) a solid research base is important for "downstream commercial success" (Contzen, 2003) and in terms of this reports Pillars of Sustainability, research excellence is considered crucial to the sustainability of RF/CIS research institutes in terms of:

   - Attracting multi-sourced funding and quality research collaborations at home and abroad (Section 5)
   - Attracting, educating, and retaining talent (Section 6)
   - Contributing to National Interest/Public Purpose (Section 7) and Societal Value (Section 8)

2. **National Purpose and Public Interest (see Section 7)**

   Smilor, Gibson, and Kozmetsky (1988) suggest that two factors are fundamental to the development of globally-competitive, sustainable technology regions:

   - The achievement of scientific preeminence in technology-based research
   - The development of new technologies for established and emerging industries

   With regards to this report, National Purpose and Public Interest includes as the clients and end-users both (1) large and small businesses, and (2) the wide

[1] The quest for S&T research excellence is also key to supporting the other sustainability pillars of Internationally Open and Networked as quality research collaborations allows RF/CIS institutes to achieve and maintain higher levels of international connectivity; Multi-sourced funding benefits from research excellence; and Young Talent as talent is attracted to institutes that have a reputation for research excellence

variety of public purposes where governments and non-government agencies are the clients including:

- Defence
- Healthcare and quality of life
- Environment and critical infrastructures

3. Societal Value (Section 8)

Both sets of users (private and public) benefit from the emphasis on research excellence and both should encourage, through discriminating behavior and the flow of funds, those research areas where excellence is being achieved. It is important to reinforce domestic and international funding and reward systems to motivate the most talented RF/CIS scientists to do their best work for increased:

- Contributions to a world-wide sustainable knowledge-base for the 21st Century
- Dissemination of scientific methods and results

As Gokhberg (2002) states in his summary analysis of RF/CIS-based PMs:

> ….it is possible to note that indicators of scientific productivity reflect an orientation to scientific results (prestigious publications) or to an economic effect (patents) as well as for public interest such as infrastructure development and healthcare applications.

LEVELS OF METRICS for Research Excellence

There needs to be a broad range of measures that can be, and should be, used to assess the research excellence of ISTC funded Science Projects as no single measure is sufficient. Using a broad range of metrics is especially important given the complexity of ISTC being a multilateral, political organization that must include the interests of Funding and Recipient Parties as it works to achieve balanced partnerships and sustainable nonproliferation in diverse regions across the RF/CIS.

Furthermore, it is suggested that **Partner Projects** be examined with an appreciation for research excellence as well as commercial potential and that **Science Projects** be examined with an appreciation for commercial potential as well as scientific excellence. Currently the main form of quality control for Partner Projects has been based on market-based decision making: The funding partner's willingness to pay for the research activity. This has been judged to be sufficient to guarantee a purposeful outcome and to justify the work. However, there is a broad range of motivation on the part of the Funding Partners and Parties. Indeed, there is a preponderance of public funds being used in partner projects. There should be no compromise on the criteria of research excellence in cases where imperatives of commercial application, at least in the short term, are less compelling.

It is important to appreciate differences in academic, government, and business metrics for research excellence as follows:

- Academic success is less time constrained and is based more on scientific excellence, dissemination of knowledge, and peer review
- Government laboratory research excellence is based more on mission accomplishment and contributions despite the cost
- Business R&D is more time constrained and is focused more on timely results, protecting Intellectual Property, and return on investment (ROI) including cost savings and increased profit

These different perspectives need to be reflected in the metrics applied to the newly forming ISTC DED responsibilities of: Fundamental Science, Applied Technology, and Balanced Partnerships and Sustainability.

Level I – Counting the Basics

- Amount of Funding
- Articles published and bibliolometric analyses

- Scientific awards
- Number and quality of research collaborators
- Projects successfully completed as assessed by Funding Parties

Level II – ROI - Valuation of Knowledge and IP

- Collaborative research projects with prestigious partners: Nationally and Internationally
- Project managers and research institutes that form Science Project agreements with national and international research centers and who earn intellectual leadership roles in these projects
- Project managers and research institutes that attract national and international funding and increased numbers of partners
- Research institutes that spin-off talent to private sector companies either within the RF/CIS or Funding Partner Countries

Level III - Balanced Partnerships and Sustainability

- Sustainable partnerships --- partnerships that grow in terms of
    - Funding and involvement of institute staff
    - Increasing complexity and scientific importance
- Project managers and research institutes that attract, grow, and retain talent
- Institutes and research teams that "learn by doing" and show progress toward increased excellence, increased commercialization success, and increased contributions to civil research
- Research institutes that
    - Spin-off technologies and talent to start-up firms
    - Acquire increasing amounts of multi-sourced funding
    - Contribute S&T to Public Interest and Societal Value

4. Economic Value

Despite the fact that ISTC's earliest programs and activities focused on engagement (funding) of Former Weapons Scientists (FWS), it soon became clear to the Secretariat that some RF/CIS funded Science Projects had commercial potential/economic value. There also was the realization that for nonproliferation to be sustainable there needed to be a segment of research activity that would provide, directly or indirectly, the financial resources to support researchers and to fund up-to-date research facilities. In general ALL of ISTC's programs and activities impact the Sustainability Pillar of Economic Value. In Section 4 we focus our description, critique, and recommendations on the following three programs:[1]

- Business Management Training (BMT)
- Valorization Support
- Patent Support

It is understood that as a result of major ISTC reorganization in early 2003 that Valorization Support is no longer an active program, that BMT is undergoing considerable reorientation, and that Patent Support is the focus of considerable review and enhanced importance as ISTC moves toward more actively supporting balanced partnerships, technology commercialization, and sustainable nonproliferation. However, it is believed that through "lessons learned" by all three of these programs, Section 4 of this report offers important and useful roadmaps for ISTC 2012.

[1] Economic Value is also supported by other ISTC programs including Science Projects, Partners, Workshops and Seminars, Communication Support, Technology Database, and Travel Support. Each of these programs is discussed under different Sustainability Pillars as indicated in Table 1, page 8.

BUSINESS MANAGEMENT TRAINING (BMT) PROGRAM

To maximize the sustainability of RF/CIS weapons scientists in peaceful research initiated through ISTC projects and enable them to secure funding independent of the ISTC parties by providing training in, knowledge of, and access to business and commercialization resources.

Mission of the BMT (2002)

In keeping with ISTC's objective of encouraging and facilitating the civil use of RF/CIS science and technology and the transition to market economies, the Business Management Training Program (BMT) was launched in 1997 to:

- Educate Former Weapons Scientists (FWS) in the basic concepts of market economies and technology commercialization
- Train FWS to be able to better promote the results of their research in international technology markets

The objective has NOT been to provide FWS with a comprehensive business education or to graduate professional managers. BMT courses are usually offered in Regional Training Centers convenient to ISTC Project Managers throughout the RF/CIS. Course instructors come mainly from local institutions with occasional international consultants. BMT programs usually have 15-30 participants and range from short-term (1-5 days) to long-term (6-16 weeks) with the overall objectives of having FWS:[1]

- Understand the basics of technology transfer and commercialization including international perspectives
- Appreciate the importance of intellectual property rights (IPR) and protection
- Consider the research results as potential technologies for commercialization
- Initiate contacts with regional experts and international professionals

[1] Specific topics include technology transfer and commercialization, technology marketing, IP management, business planning, funding opportunities, information technology for business, business communications and public relations, quality management and standards certification, R&D project management, and entrepreneurship. BMT also offers specialized courses, language training, assists in some ISTC staff training, and develops training manuals. On a case-by-case basis BMT offers training to assist with the successful completion of a specific project.

- Learn strategies for making effective presentations to the international business community – to increase self-confidence and credibility
- Understand the basics of business plans and finance and how to secure funding and investments from sources outside the ISTC

These were, and still are, very challenging training objectives as, in the words of the Director of the BMT Program (Summer 2003), "Many Former Weapons Scientists (FWS) do not even think that they should work to raise funding from their R&D results and skills." While BMT as well as other ISTC programs and activities have contributed to educating, training, and motivating FWS toward better understanding of market economies and S&T valuation, the challenges have been, and continue to be, great. Indeed, it needs to be emphasized that these challenging tasks also apply to Federal/National Lab researchers, technicians, and administrators in the US, EU and Asia - researchers who have had the benefit to be educated in, and who have spent their professional careers working and living in, market-based economies.[1] In short, it is a significant challenge to have FWS (or Federal or university-based researchers) in any developed country gain a basic understanding of:

- How to value their S&T in terms of potential markets: nationally and globally
- How to effectively present research results in terms of business needs and commercial applications
- What potential business investors and partners expect, if not demand, in a research/technology commercialization project

Realizing the limited effectiveness of "traditional" training courses, in late 2002 BMT began to experiment with training/mentoring programs within the EU and US. These "learning by doing" programs were designed to enable select RF/CIS researchers to become, at least temporarily, immersed in foreign markets and business environments

[1] "East Tennessee's 21st Century Jobs Initiative: Creating Wealth for a Sustainable Economy," by D. Gibson, J. Jarrett, G. Kozmetsky, and R. Seline (1996) a report by The IC² Institute, The University of Texas at Austin and sponsored by Tennessee's Resource Valley, Lockheed Martin Energy Systems, and Oak Ridge National Laboratory (ORNL). This report describes the challenges ORNL has is building technology partnerships with large and small or start-up firms even within the regional area of East TN.

while they worked to commercialize technologies selected from their institutes, please refer to the following example.

Case Description: Training/Mentoring in Austin, Texas

During September-October 2001, a 5-week ISTC funded and organized training/mentoring program on technology commercialization was conducted in Austin, Texas for three scientists from VNIIEF. The main objective was to have focused "learning by doing" for select champions from a key Russian lab and to take these champions to a higher level of understanding of what it would take to accelerate and expand VNIIEF technology commercialization processes. Related objectives included:

1. Getting the "trainees" engaged in technology-based business technology commercialization activities including meeting entrepreneurs, venture capitalists, networking, presenting technologies, and negotiating, etc.
2. Championing carefully selected VNIIEF technologies to potential Austin-Based partner companies
3. Building networks and relationships with key U.S. business partners so they could champion the commercialization process of VNIIEF technologies
4. "Training the trainers," having the "trainees" transfer their newly acquired knowledge and lessons learned back to colleagues at VNIIEF

While in residence in Austin, Texas the VNIEFF trainees networked with potential partners and customers through the Austin Technology Incubator (www.ic2-ati.org) and The Capital Network (www.thecapitalnetwork.com) and with local technology companies and associations (www.AngelouEconomics.com and http://www.techbiz.com. They participated in workshops, seminars, conferences, and networking events throughout Texas while being coached by University of Texas at Austin MBA students and local business mentors.

Outcomes: The training/mentoring did fundamentally change the way the trainees viewed commercialization processes, the importance of networking, and how to effectively present their technology and entrepreneurial ideas to potential customers.

Challenges: No Return-on-Investment (ROI) or lasting commercialization activities or partnerships resulted from these efforts primarily because:

- The descriptions of the VNIIEF technologies were too abstract and difficult to explain to potential US business partners and entrepreneurs, in terms of specific market applications. The gap between elegant science and real market applications was too great to establish meaningful communication leading to partnering activities.
    - There was no prior market evaluation of VNIEFF technologies in terms of Austin-based or Texas-based companies or in terms of global competitive assessments

- Building relevant and useful contacts and relationships takes time and just as these networks were beginning to be formed the trainees returned to VNIIEF after their 5 weeks in Austin
- Maintaining Internet and other business oriented communication links after the trainees returned to VNIIEF proved to be exceedingly difficult as participants in both Austin and in VNIEFF got consumed with day-to-day, near-term tasks and challenges soon after the Training/Mentoring Program ended
- There was no funding to support dedicated talent and effort to maintain and improve the technology commercialization links between VNIIEF and Austin, Texas

Recommendations for ISTC Training

I want to be as effective as possible with my work. There are always new technologies and new methodologies concerning project management, personnel management, and resource management. ISTC Staff should be made aware of these opportunities and be trained in those that are most useful to our work at ISTC, and in terms of specializations in terms of recent scientific achievements.

Senior Project Manager
Summer 2002

Most SPMs have had technology careers and been trained in science methodologies, but not project management. They rely on their own personal views and individual approaches of what to do and how to do it and this may not be the best way. As a result there are no overall standards [except for the basic ISTC procedures to follow] for Project Management at ISTC. Also, there is very little overall orientation to best practices for SPMs and to share the best techniques with Project Managers.

Senior Project Manager
Summer 2002

Training for the Secretariat and RF/CIS

The emphasis of BMT has been on introducing FWS to the realities of market economies including such topics as technology commercialization and intellectual property rights. During data collection, IC² Institute and international researchers were made aware of the general observation that ISTC Training needed to be more integrated with ISTC program activities and with the needs of ISTC staff. Indeed, such targeted training would seem to

be even more important as ISTC evolves toward balanced partnering, technology commercialization, and sustainability objectives and as SPMs and PPMs move from being "proposal to transition advocates." Such training could include:

- Technology transfer leading to ROI in established firms in the RF/CIS (Recipient Parties), Funding Party Countries, and Funding Partners
  - Challenges and facilitators to effective Knowledge/Technology Transfer across organizational and national boundaries
  - Effective Networking across multi-cultural environments: US, EU, Japan, Korea, and Norway
- How best to conduct "Quick Look" and in-depth technology assessments in terms of national and global market applications
- IPR training on how to, and whether or not to, apply for a RF or international patent (see discussion later in this section under Patent Support)
- Fostering spin-out and start-up companies in the RF/CIS
  - Venture Plan Creation, Technology marketing, and Risk Analysis
- Keeping current with legal and business changes in the RF and host countries
- Recognizing the differences in business networking and partnering with small, mid-sized, and large firms and across public and private sectors
- Resource and time management to assist with increased volumes of work including
  - ISO 9000 Project Management
  - Computer tracking and modeling for effective project management

Accelerating Regional Technology-Based Growth: IN RF/CIS and Abroad

With ISTC's increased emphasis on partner balance and sustainable nonproliferation including issues ranging from technology commercialization to regional technology-based development, ISTC Training could take on an enhanced role for ISTC Secretariat staff (e.g., SPMs/PPMs) as well as RF/CIS regional influencers (e.g., local academics and government personnel) and even select personnel from the Funding and Recipient Parties on such topics as:

1. How best to conduct regional assessments of strengths, weaknesses, opportunities, and threats (SWOT) for regionally-based accelerated technology growth in the RF/CIS
2. Best practices for accelerating the development of technology clusters in such areas as nano-technology and bio-technology through national and international alliances.
3. Technology-based entrepreneurship through regionally-based spin-out and start-up activity leading to fast-growth firms

Distance Training

Distance training would seem to be an important future consideration for ISTC given the vast geography, time, and difficulties in physical transportation to many geographically remote RF/CIS institutes. Properly used distance training could facilitate RF/CIS institute leveraging and sharing of resources, talent, and commercialization efforts and would help prepare ISTC and Institute staff for working in an increasingly global and digital world of R&D, product development, and market access.

In terms of the core mission of ISTC, it would seem that in the future the most geographically remote RF/CIS institutes will pose the most significant potential threats in terms of proliferation of weapons of mass destruction. And it would seem that the "transitioning" of the scientists and technicians at these remote institutes would be especially important as well as especially challenging. Employees at RF/CIS S&T Institutes based near the major cities have a broader range of employment opportunities outside the institute, whereas S&T Institutes located in remote regions have limited alternative employment opportunities. In addition there are increased challenges to self-sustainability due to lack of regionally-based infrastructure and local markets. With assistance from ISTC's Communication Support Program (see Section 2) these institutes do have, or could have, the needed CIT to offer customized distance training --- training based on "learning by doing" and the commercialization of RF/CIS technologies in the Funding and Recipient Parties, please refer to the below listed proposal.

Proposal for Distance Training in Science & Technology Commercialization[1]

The following scenario describes a 2-phase program leading to a self-sustaining ISTC training programs customized to the needs of a ISTC SPMs and PPMs and RF/CIS institutes including enhanced international partnering and technology commercialization.

Phase I would begin with the selection of 10-15 SPMs/PPMs (and perhaps a few carefully chosen PMs from select RF/CIS institutes). These "Core Trainees" would spend two-weeks in a technology region of a Funding Party (such as Austin, Texas) where they would be exposed to customized training/mentoring programs in S&T Commercialization. Over time different technology regions within all Funding Parties could be selected for these visits. "Core Trainees" would be selected on the basis of their being effective entrepreneurial champions and their ability to communicate in the needed languages. Follow-on training and partnering activities would be taken over the Internet at the ISTC and at the participating institutes.

"Core Trainees" would each select several "close to the market place" ISTC Science/Technology Projects as "learning by doing" examples. The "Core Trainees" would be part of "virtual commercialization teams" made up of Project Managers from the Institutes as well as US/EU/Japanese/etc. team members. Personal relationships would be initiated among these team members during the two-week training/mentoring programs in the Funding Party Countries.

"Core Trainees" would work to commercialize the RF/CIS technologies (i.e., learning by doing) during the training program that would use distance education technologies (e.g., video streaming, video conferencing, and chat rooms) to continually link RF/CIS trainees at several lab locations with executive "partners" in US, EU, Japan, Korea, etc. The objective is to have the Training/Mentoring Program be results oriented and focused on Russian realities as well as the technology commercialization needs of Partner Companies and Funding and Recipient Parties.

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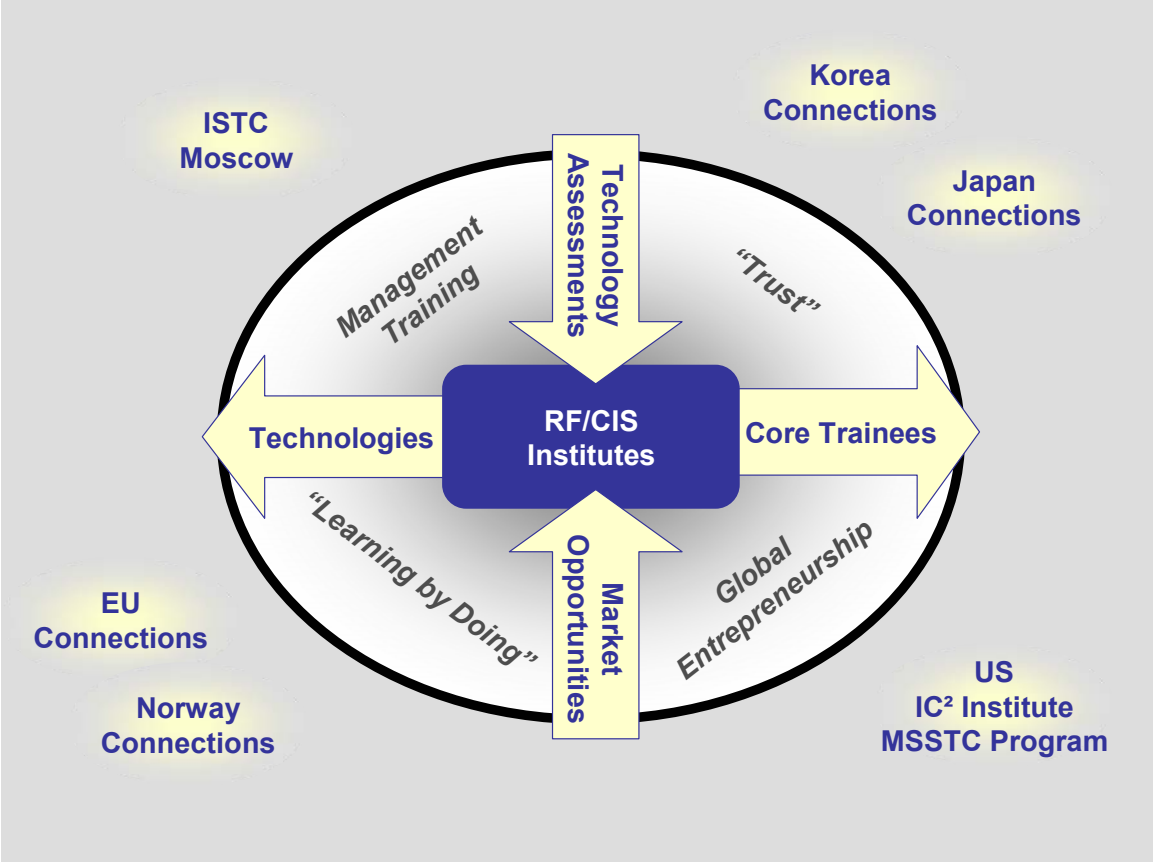
[1] This concept is based on the IC² Institute, University of Texas at Austin's one-year Masters of Science Program in Science and Technology Commercialization [www.IC2.org/msdegree]. The program has been offered since 1996 and has included virtual technology commercialization teams made-up of students from US, Europe, China, Latin America, Japan, Korea, and Russia. Executive students in Austin, Texas include such companies and their networks as Motorola, IBM, 3M, and National Instruments. The proposed ISTC Certificate Program would focus on specific knowledge and tasks most needed by SPMs, PPMs, and RF/CIS technicians/researchers/ institute directors/staff including such topics as:

- Quick Look technology assessments
- Selling to Investors: Venture and Angel Capital
- Transferring and commercializing technologies
- Spin-outs and start-ups: Building fast-growth technology-based ventures in Russia

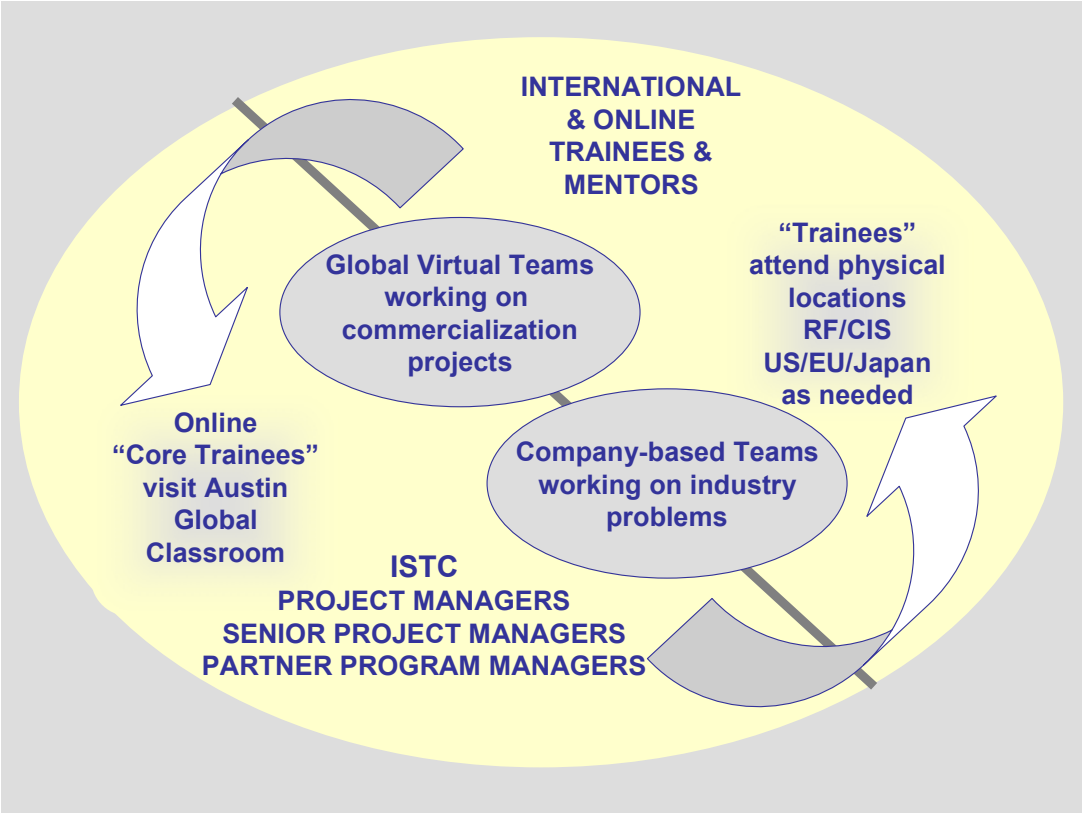
Figure 5. ISTC Virtual and "Learning by Doing" Technology Commercialization Training Activities and International Technology Commercialization Networks



Phase I would be the 1st year and a Beta Test of the program for customizing/localizing the training material. Phase II would include an expansion of the program to additional RF/CIS institutes and would benefit from "lessons learned" and the refinement of training material of Phase I. Funds for sustaining the program could, over time, come from:

- Student tuition that will be kept at a reasonable rates
- Partner Companies sponsoring RF/CIS talent enrolled in the ISTC Training Program
- Companies and VCs who have options to license RF/CIS technology spinning out of the ISTC Training Program
- Equity in RF/CIS technologies and start-ups nurtured by the ISTC Training Program and commercialized in global markets
- Equity in RF/CIS technologies/start-ups nurtured in the ISTC Training Program and commercialized in Russian markets – leading to the longer-term goal of producing wealth and jobs in the regions of the RF/CIS Research Institutes

Figure 6. Global Technology Training and Commercialization Laboratory



Leveraging Training Resources

As new training needs are assessed at the ISTC Secretariat there needs to be a review of available training options and resources to leverage the talent and expertise of established regional and international training programs/organizations such as the Academy of National Economy, RF; SABIT; and the British Council as well as training programs in other CIS regions such as the Science and Technology Center of the Ukraine [see www.cnews.ru/education]. As noted by one ISTC Staff:

> Everybody under the sun has training programs – the British Council, the Dept. of Commerce, SABIT, TACIS, DELTA Capital on such topics as effective business plans, technology commercialization, venture capital and finance, IPR etc. The question is how best to leverage what exists, to get the best of the best and to determine metrics for success? Then we need to determine ISTC's niche, where ISTC training can be value added and cutting-edge.

As indicated, "customers" for ISTC Training might be expanded to include RF/CIS regional business, government, and academic leaders concerning how to accelerate technology-based growth and the development of regional technology clusters. In addition, new training programs will be needed for SPMs and PPMs so that ISTC will be an effective change agent in promoting activities to enhance the economic value of funded research results for regional development as well as for funding Parties and Partners. Such programs should stress the importance of coordination, cooperation, and potential synergies across parties and across program areas – leveraging knowledge and networks for sustainability: regionally, nationally, and globally.

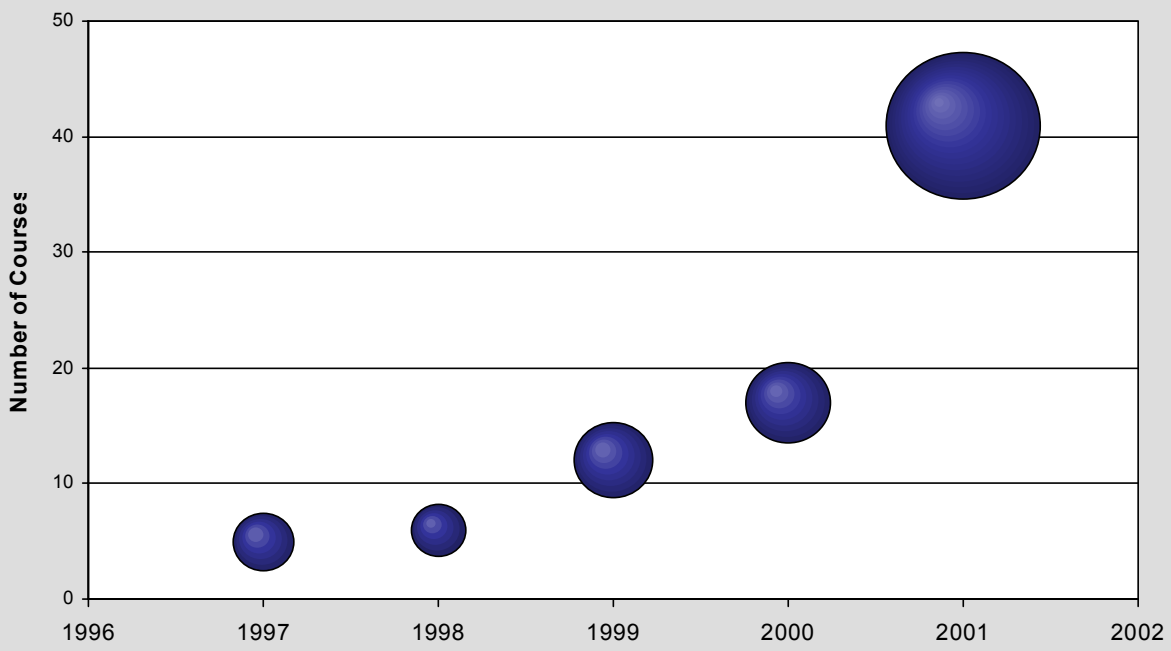
It needs to be remembered US, EU, and Asian corporations are continually training their professionals in best practices in fostering entrepreneurship, IPR, and technology commercialization and Western regional economic development professionals also are continually being trained in how best to foster technology-based growth. For example, IC² Institute's Masters in Science and Technology Commercialization Program [http://msstc.IC2.org] offers courses in technology assessment and transfer, management of intellectual property, and finance and marketing for new-to-the-world technologies to senior managers from large and start-up technology companies to managers from IBM, Applied Materials, AMD, and US Federal Labs and universities. These professionals are essentially faced with similar, but less daunting, challenges of knowledge/technology transfer and commercialization as are ISTC SPMs and PPMs. If the world's leading technology firms see the need for K/TT training it should be assumed that there are much greater training and education challenges facing ISTC staff and clients. It is not that ISTC should be responsible for all such training, but that ISTC and other national and international organizations work together to better leverage resources and talent given the immensity of the challenges.

Traditional Metrics on Training

As Figure 7 shows, there has been a steady increase in the total number of BMT courses offered from 5 in 1997 to 41 in 2001 and number of trainees has grown from 211 in 1997 to 1311 in 2001. Budget levels and funding for BMT grew from $20K in 1997 to $510K

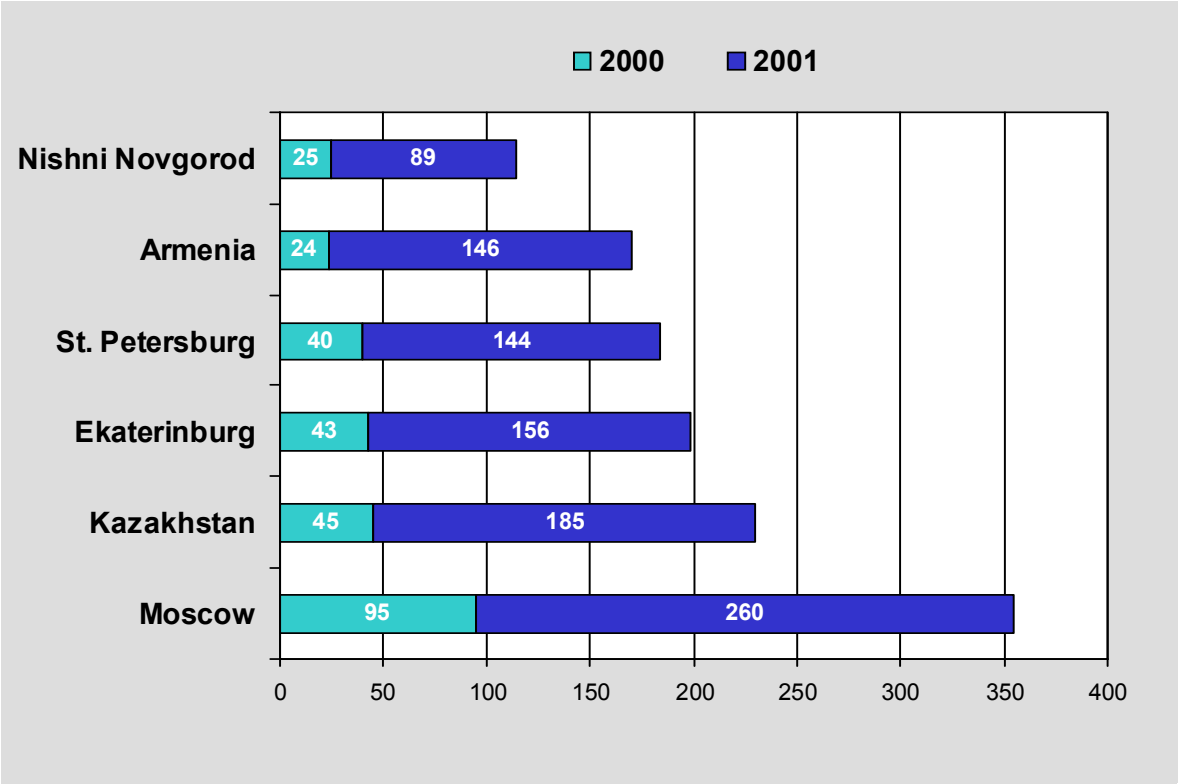
in 2000 and decreased to $490K in 2002 with a great percentage of these funds coming from the US Party. Training expenses increased from $95.00/trainee in 1997 to $322/trainee in 2001. Figure 8 shows the number of trainees by regional technology center (RTC) indicating that in 2000 and 2001 the greatest number of trainees were in Moscow followed by Kazakhstan, Ekaterinburg, St. Petersburg , Armenia, and Nishni Novgorod.

Figure 7. Growth of number of BMT Courses Offered 1997 to 2001



Bubble "height" indicates the number of courses.
Bubble "size" indicates the total number of trainees by year.

Figure 8. BMT Trainees by RF/CIS Region in 2000 and 2001



Overall, course surveys administered by BMT, indicate that the attendees gave high evaluations of course content and course instructors. According to the Gokhberg survey (2002) approximately half of all ISTC funded Science Project Managers have participated in BMT training programs.

Levels of Metrics for Business Management Training

Different levels of quantitative and qualitative metrics are listed below to indicate an evolution from "counting the basics" in term of engagement of Former Weapons Scientists to concerns of self-sustainability and balanced partnerships.

Level I – Counting The Basics

- Number and type of courses offered
- Number of Former Weapons Scientists attending a course and their
  - Institute and region
  - Technology specialization

- Cost of training
- Course Satisfaction Surveys

Level II – Valuation of Knowledge and Return on Investment (ROI)

- Training program impact on
  - Technologies commercialized
  - Partnerships formed
  - Markets accessed
- New training program impact on
  - SPMs and PPMs becoming effective transition advocates
  - Effective K/TT to Funding Partners
  - Realistic assessments of RF/CIS institutes assets and challenges for sustainability
  - Realistic assessments for accelerating regional economic development in RF/CIS

Level III – Balanced Partnerships and Sustainability

- Self-Sustainable RF/CIS researchers
- Self-Sustainable RF/CIS institutes
- Self-Sustainable RF/CIS regions

Conclusion

Science and technology commercialization leading to the increased competitiveness and growth of firms, industry clusters, and regions --- getting wealth and increased competitiveness (ROI) from knowledge --- are challenging tasks under the most favorable circumstances within developed market place economies. ISTCs stakeholders including Funding and Recipient Parties, Project Managers, DEDs, PPMs, and SPMs are faced with considerable added complexities of linking S&T knowledge developed in RF/CIS institutes:

(1) across institutional and political boundaries within developing regions within the RF/CIS, and

(2) across oceans, national boundaries, cultures, and time zones into developed market-oriented economies of the Funding Parties.

On the one hand, in the current global economic recession western and eastern businesses and economic development regions are especially concerned with minimizing risk and

maximizing profit that may tend to work against establishing partnerships and alliances with what are perceived to be high risk environments in the RF/CIS. On the other hand, these globally competitive businesses and regions are also concerned with cutting costs while having access to world-class R&D talent and technologies. The later set of issues should work to the advantage of RF/CIS-linked technology-business-linked international partnerships. A key component to meeting these challenges is effectively training SPMs, PPMs and PMs so that they are the best possible facilitators and champions for accurate and useful technology assessments and successful transfers leading to successful product/process commercialization opportunities.

VALORIZATION SUPPORT PROGRAM: Lessons Learned

There is no shortage of great technology. What the institutes don't have is management capability and access to markets. PMs see challenges with licensing in terms of the murky issues surrounding their IPR and they realize that they do not have the management and marketing skills not the funding to start their own businesses. They are looking to a middle ground which is a strategic partnership. When I ask PMs, "What do you need?" They respond, "We need a partner," meaning someone with the management skill and the funding to take their technology to market.

Maria Douglass, US STIM
Valorization Support Program
Summer 2002

Launched in 1997, the **Valorization Support Program** (VSP) was formed to support a variety of activities undertaken by ISTC staff including:

- Technology and market assessments for select ISTC Research Projets
- Funding publications such as a ISTC Monograph series
- Outsourcing projects that assess ISTC programs such as with the Center for Science Research and Statistics, Moscow to survey Project Managers on various attributed of completed ISTC projects (Gokhberg, 2002)
- Design of new ISTC initiatives

As stated in a valorization report to ISTC (Douglass, 1999)[1] "The process of fostering the sustainability of project teams is an *organic* process that is varied on a case-by-case, project-by-project, partner-by-partner basis. There are two main approaches used: a technology-driven, and a market-driven approach Technology-driven graduation refers to the utilization of project results as a vehicle for sustainability (Table 4). The market-driven approach primarily envisions a contract R&D or "sponsored research" relationship between a Sponsor (pubic or private sector) and Institute Project Team, often through the ISTC Partner Program.

Table 4. Technology-driven and Market-driven Approach Analysis.

Technology-driven, based upon project results	Common to both technology driven and market driven	Market-driven, based upon project team capabilities as demonstrated by project results
Identification and Characterization of a Result/project team's capability	Supporting Project Team's access to and awareness of Potential Sponsors	Development of Sponsor / Corporate Networks
Technology Assessment	Preparation of Project Team to work with potential Sponsors	Solicit and Process Matchmaking requests
Market Research and Industry intelligence	Facilitating Sponsor-Project Team relationships	Tendering Requests for Proposals for Partners
Technology Implementation Planning and Strategizing	Organizing Workshops for Industry	
Business Planning Assistance	Producing media to disseminate information about Project results, and Project Team capabilities.	

Under the direction of Valorization Support ISTC's "Technology Assessment Committee" (TAC) reviewed technology implementation plans and market research for these select technologies to make "go" or "no-go" decisions that: [2]

1. A technology was not competitive and no one was going to be interested in it
2. A technology looked promising enough to be promoted in world markets

[1] Maria Douglass, "ISTC Policy and Plan for Sustainability," Report to ISTC, 1999.

[2] All completed and ongoing Science Projects were reviewed, from 1994-1988, as ISTC had no database and no basic overall knowledge of what were the most promising technologies. SPMs helped identify technologies which they thought had the most commercial potential. About 50 of the "best" technologies were put through a series of reviews. Some technology and market assessments were outsourced to Funding Partner countries. For example, in 2001 a US-based consultant company conducted market research and competitive analysis of 14 ISTC Projects that had previously been identified as having exceptional commercial potential.

One-page "TOPS Technology Opportunities" flyers were developed that identified each technology's potential market and competitive advantages. While a big improvement from the more obscure Science Projects Abstracts, the dissemination of these TOPS flyers was not effective in terms of locating commercial partners nationally or globally. The US STIM worked to make contacts with US companies based on her personal relationships as well as on "cold calls." Potential partners were researched as to:

- How the company was doing financially
- Whether the company had previously licensed foreign technologies
- If the company had personnel with Russian last names as these contacts were believed to be more likely to accept a call from Moscow

As stated by the US STIM:

> I call up a company and say, 'I've got a technology that can solve this problem of yours. You're the market leader. What do you think?' Making the link from Moscow was very difficult…it takes time. It's all about building relationships and this involves time and geography.

As several SPMs emphasized it is extremely difficult to build and maintain "commercialization networks" in the U.S., EU, Japan, or other nations from an ISTC, Moscow-based location. Part of the difficulty is from sheer logistics (different time zones and high travel costs in terms of funding and time). "Telephone tag is not uncommon and people don't usually call you back" emphasized one SPM. Part of the difficulty lies in the realization that effective Knowledge/Technology Transfer benefits from face-to-face informal networking and relationship building (Gibson and Rogers, 1994).

Balanced Partnerships for Sustainability[1]

By far our most successful partnering arrangements are when we [STIMs] have a known and trusted point of contact with a company. In my view, the reason the partner program is important is because it evolves into this kind of relationship, where there's a representative of the Partner Company that's often local here in Moscow or travels here frequently, somebody that I can contact and they will take my calls right away.

I mean, for example, yesterday morning I just had breakfast with my contact from XXXX - they were an ISTC partner from day one. I was able to "sell" him because I already had the relationship. He comes in, we sit down and brainstorm, and he says, "Well, these are the kinds of things that we are doing." And I say, "Wait a minute. I see a fit here. I've got this technology in my portfolio that fits with the sort of market that you're developing. Why don't you take a look at it."

Now we are looking at an additional technology that sort of dovetails with this battery technology because the market is similar. So, all of a sudden because we had this partner recruited to begin with maybe to do some outsourcing, but now they've moved totally away from that. What they're doing right now --- it's a fabulous thing --- they're looking at this gyroscope navigation device for oil well drilling which also uses the same applications for batteries. They've already looked at the market. They know something about it. They've got some value added here.

But importantly, they are also forming "balanced partnerships" with the Russian research teams. They're saying, "You have worldwide manufacturing rights, we have worldwide distribution rights, we split the profit." That sounds pretty darn good to me. That's exactly what the Russians want. In addition to that, they bring the Russian team members to the U.S. --- they're not teaching them marketing; they're exposing them to the market and the situation that they're both in as partners. All of a sudden, when they [the Russians] can see it tangibly and talk with the equipment manufacturers that will be integrating the batteries into their systems and talk with the people that actually are out there procuring equipment and procuring power supply systems for this equipment, they all of a sudden start understanding.

The Valorization Support Group had a working group to consider ISTC and sustainability issues. As part of this effort, a benchmark was made of the "Sustainability Group" at The Ukrainian Science and Technology Center (STCU). The STCU Sustainability Group has

[1] This Case Profile is based on several interviews during February-June, 2002 with Maria Douglass, former Senior Technology Implementation Managers and Director of the Valorization Support Program, ISTC.

its own budget and supplemental programs that include travel grants, training, and patenting as follows:[1]

1. An administrator who reports to the DED and who is focused on with industry matchmaking and tracking performance metrics
2. Two Project Coordinators (similar to ISTC STIMs but who also manage Partner Projects) who are responsible for "Results Management" that involves visiting all projects to:
    a. Identify technologies with commercial potential
    b. Conduct exit counseling to explain STCU's Partner, Patent Support, and Travel Grants Programs.[2] The goal is to have the PMs be aware of STCU's programs and activities that are available to assist their commercialization efforts
    c. Assist the Sustainability Group's matchmaking activity by being a bridge for the project technologies with the needs of industrial partners
    d. A manager that oversees Training and Travel
    e. A manager that oversees all of the financial aspects of Partner Projects
    f. A specialist in intellectual property rights who also manages the matchmaking database functions.

It was concluded by ISTC's VSP that having all these activities in close coordination, in the same organizational structure, and focused on the same orientation toward specific and clear objectives contributed to the performance of the STCU Sustainability Group.[3]

The level at which ISTC administers its intervention programs is that of the individual. ISTC currently addresses institutional issues indirectly through research teams.

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[1] Based in part of business trip Technical Report of Maria Douglass and Irina Roslova to Science and Technology Center, Ukraine, July 1-2, 2002.

[2] These "exit counseling" meetings are the flip-side of ISTC's "happy face meetings" held at the beginning of a project for new Project Managers.

[3] Technology transfer/commercialization specialists, sustainability group administrator, and project coordinators were activities that were largely performed at the ISTC by STIMs on a limited number of technologies targeted for valorization. In ISTCs current organization structure these activities will be provided by the SPMs and PPMs. STCU's sustainability group is also considering hiring a specialist in technology transfer and commercialization to provide consultation to Institute Project Managers on the implementation of sustainable outcomes from STCU project results.

Nonproliferation and the shift in research activities to a civilian science innovation system is also dependent upon the institutional arrangements, namely consolidation and reorientation of existing institutions and the support of emergent institutions (Meske 2000). There are other factors to consider, including:

- Whether large and small RF/CIS firms are capable of absorbing new knowledge/technologies
- Whether regional support structures are capable of nurturing and growing spin-out and start-up technology companies
- The level of supportive government policies, regionally and nationally
- The availability and sustainability of world-class science education

Recommendations

If you're benchmarking ISTC technology transfer operations to the United States, say the university situation, you've got to look at how much U.S. university out-licensing takes place across international boundaries, across the Atlantic Ocean? For most of it they're looking at in-state versus out-of-state. That means that we should also be looking at the ISTC and saying, 'Okay, how much of ISTC technology at a given institute has been locally transferred.'

Maria Douglass
STIM
Interview, Date

Technology/Market Intermediaries might be considered by ISTC as one way to overcome many of the K/TT challenges discussed throughout this report. Such Intermediaries could come from the RF/CIS and Funding Parties and would link technologies-to-market applications by bridging the communication gaps between:

(1) PPMs, SPMs and PMs
(2) Potential technology customers or users

Because of career training, work experience, and association with particular science projects at ISTC, most SPMs (and now PPMs) are wedded to specific technologies and projects that they attempt to sell to potential customers. Such a "technology push" model

runs counter to most cases of successful technology transfer to commercial application that originate from market pull and at times "unexpected combinations of technologies and market needs and applications" (J. Contzen, 2003). Technology/Market Intermediaries should have a broad-based knowledge of customer needs within particular technology sectors, extensive personal networks within the markets they are serving, they should speak the language/jargon of the technologist. Salaries of the Technology Brokers could be based on a percentage of the deals that they are able to put together and manage to successful conclusion.

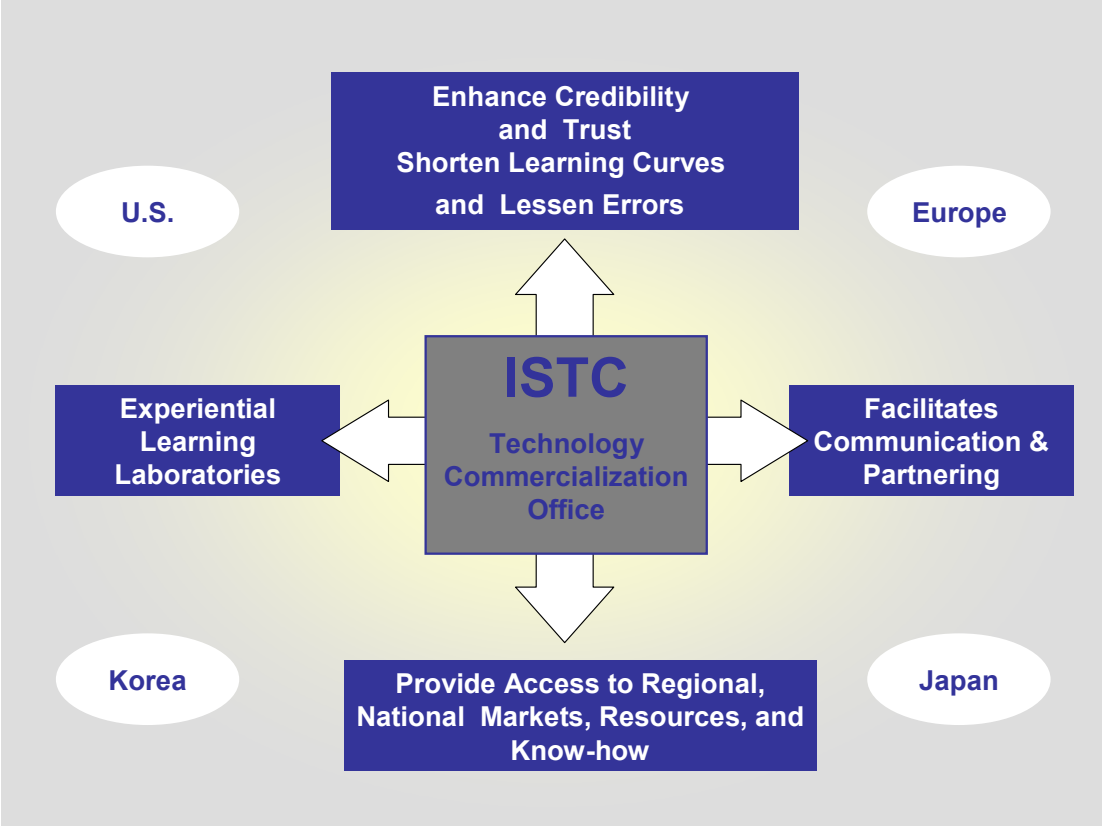
Using the Web. Specific "market challenges/opportunities," that the Technology/Market Intermediaries know about could be listed on ISTCs web page for researchers at RF/CIS ISTC-affiliated institutes as well as for review by SPMs/PPMs. Such a market/problem centered component of ISTC's web page would be a useful counter-point to ISTC's existing Technology Database Program.

Technology Commercialization Offices. This report suggests locating ISTC Technology Commercialization Offices (TCOs), within select regions of the Funding Parties to help overcome "time and geography" and other communication challenges for effective technology transfer leading to commercialization. These TCOs would perform important bridging functions between (1) the ISTC and institutes in the RF/CIS, and (2) private and public sectors organizations in the Funding Party countries. Initially the TCOs could be funded out of local Economic Development funds of select regions within the Funding Party countries. However, over time they could be supported from a small percentage of equity from new company formations or local company expansions.[1]

[1] Most of US communities have ED funds that are funded from regional taxes and these funds are used to recruit companies to their region. We propose that these funds could be used to support K/TT from RF/CIS for (1) new company development, and (2) increasing the compositeness of existing firms. For example, one of the authors of this report gave a talk on accelerating technology-based growth through partnerships with ISTC, Moscow to the Texas Economic Development Council on April 24, 2003. Out of an audience of about 100, about 8 Economic Development mangers expressed great interest in being considered a lead customer in such an experimental program.

Technology Commercialization Regions. Several of the authors of this report have conducted numerous regional economic development assessments of mid-sized communities, in the U.S., EU, Japan, and Korea. The goal was to provide these regions with a better understand their assets and challenges for building technology-based companies for the creation of jobs, wealth, and tax revenue. Many of these regions have the needed management talent and venture finance but they lack world-class technology. They may have a local university or community college but not the PhD programs in relevant technology areas. Community leaders in these regions have shown great interest in partnering with ISTC to access and partner with RF/CIS technologists.[1]

Figure 9. Technology Commercialization Centers as Learning and Innovation Poles to Foster Venture Success and Accelerated Growth



[1] Interestingly, the more technology rich regions that have major research facilities and universities were less positive when offered the vision of partnering with RF/CIS sources of state-of-the-art technology for market applications.

Levels of Metrics for Commercialization (Valorization) Support

Level I – Counting the Basics

- Number of technology/market assessments completed
- Number of contacts with private companies during the project
- "Exit Counseling" for projects targeted for commercialization.

Level II – Valuation of Knowledge (ROI)

- Number of technology/market assessments used
- Contacts with private companies continued after the project is completed
- Exit Counseling that leads to commercialization opportunities

Level III – Balanced Partnerships

- Partnerships transitioned from funds-in and out-sourcing to value-chain development of technology projects
- Moving RF/CIS FWS up the learning curve of moving their research toward meaningful technology assessments and commercialization activities

PATENT SUPPORT PROGRAM

We don't know as much as we probably should about the institutes we work with. We need to do a better job of helping project managers and others understand what they can and should patent….how they can more effectively do what is needed in terms of keeping records that will facilitate making sound business judgments about what they should work to commercialize whether it be in the RF/CIS or Funding Parties

Robert Teets
Senior Project Agreement Officer, ISTC
Interview, Summer 2002

With ISTC's increased interest in issues of self-sustainability within the RF/CIS, it is increasingly important for the Patent Support Program to facilitate efficient and effective national as well as international patenting for ISTC funded S&T. This is an extremely complex task as, through ISTC's Parties and Programs, ISTC has the potential to be

involved with the patent laws of over 25 countries. And as noted by a member of the International Research Team:

> *Overall, ISTC can expect an increasing volume of activity on patents and IP protection. However the regulation regime is not conducive to commercialization. And in many ways, ISTC's current approach to intellectual property ownership and commercialisation appears to be structured with a view to reducing the likelihood of achieving commercial value rather than enhancing it.*

ISTC's Patent Support Program was launched in March 1997 along with the Partners Program and the other supporting activities of Business Management Training, Valorization Support, and Technologies Database. There is a duality in ISTC's IPR system:

- For Partner Projects where the funds are being provided from government and private parties outside ISTC budgets, there is provision for an agreement between those involved to decide where IP rights lie and how the rights should be shared.
- For ISTC Science Projects there is a different regime in which
  - There is a mandatory requirement to register any IPR interests with full disclosure to the ISTC secretariat
  - Rights for the market of the funding party rest with the funding party free of charge. The overriding logic is that the funding party, as paymaster, has the exclusive right to own any intellectual property that might arise from the project in their domain
  - The rights to Intellectual Property in the Russian Federation rest with the researchers and his/her institute

ISTC's Patent Review Committee (PRC)

Traditionally SPMs have identified Science Projects with commercial potential to bring to the attention of the Patent Review Committee (PRC) which can provide up to $1,500 financial support to RF/CIS project grant recipients to cover the costs of obtaining a PTC patent within the RF. A PTC offers patent protection for 18-30 months during which time it is possible to further study the merits of proceeding to subsequent stages of IP

registration at national and international levels.[1] Immediately following this section we will present an overview and analysis of the following three forms that are to be completed by Project Managers concerning their Science Projects. These forms are reviewed by the PRC for consideration of being awarded a PTC Patent. These forms are:

- Record of Invention Form
- Technology Implementation Plan
- Private Sector Supplement

Traditionally all three of these forms are completed and submitted to the ISTC and the PRC near the end, or after completion, of the Party Funded research project. It is the position of this report that the "knowledge and awareness gaps" are great between the questions asked in these forms and the exiting knowledge and experience of the Project Managers.

A Typical PTC Scenario: Using the Case of a US Funding Party

A disclosure of invention is filed on a project that was funded by the U.S. government. The institute team that developed the technology approaches ISTC and request that they fund a PCT Patent that may be forwarded for consideration by the U.S., EU, Japan, or Korea. If a positive decision is made by the Patent Review Committee, The Patent Support Program will spend up to $1,500.00 for a PTC Patent and in the case of the US all this information is transmitted to the Department of State which needs to make a "yes or no" decision, within 18-30 months, to go to the national phase.

If US State Department elects not to go forward with the IP, they lose their right to exclusivity in the US market. Indeed, there have been very few cases where the US State Department has decided to go to the national phase. Given this track record, going the PTC route implies a big risk to the submitting institute especially if the patent dead-ends at the US State Department. As an ISTC respondent stated:

I went to State [US State Department] and said, excuse me these are very valuable patents. You should really do something to protect

[1] Funding parties providing the science project funding get exclusive licenses in their jurisdictions and under Russian law 15% of the royalties are to go back to the institute or the RF. STCU policy on IPR states that the recipient will own all rights worldwide to IP arising from a project. With respect to non-commercial purposes, the recipient will grant the financing entity a non-exclusive irrevocable license in its territory, with the right to sublicense, to any IP arising from the project. Inventors are to receive not less that 15% of any royalties earned from the exploitation of their patents that come from a project. Please refer to Article XIII or STCU Statute on the web.

> *them in the US. They are entering the national phase and there isn't much time left. If nobody pushes from ISTC nothing happens – we need to collectively better manage ISTC's patent portfolio.*
>
> *I can't tell you the number of times that I've gone to companies with what looks like promising technology and come to find out that we funded a patent on it and that it's expired and there's no longer any IP to protect and the potential partner company says we are not interested, this is now public domain, thank you very much, this is now free information.*

According to interviews conducted for this report, the lack of successful ISTC patent activity and lack of royalty payback are main reasons that RF/CIS scientists don't file patent requests with ISTC. The perception is that "records of invention sit in a box." Furthermore, the Funding Party is not obligated to share revenue with scientists or institutes even if the patent is filed in the national market and in this way the RF/CIS Institute loses IP rights to lucrative international markets. Accordingly, RF/CIS scientists tend to file RF patents on their own and they do not inform ISTC. As one SPM noted, "There simply is no incentive for them to file a patent and tell us about it." Russian companies also license technology directly from Russian institutes without any disclosures of invention. As noted by a STIM,

> When I find a success that involves a Russian commercialization scenario, we often have nothing on record. They do it themselves as they believe that getting us in involved in the process will just bog them down.

IPR Recommendations

The expectation is small that they [the Russian Federation] will exercise their own planning initiative plus incorporate creative lawyering so as to optimize the [technology commercialization] opportunities within the contemporary Russian legal regime. Still such an undertaking is one contribution that the ISTC parties can and should initiate and develop.

Robert Teets
Senior Project Agreement Officer
Correspondence, July 2, 2002

A regime of effective intellectual property (IPR) rights is one of the most important resources for speeding RF/CIS self-sustainability (i.e., regional and national economic development) in the 21st Century knowledge-based economy.[1] Accordingly, the effective protection and marketing of RF/CIS IPR is of central concern. Many observers and champions of RF/CIS self-sustainability through S&T commercialization and the creation of new industries have emphasized their concern with Russian IPR legislation or lack of such legislation. A serious source of concern and impediment to foreign direct investment for about 10 years has been how prior RF/CIS research results --- background IPR – would affect the ownership of S&T being created and commercialized. This ambiguity concerning ownership of background and foreground IPR has had a chilling impact on ISTC's Partner Program and other transitioning efforts toward self-sustainability. The positive news is that new Russian patent legislation (March 2003) states that absent an express reservation of rights by Russian and regional government when it contracts for work, the resulting foreground IPR will remain with the inventors and the institutes.

On the one hand, in the interest of minimizing potential IPR bottlenecks with ISTC funded research, one option is to narrow the Secretariat's IPR rights and responsibilities by placing them upon the originating institutes and scientists. In short, leave IPR

[1] For example, 2/3rds of US companies' market value come from their nonmaterial assets. Newly educated Russian S&T talent, despite recent State Budget salary increases, are still being lured by the higher salaries of Western research institutions and firms (K. Kakhiani, Moscow News, October 16-22, 2002).

ownership with the RF/CIS institutes and get the ISTC out of the process.[1] On the other hand, it is not clear how many of the institutes would, as of now, be able to effectively protect their IPR domestically or internationally. Indeed, international IPR protection is an on-going challenge for business, government, and academic institutions is the West and East so such a regime of local IPR ownership and responsibility would currently be an immense and perhaps overburdening challenge for RF/CIS Institutes.

There are additional concerns of having RF/CIS institutes own all IPR resulting from ISTC funded research. First, it could re-open complaints from the RF/CIS government's of unfair IP treatment if "foreign businesses" take advantage of the institutes' lack of knowledge of global IP issues. Complaints that "led (in 1995) to the "IPR Russian and US Working Group" that came up with nine nonbonding guidelines on IPR.[2] Second, there is the concern of having RF/CIS entities owning international IPR rights for the S&T funded by these same foreign governments. An option for the later case would be to have shared IP ownership between RF/CIS and the Funding Parties.

A scenario that is more in keeping with the drive toward self-sustainability of RF/CIS Institutes, is the delegation of the Funding Parties IPR to the ISTC Secretariat. This would require an additional allocation of financial and other resources to support an expanded ISTC role of working with the Funding and Recipient Parties to aggressively patent and market ISTC funded technologies worldwide. Initially some of these IP responsibilities could be outsourced to private companies within the Funding and Recipient Party countries. In terms of balanced partnering, this option also has the advantage of educating institutes about IPR (e.g., learning by doing). A percentage of royalty streams could flow back to the ISTC to fund these expanded IPR operations.

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[1] This discussion benefits from the email correspondence of Robert Teets, Senior Project Agreement Officer, ISTC and Judson Hightower, October, 2002.
[2] Judson Hightower, email correspondence to Robert Teets, October 10, 2002.

IPR Harmonization among all Parties

The whole issue of the RF position as well as the CIS needs clarification in that most of the institutes are still affiliated with some organ of state power and these are also likely to have an interest in IPR. I have a counterpart at Rospatent – we have met and talked a couple of times, but generally we suffer from a serious lack of collaboration/communication between the Secretariat and the legal staff of the Funding Parties, and the Russian party.

Robert Teets
Senior Project Agreement Officer
ISTC, Interview date

There is a concern with the lack of cross-party awareness and knowledge of US, EU, Japanese, RF, and CIS legal regimes regarding IPR issues and the ISTC. These concerns will become increasingly pronounced as the ISTC evolves its programs and activities toward:

- Transition of SPMs and PPMs to be more concerned with and effective about technology commercialization
- Enhanced sustainability of CIS/RF researchers and institutes
- Enhanced ROI on Partner Projects.

It would be useful to clarify where the legal regimes of the Parties pose different if not contradicting responses to various IPR scenarios as well as where the legal regimes are harmonious. For example, ISTC and Party policies are unclear regarding IPR rights concerning multiple ISTC project generations that involve several funding Parties. In this regard, this report recommends the convening of a working group of IPR experts from the Funding and Recipient Parties and those central to ISTC IPR issues. Such a group would be charged with:[1]

- Clarifying the legal regimes of the Funding and Recipient Parties regarding protection of IPR created by ISTC-funded and/or administered projects
- Assessing how past ISTC legal issues have been resolved while looking for lessons learned as to what to do and what not to do

[1] Notes summarized from email draft of Robert Teets, Senior Project Agreement Officer, ISTC January 15, 2002.

- Building on past ISTC experience and current legal knowledge in order to anticipate potential legal challenges as well as potential opportunities for "legal harmonization" across all Parties in the near- and longer-term
- Providing legal advice for ISTC Secretariat management and Party Principles as an aid to policy development and decision-making
- Considering how the values of professional collegiality plus institutional organization and transparency might be improved and/or restructured among legal experts involved with ISTC

To this end, it is recommended that travel funding and other logistical support be provided for the formation and convening of such an IPR Working Group. In addition to providing travel and logistical support for increased visits by appropriate ISTC staff to the RF/CIS institutes.

IPR and Training

I get episodic instances where the ISTC Partner is saying, not unreasonably, to the Project Manager, "Give me the background results," and the Project Manager is saying, "What are background results?"

Robert Teets
Senior Project Agreement Officer
Interview Summer 2003

Increased IPR training across the ISTC Secretariat and Funding and Recipient Parties is considered central achieving balanced partnerships and self-sustainability It is necessary to ensure that RF/CIS institutes and researchers, over time, are up to the challenge of managing and obtaining fair commercial value out of their knowledge assets. Effectively moving in the direction of vesting IPR rights with CIS/RF Institutes will require substantial training programs, professional development, and financial support at the institutes along with more fully developed IPR training and support for PPMs and SPMs. What is needed is realistic incremental improvement at the RF/CIS institutes. Toward this objective, IPR training programs need to be developed and delivered to institutes that have established marketing or technology patent offices and where IPR issues are

currently most acute and to use these efforts as models to be emulated by other institutes. Such training should include:

- The importance of clearly setting forth background results – whether it's a party or partner project - clarifying and protecting what's background knowledge determines what's foreground knowledge.
- How to be more effective by keeping records that will facilitate making sound business judgments about what can be patented and commercialized whatever the context
- Improvements in the preparation of record-of-invention documents for Party/Partner Projects and the ISTC – this gets to the important issue of background and foreground IPR
- Developing decision-making criteria for choosing between different Funding Parties and the RF/CIS as the most appropriate locales for filing initial patent applications – perhaps the development of a decision matrix on (1) what kind of patent applications are possible, and (2) where and how such patent applications should be filed
- Clarification of RF/CIS views on current and pending patent legislation, especially on the vital question of IPR ownership from old, current, and new projects funded by ISTC

One option to facilitate the timely delivery of such IPR training is to go outside of ISTC and to contract with Russian and international IP lawyers/instructors (e.g., The Russian Academy of Sciences and the U.S. Navy's Office of Naval Research International Field Office's (ONRIFO) or the US National Institute for Health. Such training could be augmented with "learning by doing" by selecting talented institute staff to work as IP interns in the Secretariat as well as the Funding Parties.

Metrics of ISTC Patent Support

There have been about 200 records of invention/patent applications that ISTC has supported and forwarded to the Parties that have yielded 3 U.S. patents, 1 license, and no royalties to date as well as 67 patent applications in the EU, 53 in Russia, and 2 in

Eurasia with no patents issued. Few patent applications have gotten to the full registration stage and of those that do, many languish on the desk of the Funding Parties agencies which seem to have few incentives to actively pursue commercialization options.[1] In short, ownership rights are piling up at the Parties and actionable time lines are shrinking.

Levels of Metrics for Patent Support

This report offers a framework of different levels of quantitative and qualitative metrics indicating an evolution from engagement of Former Weapons Scientists to concerns of self-sustainability including balanced partnerships, sustainable research institutes, and regional development. In regards to the Patent Support Program balanced partnerships gets to the issue of protecting IPR rights for RF/CIS scientists and institutes as well as ISTC Partners and the Funding and Recipient Parties.

Level I – Counting the Basics

- Number of PTCs
- Number of national patents by country
- Number of national licenses by country

Level II – Valuation of Knowledge (ROI)

- Value of patents by country
- Value of technologies licensed by country
- Developing decision-making criteria for choosing most appropriate locale for filing initial patent application
- Patents that lead to profitable products and markets by country
- Being able to anticipate potential legal challenges
- Providing effective legal advice to ISTC Secretariat

[1] Partner Program technology licenses and patents are more difficult to count or assess as partners from all the Parties generally want to operate "outside of the sunshine" in that they do NOT want ISTC or the institutes to broadcast their areas of research or where they have had successes and/or disappointments as this is potentially important competitive knowledge.

Level III – Balanced Partnerships

- Effective record keeping on IPR issues at institutes
- Improvements in record-of-invention documents
- Perception of fair IP treatment by RF and CIS Parties
- Education and training of institutes and scientists in IPR
- Strategic partnerships among institutes and partners created and maintained
- Harmonization of funding and non-funding parties
- On-going contacts with private companies established during and continued after the project
- Clarifying legal regimes of Funding and Recipient Parties including old, current, and new projects funded by ISTC
- Improvements on knowledge valuation – human and intellectual capital at institutes
- Lack of IPR bottlenecks for Partners

ANALYSIS OF ISTC FORMS for Record Of Invention (ROI), Technology Implementation Plan (TIP), & Private Sector Supplement (PSS)

Following is an overview and analysis of three forms that ISTC requires to be completed by Science Project Managers and their team of technologists (Former Weapons Scientists) that are based at the RF/CIS Institutes:

- Record of Invention Form
- Technology Implementation Plan
- Private Sector Supplement

Traditionally all three of these forms have be completed, or worked on, and submitted to the ISTC and the ISTC Patent Review Committee near the end or after completion of the Partie Funded research project.

On March 26, 2003, one of the authors of this report attended a Patent Review Committee meeting at ISTC, Moscow. The meeting was somewhat unique in that of the 20 applications of a PTC ---- were granted and ------ we postponed with the strong

recommendation that meaningful feedback be provided to the SPMs and PMs on why this sharply decreased approval rate was occurring.[1] As noted by one of the PRC members:

> My Russian colleagues treat a patent as an award for technical competence – an award of appreciation for a technical solution and recognition of technical skill – like some sort of honor – saying "look guys see how clever I am," rather than applying for a patent to protect a business application or to protect a technology/process that is ready to go to market.

It is the position of this report that the "knowledge and awareness gaps" are great between the questions asked in these three forms and the exiting knowledge and experience of the Project Managers as well as SPMs and PPMs. In the following review we will list the questions asked on each from of the PM and we will provide an analysis (*in script*) of the relevance and effectiveness of such questions. In brief, it is a recommendation of this report that:

- All three forms be shortened, and made less complex
- Answers to technology transfer and commercialization questions be initiated and discussed by the Project Manager and his research team as well as Institute administrators as <u>part of the funding application process and that these preliminary statements be considered by the Funding and Recipient Parties and the SAC in the funding decisions</u>
- Project Manager's answers to these questions should be updated during the research process (e.g., potential uses of the invention, marketable results, and business partners) and that these "updates" be conducted with the assistance of the

[1] In contract in 1997, 15 ISTC projects encompassing 23 separate inventions received patenting support from the Secretariat. In 1998, the Patent Support Program received 31 applications and provided financial support to 12. In 1999, the Patent Review Committee received 44 applications and provided financial support to 28. In 2000, the Patent Review Committee received 29 applications and provided financial support to 21 patent applications. And in 2001, 33 patent applications were received, and 25 received financial support.

SPMs and with the support of other ISTC relevant programs and activities such as listing in the Technologies Database Program or having the research team members attend training programs and workshops

It is also suggested that as Partner Project Managers (PPMs) and Senior Project Managers (SPMs) move from being "proposal advocates" to "transition advocates" that they become "technology transfer and commercialization" mentors and network facilitators for the RF/CIS Institute-based PMs. The PPMs/SPMs would be the main point of contact, during the research process, for advising the PMs as to the most appropriate strategy for acting upon the S&T transfer and commercialization issues noted in the questions of these forms. It is also recommended that:

1. Training programs be provided for Project Managers and their research teams, Institute Administrators, and Senior Partner and Project Managers and their Project Officers, and
2. That these training programs be focused on how best to evaluate and act upon the S&T transfer and commercialization questions being asked of the PMs in each of these forms.

Record of Invention Form

Questions asked of institute researchers

I. Title of Invention

II. Inventor Information: Name, title, contact information

III. Abstract of Invention:

Traditionally emphasis has been placed on the quality and novelty of the science. Generally, minimal if any consideration has been given to market application especially in terms of specific corporate partners.

IV. Uses of the Invention including:

-- to which many successful applicants list (None)

a. Actual past and current uses of the invention including dates and location

b. Government uses or possibilities for use

– to which many successful applicants list (None)

c. Commercial uses or possibilities for use

– to which the PM often responds in general to the way the research/technology is perceived to be useful for industry.

V. Documents Describing The Invention:

Often included in responses to this question are publications, papers, and presentations describing the invention that have been published or presented or that are being prepared or planned for the coming year.

VI. Related Documents:

Responses to this question focus on RF, CIS, and international patents that are being considered, applied for, or granted. And such patents are often applied for to confer "special status or recognition on the technical merits"

As noted, it is a recommendation of this research report that such Records on Invention be initiated at the start of the research process and be part of the original research proposal that is reviewed by the Recipient and Funding Parties and by the Scientific Advisory Committee. Such reviews and associate comments would at least get the PM and his research team to begin considering the relevant issues and it would also allow for initial feedback from the reviewers as to possible applications for the research/technology being funded.

It also needs to be recognized that providing such technology assessments, nationally and globally, is an extremely difficult challenge for Western-Based research institutes and universities including corporate labs; however, the goal here is to initiate the orientation to "problem or market driven" research to help guide the research process and to better orient research collaborators rather than waiting until the research is largely complete.

These are difficult question for a Project Manager to answer at the beginning or the end of the research process. As indicated, often the response used after a, b, and c is (None) or the science/technology is described with potential or perceived market applications with little consideration for a national or international market or competitive technology assessment or production cost estimates. However, considering these issues during research proposal writing and review and throughout the research process would likely lead to a faster and more seamless consideration or realistic market applications at the end of the research process.

Technology Implementation Plan (TIP)

Questions asked of institute researchers

As noted, traditionally the Technology Implementation Plan (TIP) for Regular Science Projects has been completed near the end or soon after the end of the research. As with the Record of Invention it is suggested that the TIP be considered in the funding review processes and be initiated at the start of the research and be continually re-visited throughout the research process.
At the beginning of the TIP process should in the Proposal questions should be asked:
Is there a "need" for this research?
Has it already been done?

1. What marketable results have been achieved or are anticipated:

a. Title of the result possible for utilization
b. Type of intellectual property (IP)
c. Owner of results
d. Intention for utilization

Again it is suggested that it would be an advantage if these questions were at least thought about by the Project Manager and his research team at the start of the research project. In addition the review process by the Recipient and Funding Parties and the SAC and the on-going monitoring by the Research Collaborators and Senior Project Managers could also be more oriented toward marketable results that might help shape the research process as well as to help locate potential industry partners.

2. What tasks remain in order to "complete" your result and meet the requirements of your target funding sources? How do you propose to meet them and on what time frame?

a. Development Stage
b. Applied Research
c. Prototype Test
d. Field Prototype

Answers to these questions seem traditionally concerned descriptions of the technology in terms of Applied Research, Prototype Test, and Field Prototype application and not potential business or market applications.

3. What is the status of the Intellectual Property of your results?

a. Patent Application is Submitted
b. Patent Decision is Approved
c. Patent is Received
d. Patent is Registered

4. Summarize the approximate schedule for activities planned to implement your project results and graduate your project team

a. Activity on Introduction of Results
b. Attracted Partners
c. Work Schedule
d. Evaluation of Estimated Expenses

The traditional focus of the TIPs has been on the science/technology in terms of refinement of parameters and technology specific clinical testing for introduction of results and the attraction of partners.

5. What is your plan to reach your target industry and public sector with your message and results?

*The focus of reviewed TIPs, where this section was completed, was on listing research collaborators and conferences attended. There was little mention of target industry and public sector organizations, nationally or internationally. Again, having the Project Manager and his research team and perhaps his Institute, along with the SAC and Research Collaborators and Senior Project Manager consider these issues at the start and during the research process would seem to be a reasonable strategy for increased success. As noted by one SPM: "Increased success depends on finding collaborators/partners before the proposal is written. It is also possible to do this during the preparation of the work plan. For project #****, I was able to get the project proposal to the collaborator. They through the draft work plan in the trash and during 3 days wrote the definitive work plan. This should be done more often."*

6. What steps have you taken to implement this plan and what are the results?

a. New contacts from target industries
b. Market intelligence
c. Conferences

Most reviewed TIPs left this section blank. The most frequent inclusion was to include a list of conferences attended (usually research oriented) and contact with research collaborators (usually university or laboratory based) within the Funding Parties.

7. Do you have everything you need at this stage of the project to accomplish your objectives for post-project completion and sustainability?

A common answer to this question by the Project Manager was "NO." And it might be inferred that the usual Project Manager does "Not Know what questions to ask much less what they need to know." But, again if such a question was initiated at the start of the research project and discussed during the review process and during the research process with the Research Collaborators and Senior Project Managers it is more likely that a targeted list of "needs" leading to sustainability could be more realistically considered by the time the research project was near completion.

Again as noted by an SPM who is well trained in his technical field and is well connected to business contacts: "Most SPMs have no idea. They have no training and no contacts."

8. What additional services can ISTC provide that would assist you in reaching your target? (included categories are)

a. Assistance in identifying industry conferences?
b. Assistance in clarifying a "graduation" or "vision" for industry development of the technology?
c. Assistance in identifying target companies or organizations?
d. Assistance in attaining Business Management Training?
e. Assistance in refining market intelligence?

f. Database access?
g. Patent support?
h. Other (Please Explain)?

In the TIPs reviewed the Project Manager checked all of the above. These areas of support would seem to be an ideal and beginning focus to concentrate activities for the newly oriented Senior Project Managers as "Science Project Transition Advocates."

Private Sector Supplement

The below listed questions are included in the Private Sector Supplement to the Technological Implementation Plan and, like the TIP, these questions are considered quite difficult to be meaningfully answered by Project Managers at RF/CIS Institutes.

Indeed it is suggested that it would be difficult for most Funding Partie Based researchers (in the US, EU, Japanese, Korean, or Norway) to be able to adequately answer these questions. To get to this level of national and international market assessments of potential applications of Research Project results will require the full support of Senior Project Managers, Research Collaborators, and a variety of ISTC's Programs and activities. As suggested in this report leveraged "external" assistance might also be provided by a broad range of technology commercialization professionals and appropriately trained graduate students from the Funding Parties and in the RF/CIS. The objective being to maximize the relevant "application know-how" and the professional and personal networks that can be used to access planned and unexpected market applications and corporate partners.

In the reviewed forms the answers provided by the Project Managers to the below listed questions almost always centered on describing the "superior" characteristics of the technology being presented.

1. **What are the possible applications of the technology (product) in the technological process/industry (define)?**
2. **What is the industry Application Code of the application of your anticipated result (please consult the ISO's Industry Standardization Codes)**
3. **What is the stage in the Technology Process or Cycle to which your anticipated result relates**
4. **Please provide a brief description of the known technological process (define) and its modifications**
5. **Please describe the possible applications of the technology (product) in the concrete technological cycle.**
6. **Please evaluate the technical state of (technological processes) in the industrially developed countries in the RF. What is the status of technical development of (technological processes) in the aforementioned countries (basic, applied research, research and development or industrial introduction).**
7. **Which of the companies/enterprises engaging in the technological processes provide analogous (competing) services/products (or are investing in companies providing these services/products) at the same phase in the manufacturing cycle you have identified?**
8. **List the companies in your industry that provide compatible services/products near the phase in the manufacturing cycle you have identified (technology assessment).**
9. **How would you characterize the industry including (International industry and technology assessment):**
    a. **What is the legal status, size, age and ownership structure of competitors for sales or products or services in the private sector?**
    b. **What is the structure of interrelationships among sub-contractors, contractors, and customers?**
    c. **What is the mechanism for selling and obtaining funding?**
    d. **Is your technical result competitive in this marketplace, and if not, what steps do you plan to take to ensure that it w ill be?**

   e. **Do you have other results that may find a niche in this market?**
   f. **Should other markets be explored?**

10. **What is your "graduation strategy" and how is it justifiable (business development assessment)?**
    a. **What is the target market, the size of the market (in units and money) and what market share do you envision capturing with the industrial deployment of your technology?**
    b. **How would you characterize your resultant technology?**
       [Respondent answered Revolutionary!]
    c. **How do you envision the commercialization/industry deployment of your anticipated results?**
       i. **Investment from outside source such as Venture Capital**
       ii. **Strategic Partnership**
       iii. **Licensing**
    d. **Which companies from the above lists (provided by the Project Manager) would be the most likely candidates for the type of relationship appropriate for your Project Team's commercialization of the Technological Results?**
       i. **Characterize the top five candidate companies and explain why your technological result, Project Team, and Graduation Strategy are compatible with their corporate culture:**

5. Multi-Sourced Funding

Russian High Energy Physics Laboratories such as Dubna, Serpukhov, Novosibirsk and others have established a long-lasting partnership with CERN in Geneva. CERN has provided more than 11 million Euros in partner funds to these laboratories and their engineering associates. Another significant example has been the partnership between the chemical giant Bayer AG in Leverkusen and the Institute of Physiologically Active Compounds of the Russian Academy of Sciences in Chernogolovka.

Multiple stakeholders and funding sources are an advantage to any nation's science and technology (S&T) system. Multi-sourced funding contributes to independence, and possibly controlling interests, from one dominant party and is important to self-sustainable S&T systems for a variety of reasons that include: Being Open and Networked, Research Excellence, Economic Value, Attraction of Young Talent, Public Interest and National Purpose, and Societal Value. In short, RF/CIS S&T systems as a whole, and the majority of their component institutes, should be encouraged to seek multiple sources of income to sustain excellence and to expand research and related activities. Multiple sources of funding should include a mix of national public R&D budgets, domestic and international industry, international research programs and institutions, and foundations.[1] Section 5 of the report focuses on two ISTC Programs that have had an important impact on RF/CIS researchers and their institutes in obtaining multi-sourced funding:[2]

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[1] For example, the Iofee Institute, which is affiliated with the Russian Academy of Sciences, currently has about 3,000 employees with an annual budget of about $1.5 million. One-third of Institute's budget comes from RF government and 2/3rds comes from the other research activities of Ioffe scientists. Within the last two years, the Institute has benefited from increased funding from international research grants and industry contracts in addition to key support from the RF and the Russian Ministry of Science and Technology. Part of this RF funding is in the form of non-competitive subsidies (bas funding) and part is offered on a competitive basis.

[2] These two ISTC Programs also support other Sustainability Pillars and the search for multiple sources of funding is also supported by the other ISTC programs including Travel Support that provides funds necessary to promote face-to-face meetings with potential partners and clients; Business Management Training in how to present and sell a research idea or technology idea; Valorization Support in terms of finding a partner and market need; Workshops that introduce RF/CIS technologies to potential partners; Patent Support that helps to evaluate and protect IPR, and Communication Support that helps to provide RF/CIS institutes with needed computer and information technology required in the global, knowledge economy.

- Partner Program
- Technologies Database Program

In the Former Soviet Union, Russian S&T was 100% funded by public money. In keeping with ISTC's nonproliferation mandate, in the early- to mid-1990s, it was crucial to provide immediate and direct financial support to former weapons scientists (FWS), to keep them working in RF/CIS institutes, and to minimize the risk of knowledge and weapons transfer to rogue nations. Under the direction of ISTC's Science Advisory Committee (SAC) the **Science Projects Program** was the primary means to accomplish this task. In 1997 the ISTC Secretariat and Governing Board launched the **Partner Program** to add to the funding mix and to help wean researchers from sole-source ISTC Party Funded Research Projects. Under the Partner Program government and private sector entities from the Funding Parties (US, EU, Japan, Korea, and Norway) are invited to fund RF/CIS research projects. In some cases Funding Partners are sought by ISTC staff and by RF/CIS researchers. In others cases the Funding Partners drive the process by asking ISTC staff to help locate specific RF/CIS talent and technology capabilities. In either case, these partnering activities fund RF/CIS scientists and technicians and help them shift their research activities toward civilian and commercial sectors. In addition, through the Partner Program, RF/CIS research talent is introduced to the challenges of project management and the importance of meeting "customer" expectations by providing deliverables that meet Funding Partner expectations including market and commercial applications.

Technologies Database Program (TDB). With the Science Projects Program, ISTC has over the years helped develop research activities and networks in a broad range of RF/CIS research institutes and centers. Many innovative research projects and technologies have been identified and developed. In 1997 ISTC/s Secretariat established the **Technologies Database Program** (TDB), formerly the Promising Research Abstracts Database – **www.tech-db.ru** - to:

1. Promote the S&T expertise of RF/CIS researchers and institutes to potential public and private sector partners

2. Facilitate cooperation between RF/CIS researchers and institutes and technical experts worldwide

More recently there are increasing, favourable indicators supporting multi-sourced funding concerning regional and national RF and CIS industry and government (Boris Saltikov, former Vice-Premier of the RF in 1992–1993 and Minister for S&T from 1991-1996; during a presentation in Brussels in the Autumn, 2003) and they include:

- The growth rate of the Russian science and education budget for 2002-2003 has been between 30 and 50%
- Industry is again financing research in Russia; in 1990-1993, the Government was financing 85% of the R&D expenditure, now this figure is less than 50%
- The Russian Federation is accelerating technological transfer through the creation of technology parks, more than 40 parks currently exist, favouring the development of innovative SME's that amount now to about 30 000.

The Partner Program

The Partner Program is a major part of ISTC's accomplishments, offering the best chance that ISTC will achieve sustainable results though international cooperation.

Dr. Michael Kroening
Statement from the Executive Director
ISTC Annual Report, 2001

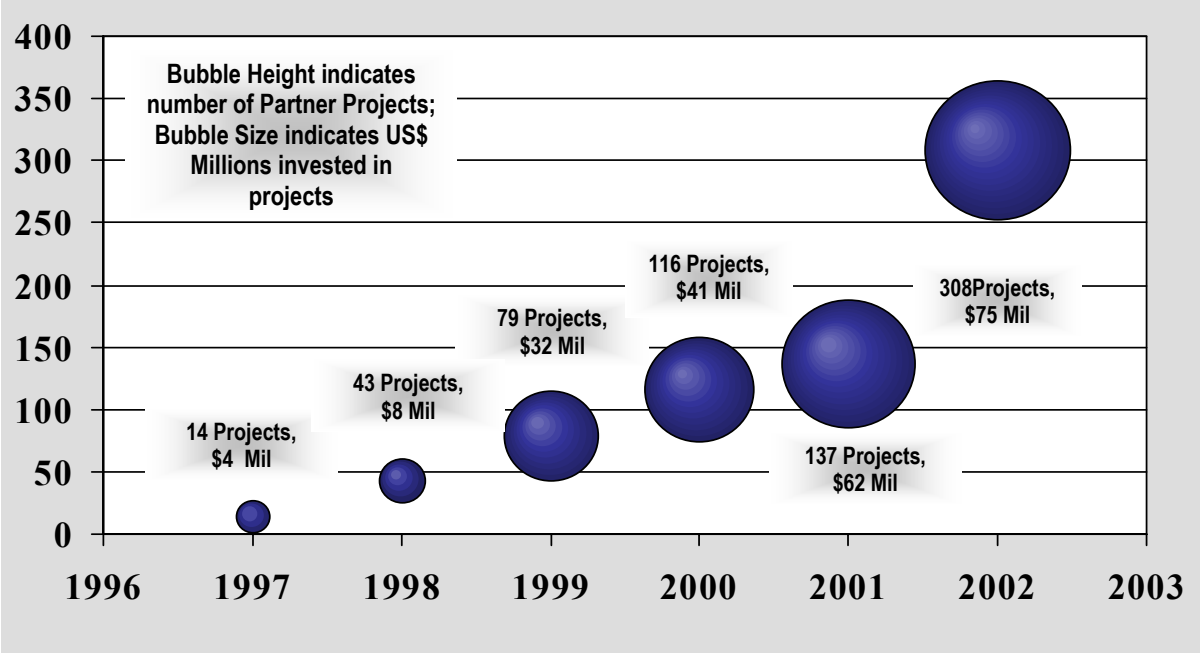
The Partner Program reinforces the self-sustainability of ISTC's nonproliferation objectives by expanding opportunities for private industry, foundations, academic and scientific institutions, other intergovernmental or non-governmental organizations to participate in and fund RF/CIS research. RF/CIS Institutes in general and Project Managers and project teams in particular have benefited in numerous ways from ISTC's Partner Program including:

- Obtaining diverse sources of funding
- Expanding research and technology commercialization networks
- Being exposed to market economies in the US, EU, Japan, Korea, and Norway
- Being introduced to and "learning by doing" about the importance of meeting customer expectations including challenges of project management, effective

knowledge/technology transfer, and providing deliverables that satisfy market and commercial applications.

By the end of 1997, 15 Government and Corporate Partners were funding ISTC projects worth $4.3M. In 1998, $3.7M in new funding was processed through the Partner Program and there were 29 new partner organizations, bringing the total to 44 (79) partners contributing nearly $8 ($32) million. In 1999, 19 new partner organizations were added, and partner program funding totaled $8M across 41 partner projects. In 2000, 31 new partner organizations and $24M in funding was added, bringing the totals to 98 partners and $41M in funding by the end of 2000. In 2001, 34 new partner organizations joined ISTC, bringing the total to 135. In 2002. 104 partner projects were approved for funding which brought the total amount contributed by partners to more than $72M.

Figure 10. Growth of Corporate and Government Funding Partners from 1997-2002



ISTC has Funding and Non-Funding Partners. A Non-Funding Partner could be an organization that is searching for a partner or technology, or has expressed an interest in working with and funding RF/CIS research in the future. Non-Funding Partners can also participate in ISTC activities as collaborators or advisors. Funding Partners represent both

corporate and government interests. ISTC ostensibly offers the following advantages in initiating and managing partnerships at S&T institutes throughout the RF/CIS:

- ISTC provides administrative support in:
  - Processing tax-free payments for research directly to RF/CIS scientists
  - Structuring legally binding project agreements that stipulate the rights and responsibilities of all parties including:
    - Auditing and technical monitoring
    - Safeguarding of proprietary information
  - Obtaining official Recipient Party (host country) and Funding Patty concurrence for all ISTC projects. This ensures that, after a research project is started crucial RF/CIS and Funding Party government agencies cannot arbitrarily block the projects successful completion
  - Procurement of needed supplies and customs clearance
- ISTC provides logistical and administrative support to minimize difficulties in:
  - Achieving access to the most promising RF/CIS S&T talent and institute candidates for a particular research project
  - Navigating RF/CIS and institute administrative procedures that are at times quite complex
  - Securing needed infrastructure to facilitate logistical operations in challenging and remote environments within the RF/CIS

Corporate Partners' Views About ISTC's Partner Program

Phone and email surveys were used to collect data on current ISTC Funding and Non-Funding Corporate Partners in the US, EU, and Japan to: [1]

[1] Forty-four corporate partners out of a sample of 63 completed either the phone or email survey including 21 Funding and 23 Non-Funding Corporate Partners in the EU, Japan, and US. Responses are presented in detail in Appendix D and interested participants are encouraged to review these individual partners' comments to better understand the range and the diversity of views. The total response rate was about 70% in this non-scientific survey. Ten responses were not used because the interviewee emphasized that their company had minimal interaction with ISTC or the ISTC designated contact was no longer with the company. Information from funding partners was collected by members of the International Research Team primarily through telephone, email, and in-person interviews. Non-funding partners were contacted primarily through an email survey. Assurances were given that all responses would be anonymous.

1. Determine ISTC program performance against the needs and expectations of Corporate Partners
2. Provide feedback about potential changes for improving ISTC relations with Corporate Partners

Based on the Corporate Partner Survey it was determined that most funded partner agreements were the result of:

- A general interest in RF/CIS technology and desire to work with scientists who are recognized leaders in particular areas of research
- Personal relationships and reputations of select RF/CIS researchers and institutes
- Research collaborators becoming Funding Partners
- Visits to RF/CIS Institutes

Corporate Funding Partners: Summary of Survey Findings

- For Corporate Funding Partners the primary goals or expected outcomes of Partner Projects are: Basic research, new products/processes, and general interest in Russian technology followed by an interest in finding cost savings and process and product improvements as a result of RF/CIS S&T.
  - Most Corporate Funding Partners reported that actual benefits from the research project have yet to be determined; that it is extremely difficult to determine precise benefits and results from commercialization that may take from 5-to-10 years
  - Completed projects have generally met Funding Partners' expectations concerning the quality of the science and technical research leading to:
    - Cost avoidance primarily in allowing the company to eliminate further research
    - Progress achieved in materials technology and a potential class of new products
    - Potential savings in 10s of millions in Euro: Over 50% of the responding Corporate Funding Partners indicate that they expect their project to lead to valued intellectual property (IP)
      - A key observation was that while ISTC's IP regime seemed sufficient for conducting pre-competitive or basic R&D it was seen to become

increasingly problematic when moving downstream to commercial applications

- These perceived increasing complications were causing Partners to fund institutes directly when considering commercial applications

- 50% of the responding Corporate Funding Partners work only with ISTC in Russia and 50% work directly with RF institutes and other organizations as well as ISTC
  - The most frequent "other organization" was CRDF which was the preferred alternative for several respondents
  - Criticisms of working with some RF/CIS Institutes centered on their having too much bureaucracy, a culture of the past, and outdated equipment
- When asked whether the Funding Corporate Partner anticipated using ISTC for additional projects in the future?
  - 50% said "yes"
  - 30% said "no"
  - 20% said they were unsure
- Fourteen of Sixteen Corporate Funding Partners said they would recommend that a colleague use ISTC, but they would make the recommendation with caveats or conditions – Two would not recommend a colleague to work with ISTC

Non-Funding Corporate Partners: Summary of Survey Findings

- Two-thirds of the responding Non-Funding Corporate Partners had been formally associated with ISTC for less than two years
- Over 50% of the responding Non-Funding Corporate Partners do fund projects directly with RF/CIS institutes and many had been doing so since before ISTC's began operations in 1994
- The majority of responding Non-Funding Corporate Partners are interested in specific categories of RF/CIS technology and expertise and state that they would become an ISTC Funding Partner if the partnerships were developed under the "right conditions," conditions which varied by each respondent

- Ten (out of 23) Non-Funding Partners provided specific comments about their interaction with ISTC and of these respondents about 50% made significant critical comments (Please refer to the following pages and Appendix D)

Overall Summary of Findings

The majority of Funding Corporate Partners report that RF/CIS technical and scientific research has been conducted according to their expectations, and that they have been generally satisfied with the outcomes even if the results were not always what they expected. But while 50% of the funding partners reported uniformly positive comments; 50% were critical with several corporate partners very dissatisfied. Respondents who seemed most knowledgeable about ISTC and Russian S&T capabilities also tended to be the most critical. At the top of the Corporate Funding Partners list of critiques was:

- The high complexity of ISTC processes coupled with infrequent and poor communication about these processes and the desire for enhanced responsiveness by ISTC staff (See Critique #1, pp. 92-93)
- Faster processing of partner agreements including the Partners lack of understanding of, and frustration with, Concurrence Processes including the "lag time" from conceiving and actually starting a project (See Critique #2, pp. 93-96)
- Full payment being required at the beginning of projects (See Critique #3, pp. 96-98)
- Clarifying and making improvements to the handling of IP especially with regards to expectations of commercialization including confusing and ambiguous IP issues for projects with commercial potential (See Section 4, Economic Value for a discussion of ISTC's Patent Support Program)
- ISTC's lack of ability to facilitate customs procedures
- Improved technical translations by ISTC of RF/CIS Research Abstracts (See Technologies Database Program at the end of this Section).

Critique #1: Communication Issues

The most frequent complaints from the Corporate Partners (both funding and non-funding) centered on:

(1) The excessive bureaucracy and complexity of ISTC's administrative processes and,

(2) The lack of responsiveness and timely resolution of problems.

These critiques were accentuated by the respondent's contention that they did not know who to contact at ISTC:

- About solving their specific concerns
- To determine the status of their proposed or existing project
- To check on progress in resolving a specific problem.

Even if contact points at ISTC and the RF/CIS Institute were established at the start of a Partner Project they had become obscure due to personnel change or for a variety of other reasons.

Recommendation: Establish a "Help Desk" at ISTC

While SPMs (and in the future PPMs) would appear to be the best point of contact for Partners and others to access the "right" person at ISTC and at RF/CIS Institutes, many Partner Survey Respondents found such communication difficult for a variety of reasons including:

- Time-lag between submitting a project proposal and starting the project
- Personnel change either at ISTC or the Funding Party
- Geography and time making it difficult to establish contact with the needed person at ISTC or the RF/CIS institute

Such an ISTC "Help Desk" should be customer-friendly and reachable by phone, fax, and/or email as well as by highly visible contact information for the Partners on ISTC's web page. Such a "Help Desk" should employ full-time assigned personnel (perhaps bi-lingual individuals representing each Funding Party) who the Funding Partners could get to know

and trust no matter what the query. Such a "Help Desk" should be viewed by the Partners as an advocate to help them cut through unnecessary "red tape" and to interface with PPMs/SPMs and other ISTC staff as needed as well as PMs and institute administrators. The "Help Desk" would be a friendly and "known face" to all Partners shielding these "customers" from any confusion within ISTC and or the RF/CSI and the partner institutes. The "Help Desk" should be pro-active in its communication --- with the Partners as well as the PPMs/SPMs at ISTC's Secretariat and the Project Managers at the RF/CIS Institutes --- about suggestions and ideas for improving the Partner Program.

Critique #2: Concurrence Processes and related "Lag Times"

The Concurrence Processes is often perceived as confusing and as an unnecessary barrier by Funding Corporate Partners. Some do not clearly comprehend the purposes or procedures of the concurrence process and expected timetables. A related concern is the resulting "lag time" from project inception until contracts are signed and research work actually begins. It is generally not clear to the Partners that obtaining concurrence on the front-end of their research project is actually a safeguard so that RF/CIS government agencies or those of the Funding Parties cannot arbitrarily block a S&T project after it has been initiated and funded. Either the needed and relevant information on Concurrences Processes is not reaching the proper partner representatives or the information is inadequate. Related to this issue, is the concern (as noted in Critique #1) of exactly who to contact with questions regarding the status of proposed and funded projects.

The Case of Schlumberger: Concerns with "Lag Times" and "deliverables"

In 1998 Schlumberger decided to develop research activity in Russia and as of Winter 2003 the company had about 25 active R&D projects mostly with civilian institutes including The Russian Academy of Sciences and various Russian universities. The company is currently completing its first research project using ISTC's Partner Program. As noted by Dr. Christian Besson, Research Director, CIS, Schlumberger Oilfiled Services, Moscow:[1]

[1] Dr. Christian Besson began his career as an academic research scientist in France. He initially worked for Schlumberger in technology development, a position that took him to many worldwide locations. He then moved to marketing and then research. During his career with Schlumberger he has worked in the US, UK,

This is our first contract with ISTC, we have had several discussions for more projects, but we are sort of waiting to see how this one turns out and there is both good and bad.

The Russian researchers we are working with at VNIIEF are very good – very professional. They had been working for the Russian military and they are very organized, very meticulous. The technology we are developing is for the perforation of wells drilled for oil and gas. The technology was initially developed by the Russians for shooting tanks. It involves experimental work not computer modeling. It's not that the technology is better than what is available in the U.S. but we are working with the Russians on slight variations of the technique. There are probably 3 or 4 countries in the world where you find researchers with this type of expertise. Certainly, it's cost efficient. That's one of the reasons we do research here, but without ISTC we never would have attempted this project.

Now the negatives – there are two. The first is related to the ***lag time*** *between the time the project is defined and when it actually starts. It has been a long process to start this project. We all agreed on the parameters of the research project in the beginning, but you know private companies tend to change their minds from time-to-time. But after a one-year lag before we began the project some of the enthusiasm at Schlumberger dropped. Actually, there are a couple of other projects we would have started at ISTC if it wasn't for this long delay. There is the contract preparation and this is a long process – 1st approval by management, then approval by MinAtom, then it goes to the ISTC process – it has largely to do with the Russian side.* ***They [RF] have to understand that if they could turn things around sooner it would generate more business.*** *You know with the civilian research groups we work with through the CRDF – its about 3-months and that's a good time frame.*

The second problem involves the ***deliverables.*** *Our original intention was that after the Russians had completed the design, tested it, and validated it – they would manufacturer it. But we have had to abandon that idea. This is special equipment – its an explosive - and we can get approval to export only AFTER we have demonstrated its civilian application which is something we cannot do because it is a piece of equipment that we put in a bigger piece of equipment that we use in other countries. So there is no way we can demonstrate to their satisfaction, you know…the way the technology is going to be finally used.*

Fortunately, I had the foresight to put into the contract that for whatever reason if they [VNIIEF] could not manufacturer it, there is an escape clause where we can recover the design and manufacturer it somewhere else. We do have manufacturing in Russia, ***but the Russian government makes it very difficult for projects to lead to fabrication of parts that you want to export.*** *If we were talking a billion dollar*

France and Japan before coming to Russia in 1988. Schlumberger's Russia office is on the campus of Moscow State University. This interview was conducted in Summer 2002.

market I am sure we would have worked to negotiate a deal with the government. But this is not that big. It's a niche product. But, in terms of helping with the long-term sustainability for some small Russian enterprise it's fine. We are used to regulations on explosives. It happens in all counties and even more in the U.S. But, this was very disappointing. You know, this is not a strategic issue for the Russian government. If it were manufactured here, in Russia, it would have gone to our product development center in the U.S. and been integrated into our own equipment and shipped all over the world. Now it will be manufactured in the U.S.

Why do we use the ISTC or the CRDF? There are two reasons. First, in both cases, the Russian scientists receive their funding tax-exempt. Second, CRDF and ISTC are organized to make sure the money goes to the scientists performing the work. This has to be carefully managed. And in this way we are confident that all the financials are legal. We believe it is important to support Russian scientists. To do this ourselves and to work with the Russian banks, well that would be very difficult. We make certain that we do technology oversight. This is very important to us and we wouldn't leave that to anybody else. On all our projects we do regular technical reviews.

Recommendations Concerning "Time Lag" and "Deliverables":

- ISTC should provide clear and "easy to access" explanations for specific project proposals including the ability to locate where the projects are in the concurrence process as well as feedback on the reviews at different stages of the process
- ISTC should do a better job of communicating with the appropriate RF/CIS governmental agencies about the business, economic, regional development costs to the RF/CIS of extended "lag times" and excessive administrative controls (e.g., as noted in the Schlumberger case above). Such explanations could include documented examples of where potential Funding Partners have elected to fund S&T projects in:
  - Other RF/CIS institutes not affiliated with ISTC and thereby <u>not</u> supporting sustainable nonproliferation, and
  - Other countries with competitive and low cost S&T such as China and India thereby <u>not</u> contributing to RF/CIS economic development.
- As ISTC moves toward balanced partnerships and self-sustainability of RF/CIS institutes metrics of evaluation become increasingly complex. For example, when a Science Project is not commercialized as expected the cause should be clarified and documented so that ISTC is not unfairly perceived as "the problem." The innovation/commercialization process from R&D to the marketplace is a long and

complex process where a broad range of intervening variables can cause "failure," including unexpected government intervention (e.g., from Recipient and Funding Parties), lack of external funding, poor management on the part of the Funding Partner (e.g., inadequate marketing, sales, and distribution), or an unpredictable change in global politics and economies. Tracking and recording the reasons for "lag time" and technology commercialization "failures" would help clarify areas of responsibility which are often those of the Recipient or Funding Parties and NOT the fault of, or under the control of, the ISTC or the RF/CIS Institutes.

Critique #3: Full Payment at Start of Project

While the amount of ISTC's administration fees is generally not considered a problem, Corporate Partners expressed concern about being required to provide full-payment up-front --- within 10 days of the project start-date. Some noted that such procedures are not standard practice when funding R&D in US, EU, Japan, or even RF/CIS universities and research institutes. Some respondents indicated that they were able to negotiate what they considered more reasonable payment conditions with ISTC and some indicated that the current payment policy encouraged them to sequentially fund one-year projects. Accordingly, the ISTC Secretariat might consider establishing flexible administrative fees rather than the current fixed fees for Partner Projects. The Parties could decide how best to adjust administrative fees to encourage support of ISTC's objectives of balanced partnerships and self-sustainability, such as:

1. Lower fees[1]
    a. If multiple and related projects are being funded by the same Partner
    b. For funding research projects at RF/CIS Institutes that are targeted as a special concern for nonproliferation or needing increased Partnering activity to transition toward balanced partnerships and self-sustainability
    c. If the Partner seeks to commercialize existing S&T that was developed under a previously Party Funded Project

[1] One ISTC staff member suggested eliminating the fee entirely if the project seeks to commercialize a technology previously initiated under a Party funded project. To contribute to its self-sustainability, ISTC might consider taking an equity position in such "spin-off or spin-out" ventures.

   d. If the Partner qualifies as an SME and will provide considerable value-add commercialization experience to the PM and his/her research team
2. Allocating a portion of overhead fees to enhance ISTC support for the Partner Program, e.g., establishing a Partner "Help Desk" as described above
3. Setting fees according to the amount of oversight required by PPMs/SPMs (e.g., the more complex the project the larger the fee)

Overhead Payments to RF/CIS Institutes

Related to the Funding Partners critique of the full-payment at the beginning of a project is the complaint heard from RF/CIS Institutes of not receiving overhead payments (of 10%) until after a project is completed.

> *Professor A. Zabrodskii, Vice Director, Ioffe Institute, St Petersburg emphasized that ISTC's Partner Programs are very important to Ioeff Institute as they facilitate the commercial application of technologies and research. However, he is also critical of the overhead payment of 10% of the value of the project to be paid by ISTC to the Institute only after the project is completed. He emphasized that this poses significant challenges for the institute in terms of paying indirect costs for:* [1]
>
> - *Electricity*
> - *Water*
> - *Services*
> - *Custom operations*
>
> *This "pay after the project is completed" procedure is especially challenging for longer term projects like the one Ioffe recently signed with Komatsu, Japan that will last 5 years. Zabrodskii's recommendation is to allow for the payment of indirect costs at different stages of project development and perhaps every year for multi-year projects.*

This concern about the "lag-time" for overhead payments to RF/CIS institutes would seem to be a critical component of the sometimes strained or conflicting objectives and metrics for success between:

(1) Institute administrators and staff, and

(2) ISTC funded Project Managers.

[1] Direct costs of researcher salaries are paid by ISTC directly to the researcher during the project.

ISTC payment procedures are structured to ensure research funds go directly to FWS or Project Managers. However, since these researchers and their research teams and facilities are part of the larger institute, it would seem that delaying overhead payments is frustrating one clear benefit to the institute overall.[1] Furthermore, with the transitioning of ISTC's mission to focus more on balanced partnerships and self-sustainability the "clients" of ISTC support need to include RF/CIS institutes and even the regions in which these institutes are located as well as the PMs and their research staff.

Additional Recommendations for the Partner Program

Benchmarking the Competition

ISTC's Funding and Non-Funding Partners are quite knowledgeable concerning the competitive advantages of RF/CIS S&T as well as the comparative benefits of working with the ISTC. Many of these firms have been active in financially supporting RF/CIS S&T for many years. These potential ISTC Partners are not a captive audience. There are other options. Many are funding projects directly with RF/CIS institutes and CRDF is viewed by a number of ISTC partners as a preferred alternative to ISTC. In terms of international competition, ISTC Partner Companies are funding increasing amounts of S&T projects in China and India, countries that also have excellent and cost effective science in addition to large and growing domestic markets.

To help determine realistic quality improvement and expansion plans for the Partner Program, ISTC should conduct regular and systematic data collection on existing partners, potential conversion partners (collaborators, non-funding partners), and government partners to determine how they value ISTC and RF/CIS Institute S&T capabilities and their current and planned national and international S&T objectives and preferences. An important place to begin such a benchmarking within the RF/CIS would be with the CRDF Industry Program's features, services, and policies (Next Steps To Market Programs in particular). This comparison should include interviews with partners which use the CRDF to determine

[1] For example, US universities require funded research projects to pay overhead to the university to support the general facilities and administrators, e.g., libraries, research labs, staff. Such indirect costs are generally at the level of 50% and at times are higher or lower depending on other "value-adds" of the research project to the university's overall mission.

key challenges for ISTC's partner program regarding its communication and administration, concurrence processes, fee structures, and other competitive characteristics. Although this is not a perfect benchmark as ISTC and CRDF have different mandates and resource constraints, according to the IC² Institute survey of US Corporate Partners respondents, CRDF is valued because it:

- Requires less red tape
- Provides matching funds
- Is more efficient at shipping equipment
- Is more service oriented
- Is easier to work with because of time zone differences in working with ISTC

Advisory Board Composed of ISTC Partners

ISTC should consider creating an Advisory Board composed of Funding and Non-Funding Partners to enhance communication with the ISTC Secretariat and Funding and Recipient Parties about how to make it easier for the Partners to provide important and direct feedback to ISTC Secretariat. To maximize value-add for the Partners, the Advisory Board should be organized by sub-groups that focus on concerns of:

- Commercial Partners including sub-groups that focus on the specific challenges and needs of small, mid-sized, and large firms
- Government Partners
- Different technology programs such as bio- and nano-technology
- Different regions within the RF and CIS as well as the Funding Parties in terms of fostering self-sustainability

The Advisory Board could consider solutions to partnering challenges that are discussed in this report including:

- Communication Challenges: Access and responsiveness
- Concurrence Processes and Lag Times
- Fee Structuring and Payment Schedules to ISTC and to the Institutes
- How to encourage and sustain Balanced Partnerships

- Multi-Sourced Funding
- Enhancing Market Pull for RF/CIS S&T
- Enhancing ISTC "Brand Awareness" within Funding Parties

The Advisory Board could also serve as a conduit of suggestions for improving the process of recruiting new partners and converting Non-funding Partners and Party Projects to Funding Partners. Based on the Partner Survey conducted by IC² Institute, over 50% of non-funding partners are interested in funding projects in the near term. These potential customers need to be targeted as to their needs for becoming a Funding Partner

Transitioning from Engagement to Balanced Partnerships

Balanced Partnerships are where there is return on investment (ROI) for both the (1) ISTC Partner, and (2) the RF/CIS Project Manager and his/her institute: Where the Partner Project is successfully completed and where the deliverables meet or exceed the Funding Partners expectations, and value-added learning benefits the Project Manager, his/her research team, and institute in terms of transitioning toward self-sustainability. Distinctions of how best to encourage and reward Balanced Partnerships are considered important for ISTC to consider as the organization's programs and activities move toward meeting the considerable challenges of fostering self-sustainable S&T and innovation systems within the RF/CIS. Such an orientation leads to a more complex assessment of metrics that emphasize the quality of partnerships vs. counting the total number of partners or the total amount of partner funding. For example, a $30,000 project with an SME might well provide a more beneficial learning environment for the PM and his/her team and contribute to regional sustainability than a $300,000 project that focuses on outsourcing R&D.

Amount of funds-in is clearly an important metric, but given the ISTC objective of sustainable non-proliferation, goals and metrics of the Partners Program should also assess and take credit for graduated partner relationships and transitioning from engagement to:

- Conversion of research and research teams to civil and commercial purposes including being a catalyst for change for PMs, their staff, their Institutes, and perhaps their regions

  - Where ISTC programs and act ivies are considered a catalyst for regional technology-based growth within the RF/CIS
- Forming commercial partnerships that increase in the value-added exchange for both the RF/CIS and Funding Parties
- The number of Partner Relationships that prosper beyond project completion and the ISTC support framework
  - An RF/CIS Institute's ability to conduct world-class science and work with Funding Partners without ISTC's assistance
- Research and commercialization activities that would NOT have occurred without ISTC involvement
- Conversion of Party-Funded Projects, Non-Funding Collaborators, and Non-Funding Partners to Funding Partners

The Komatsu Project: Transitioning toward a balanced partnership [1]

In the early 1990s ISTC was crucial to Ioffe Institute's survival and for the retention of our key scientists; however, now ISTC is crucial in terms of scientific projects and partner projects for select groups of IOFFE researchers. ISTC programs and activities are very important to helping them advance their science in terms of commercial activities.

Professor A. Zabrodskii
Vice Director
Ioffe Institute, St Petersburg
Interview Summer 2002

As noted by Vedernikov Victopovich, Project Manager, Ieoff Institute (August 2002), "For us cooperation with ISTC has been very important and very effective. Six years ago it helped us establish connections that have now prolonged into longer lasting and mutually beneficial research projects like the one we have recently established with Komatsu, a world leader in thermo-electric coolers. This partnership did not happen quickly, it evolved over several years. First, contacts were established, between researchers at Komatsu and Ioffe, at workshops and conferences. Over time relationships were formed and maintained but, "these relationships were not tight." *Then, continued Victopovich….*

[1] This case is based on an interview with Vedernikov Marat Victopovich, Project Manager and Mikhail I. Fedorov, Senior Researcher, Laboratory of Physics of Thermo-Elements, Ioeff Institute, St. Petersburg, August 2002.

in 1999 The Japanese government launched a national competition for an "ecological generator." Based on Ioffe's established work in exploring cheaper and more ecological materials such as silicon material, transition metals and representatives, Komatsu asked us to assist them with developing technology for this competition. This initial contract was not all that successful, but it led to three follow-on projects – one per year – on energy conversion.

These short-term projects were a special challenge. One-year is too brief for a serious research project. There were many meetings here and in Japan. You have to deal with all the bureaucratic mechanisms and there is always the question if the project will be continued, so halfway into the project the research team is worried about "what next." But the funding was crucial for individual researchers and for the Institute. Now we have a Five-Year Komatsu Project with yearly updates and this is ideal.

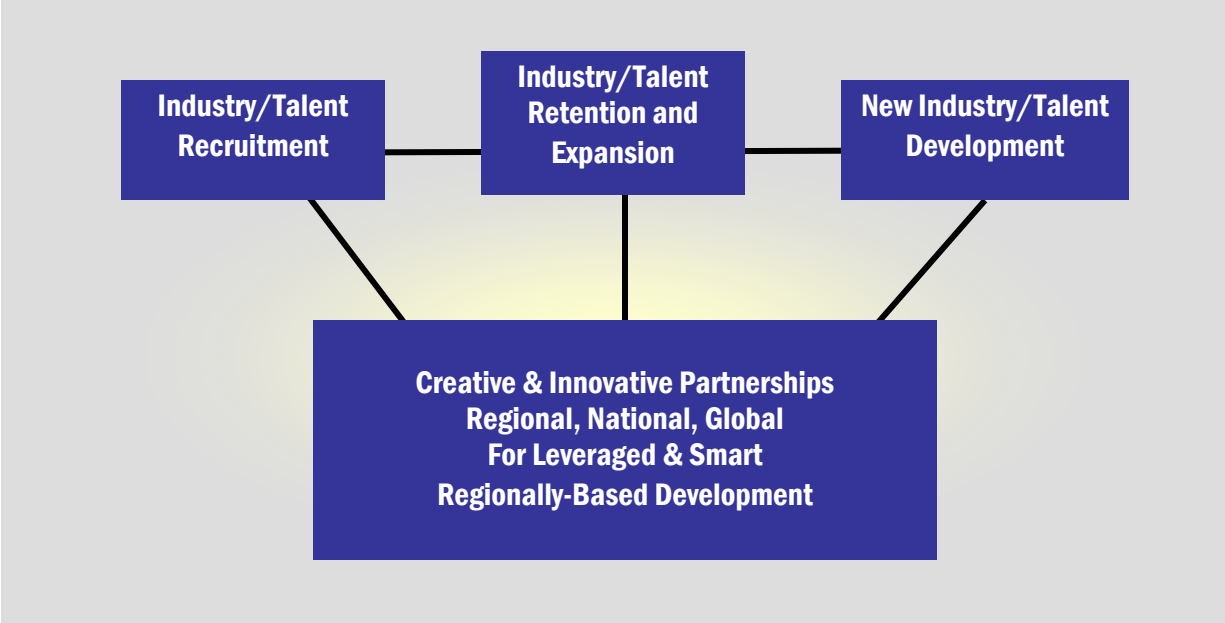
This is one of the first long-term projects that has passed through ISTC and we are in our second year. Komatsu pays a relatively small amount of money for this kind of work --- the investigation and development of advanced thermoelectric materials and devices --- that if done in Japan, the EU, or the US would cost 5-to-10 times as much. But it important to emphasize that this funding is crucial for our research team. As of 2002 we don't need much technical or analytical equipment and we have sufficient CIT support. We make much of our own equipment. What we need are long-term partners, funding support, and access to markets.

Strategies for Regionally-Based Economic Development within RF/CIS and within the Funding Parties

Worldwide there are four basic strategies for fostering regional economic development, Figure 11. Within the RF/CIS, S&T Institutes have been a catalyst for industry and talent recruitment. At times foreign industry locates facilities near an RF/CIS Institute and at times foreign industry recruits talent from the RF/CIS Institute. However, for RF/CIS self-sustainability increased attention needs to be paid to the other three strategies of regional economic development:

- The retention and expansion of RF/CIS industry
- New industry and talent development within the RF/CIS
- Creative and innovative partnerships for leveraged and smart regionally-based economic development

Figure 11. Four basic strategies for regional economic development



The proposed strategy is for ISTC programs and activities and S&T to be a facilitator for national and international partnerships to foster new firm growth as well as firm retention and expansion within the RF/CIS as well as for Funding Parties.

Technology Push vs. Market Pull

To date, a great deal of ISTC transfer efforts have focused on technology push as a result of :

1. The accumulated S&T and established knowledge capital at RF/CIS Institutes, and
2. ISTC's Science Project Program focused on engagement of Former Weapons Researchers and transitioning their research to civil purposes

Technology push is an especially difficult way to achieve successful transfer to commercial application as documented by numerous studies and as demonstrated at US, EU, and Japanese universities and federal laboratories (Gibson and Smilor, 1991; Gibson and Rogers, 1994). Indeed, it would seem that many technology organizations are overwhelmed with available technology opportunities at home and abroad. A great percentage of successful "leapfrog" technology commercialization in the US has occurred through entrepreneurial activities that foster spin-out and start-up companies (Brett, Gibson, and Smilor, 1991).

To increase "market pull" there needs to be a heightened awareness of the most important needs or problems of the "customer" whether within the Funding Parties or RF/CIS. The "customer" can be at the point of sale in the marketplace or a firm that is producing a product or service for sale. For such customer awareness to occur researchers at RF/CIS Institutes need to better appreciate real market opportunities within the US, EU, Japan, Korea, and Norway as well as the RF/CIS. ISTC workshops held in select regions of the Funding and Recipient Parties helps with this knowledge transfer of "market pull" possibilities to RF/CIS researchers. But more needs to be done to increase the awareness of RF/CIS researchers of key market or customer oriented research opportunities and needs.[1] In short, ISTC's needs to do more to strengthen RF/CIS institute researchers capabilities to accurately detect market needs within Funding and Recipient Parties and to be able to sell to these "downstream" entities. In the following pages we offer a range of additional funding and partnering alternatives that focus more on market pull and these include:

- The use of ISTC Technology Intermediaries (Opportunity Recognizers)
- Fostering the growth of Small and Mid-Sized Enterprises (SMEs)
- Partnerships with cities and regions and S&T institutes/universities
- Regional and national RF/CIS industry and government funding to foster job and wealth creation within the RF/CIS [2]
- International foundations that have a special interest in the RF/CIS having sustainable economic development activities

[1] There needs to be more tenders (requests for proposals) from industrial, private partners. The tender and RFP process makes sense in that it is a custom of many R&E groups, it allows for expertise of the ISTC staff (SPMs) to become utilized, and focuses Russian scientists on market-oriented S&T challenges. Increased use of tenders may also be a method for identifying and attracting more private partners to use the ISTC.

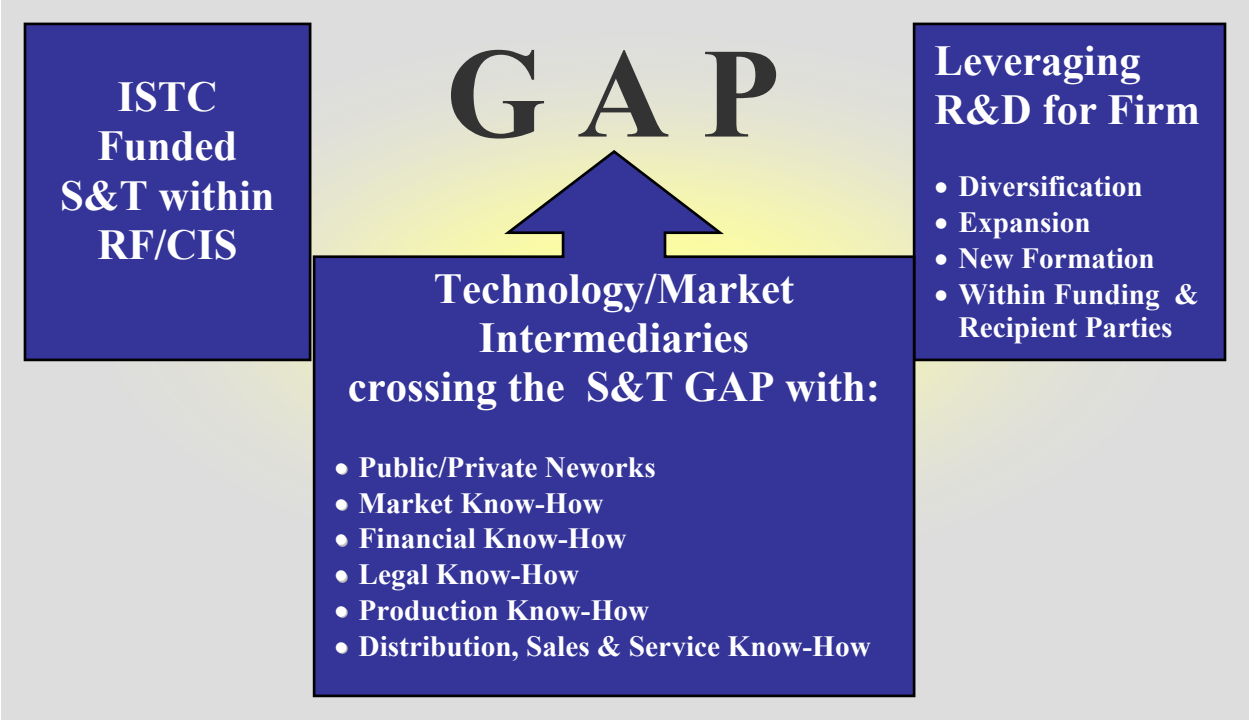
[2] According to CSRS's innovation survey, private sector investment in R&D is growing consistently and there may be opportunities in the near future for Russian business to sponsor and collaborate with the Institutes.

Technology/Market Intermediaries

> **On the one hand, the individuals who come up with radical ideas usually have only a vague notion of application domains; their market knowledge does not reach the threshold of understanding and judgment required to bring opportunities into focus. On the other hand, opportunity recognizers have market knowledge and organizational positions that help them connect ideas with application possibilities. They have the ability to think broadly about potential connections across different fields of science and about social trends, markets, and customers. They perceive opportunities others fail to see or see them before others do….In this sense, they serve as critical links between idea generation and initial opportunity evaluation.**
>
> **R. Leifer, et. al.**
> **Radical Innovation (2000)**

Technology/Market Intermediaries (Opportunity Recognizers) working for ISTC would be selected from Funding Party countries to represent and champion ISTC funded technologies and to act as communication "bridges" between (1) RF/CIS Project Managers, (2) PPMs/SPMs, and (3) the customer. Their activities would support the SPMs/PPMs as they would be experienced in knowledge/technology transfer in particular knowledge areas, but most importantly have established industry networks within the Funding Party countries, Figure 12. Excellent examples of such intermediaries are Technology Futures located in Austin, Texas [www.tfi.com] and The Lughy Group located in Dallas, Texas [http://www.luthygroup.com]. Their pay could come from a percentage of successful transfers or royalty fees from successful technology applications. Lessons learned from using Technology Intermediaries in the Funding Parties could be applied to using similar "opportunity Recognizers" within the RF/CIS.

Figure 12. Using Technology Intermediaries as bridges to cross the GAP between RF/CIS based S&T institutes and customers within Funding and Recipient Parties



Small and Mid-Sized Enterprises (SMEs)

In Europe and the US, SMEs are known to be important sources for job and wealth creation. Accordingly, given the goals and objectives of sustainable nonproliferation, ISTC should work to engage more SMEs, domestic and international, with RF/CIS Institutes. A key challenge is the reality that establishing and managing a small Partner Project with an SME can take as much, if not more, effort and resources on the part of ISTC staff than a large Partner Project with a large firm. Accordingly, it would be important to evaluate SME partnerships differently than those with large multinational companies. For example, it would be important to consider metrics for success that include enhanced "learning by doing" for the RF/CIS Project Manager and his/her team and how such "value-added partnering" leads to self-sustainability for RF/CIS Project Teams and their institutes including company spin-outs and start-ups that are sustainable and grow within the RF/CIS as well as internationally.

SMEs and The Ukraine Science & Technology Center (STCU)

The Ukraine Science and Technology Center (STCU) has many Canadian SMEs funding relatively small projects where the Ukrainian scientists become an integral part of the firm's management and technology team including making sales presentations to potential customers. As of early July, 2002, STCU had a total of 87 Funding Partners and Canada had about 25 SMEs that had concluded partner agreements. The large number of Canadian SMEs at STCU, which has roughly one-fourth the staff as ISTC, is primarily due to a program of the Canadian International Development Agency (CIDA) where a full-time CIDA staff member visits Canadian SMEs to inform them of the partnering opportunities in the Ukraine, Uzbekistan, Georgia, and Russia.

Building on a market-pull model, Canadian SMEs are invited to send STCU summaries of the technologies and research fields in which they are most interested. STCU staff work on matchmaking between the needs of the SMEs and Ukrainian researchers and 2-times a year arranges for 10-15 Canadian SME's to visit Ukrainian S&T institutes. CIDA pays for half of the travel costs, or up to $2000 per company participant. Even if the delegation visits do not result in specific partner projects, Institute scientists find the visits beneficial in terms of expanding networks and in terms of marketing their technologies to potential partners. Based on the CIDA/STCU results, the ISTC might consider:

- Applying for government, foundation, and other funding within each Funding Partie (i.e., EU, US, Japan, Korea, Norway) to provide travel subsidies for select SMEs within their country. In the US, such funding support could come from state and city governments as well as regional Economic Development Associations, see below.
- Informing SMEs within Funding Parties of how ISTC can facilitate in providing S&T and other partnering opportunities within the RF/CIS [1]
- Working with select SMEs within RF/CIS in terms of partnering opportunities with international companies that are partnering with RF/CIS S&T institutes.

[1] Based on the success of the Canadian focus on SMEs," the EU has started a similar process with the STCU. To date, there have been two SME delegations from Finland and several companies from Germany that have visited the RF.

Establish an ISTC Commercialization Fund for SMEs

ISTC might consider creating a bi-lateral or multi-lateral commercialization fund to foster RF/CIS technology venturing and start-up activity at the regional level. There is precedent for such bi-lateral and multi-lateral funds. For example, in 1977 Israel established the BIRD Foundation (Israel-U.S. Binational Industrial Research and Development) and in 1994 the Canada-Israel Industrial Research and Development Foundation (CIIRDF) was established. Key to both programs are the loans provided to joint ventures. With the BIRD Foundation,

> Any pair of companies, one Israeli and one U.S.-based, may apply jointly so long as they can demonstrate the combined capabilities and infrastructure to define, develop, manufacture, sell and support an innovative product based on industrial R&D…. Their willingness to share in the financial risk of product development as well as in the financial gain of commercialization, are key factors in BIRD's evaluation. Typically the role of the larger company is product definition and specification, sales, and service, while the role of the smaller company is in innovation and product development.

Both the BIRD and CIIRDF foundations use small feasibility grants and larger development loans that range from $500,000 to $1,000,000 over two to three years. Investment by the companies is expected to double the foundation loans. Both generally take a hands-off approach to the joint venture and do not take equity positions or become involved with IP, and have reasonable repayment terms. In the case of CIIRDF, total repayment never exceeds the original loan amount. For the BIRD Foundation, total repayment never exceeding 150% of the original amount. Both foundations have provisions for repayments through gross sales, royalties, licensing, and outright product sales. If the ventures fail neither the BIRD nor CIIRDF foundation require repayment.[1]

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[1] BIRD supports 25-35 projects annually with a total investment of around $14 million per year. To date, BIRD has invested over $180 million in 600 projects, which have produced sales of over $7 billion. Repayments in the year 2000 totaled $6 million. Since the establishment of the Foundation 25 years ago, the accumulated repayments have totaled $64 million.

CIIRDF is much smaller in scale. Since its inception, it has received approximately 70 applications for funding, approved about 40, and committed approximately $15 million. Fifteen projects have been completed, and 10 have resulted in commercialization. Seven of the projects are generating royalty payments, and the total royalty payments to CIIRDF have been about $1 million. Within the past year, the CIIRDF has become more focused in its technologies and is placing more emphasis on several industries, based on the two nations' priorities.

Regional Economic Development and Market Pull

ISTC could be an effective catalyst for regional economic development within select regions of the Funding and Recipient Parties. Accelerated technology-based growth is an important economic development objective of developed and developing regions worldwide.[1] What most region's lack is advanced, globally-competitive S&T, a dominant asset in RF/CIS Institutes. A meaningful role for ISTC in the coming decade may well be initiating and managing international partnerships for catalyzing accelerated regional technology growth within select regions of the Funding and Recipient Parties. These regions would be assessed as to strengths, weaknesses, opportunities, and threats (SWOT Analysis) as to fostering the growth of specific types of technology clusters and where ISTC technologies could be the crucial catalyst for "take-off."

Funded by local Economic Development funds, **ISTC Satellite Offices** could establish a physical presence within key regions within Funding Partner countries to assist with:

- Facilitating communication with target companies and markets as well as providing support for Funding Partners. As these Satellite Offices would be regionally-based within the Funding Parties they would not be constrained by distance, time, and cultural barriers as is the case when trying to establish and maintain communication from ISTC, Moscow
- Collecting and analyzing regional and national information on:
  - Market Pull for select S&T by assessing the needs of particular markets and targeted companies
  - Competitive market analyses for specific technologies

Additional information about the Bird Foundation can be obtained at: http://www.birdf.com/what.html and related sites. Additional information about the Canada-Israel Industrial Research and Development Foundation is available at: http://www.ciirdf.ca/ , particularly the link on the Information Handbook, http://www.ciirdf.ca/publications/handbook.pdf

[1] While IC² Institute and The University of Texas have few technology companies "knocking on our door" for globally competitive technologies there is a continual stream of public and private leaders from the US, EU, Japan, and Korea seeking assistance in fostering technology-based growth. This strategy of "S&T Insertion" has been advertised and accepted by regional champions in several regions within Texas.

Organizing value-added S&T workshops for ISTC and conducting follow-up actives for these workshops

It is important that these "Satellite Offices" be established in regions where successful "Technology Pull" can be most easily realized and this may be most prevalent in emerging technology regions rather than technology "hot spots." In short, these partnering efforts might be most successfully launched in regions that while being S&T poor are rich in regional champions from business, local government, educational establishments, and finance. Within such regions there will be less of a need to spend resources and time competing with established technology R&D centers (e.g., universities, businesses, and labs) and trying to overcome resident NIH (not invented here) while competing for management talent and finance. Furthermore, within emerging and developing regions in the US it is believed that there are regional economic development funds (e.g. Chambers of Commerce, Economic Development Councils, City budgets) that could be used to fund these efforts.

Tracking Metrics Over-Time

Given ISTC's goals of balanced partnerships and self-sustainability, it is important that (1) the metrics used by ISTC's Funding Parties and other observers to assess ISTC, and (2) the metrics used by ISTC to assess its staff be sensitive to the transition toward graduating partner relationships. To do this ISTC needs to track the outcomes of Science and Partner Projects over time. To help in this regard, ISTC should consider adding a requirement to new agreements that Project Managers are expected to continue providing information on funding, research activities, publications, and collaborations for 3-to-5 years or more beyond the completion of their ISTC funding to track such metrics.

In this regard an important success metric would be the number of relationships that have prospered beyond the ISTC support framework following project completion including:

- Projects that could have been launched only with ISTC support, but whose subsequent phases were performed without ISTC involvement.
- Identify contractual agreements between national and international entities (corporate and government) and the Institute for a period of years after conclusion of the initial,

partner-ISTC-institute agreement to determine ISTC's role in facilitating the longer-term partnership

- Partner-projects as a follow-on to ISTC Party–funded projects where the Research Project Team and the Funding Party have a vested interest in taking the IP to market.

Levels of Metrics for Partners Program: Current & Proposed

Level I – Counting the Basics

- The number of Funding and Non-Funding Partners and amounts by
  - Ratio of government and industrial/commercial
  - Ratio of large, mid-sized and small Funding-Partners
  - Funding and Recipient Party Location
  - Technology area
- Other sources of funding
  - Foundations
- ISTC Staff who assist in securing Funding and Non-Funding Partners as well as other sources of funding and by amount

Level II – Valuation of Knowledge/Return on Investment (ROI)

- Reasons for project continuation (and reasons for not continuing project)
  - Commercial product – sales, market share
  - Technology and Process improvement
  - Cost savings
  - Access to research/knowledge
  - Patents - IP
- Value gained by partner from ISTC
- Conversion of Non-Funding Partner to Funding Partner
- Conversion of Science Project to funded Partner Project

Level III – Balanced Partnerships and Sustainability

- Continuation of project – on-going partnerships
  - Direct funding and partnering with institute facilitated by ISTC
  - Other funding acquired for project
- Knowledge transfer among project partners
  - Learning-by-doing (e.g., technology development, marketing, sales, distribution)
- Technology Venturing and Entrepreneurship
  - Joint Stock Companies formed
  - Spin-outs and Start-ups

TECHNOLOGIES DATABASE PROGRAM

Over the years the ISTC established networks and contacts in formerly closed and other research institutes and centers throughout the RF/CIS. Many innovative technical and research projects either underway or planned were identified which conformed to ISTC's nonproliferation objectives and which were also seen to have commercial potential. In recognition of this reality, the "Promising Research Abstracts Database Program" was funded by the Government of Japan in mid-1997 to provide a broad overview of ISTC supported research and its potential applications to a wide audience of private companies, universities, research institutes, and government agencies in the RF/CIS and worldwide. As of 1998, 1260 abstracts were collected, formatted, and distributed on CD-ROM and disseminated via the ISTC website. In 2000, Version 3 of New Promising Research Abstracts was released with 1,410 abstracts. Version 4 with 1,620 abstracts was published in early 2001.

Building on this effort, ISTC established the Technologies Database Program in January 2001 to expand information exchange concerning select research activities to:

- Promote the expertise of RF/CIS researchers and institutes
- Facilitate cooperation between RF/CIS researchers and institutes and technical experts worldwide
- Facilitate the integration of RF/CIS weapons scientists into the global scientific community
- Assist in the transition to market economies by promoting unique research activities with commercial applications to potential investors

Also in 2001, the new CIS Science and Technologies Internet Portal was opened with six organizations as initial portal participants [www.tech-db.ru]. As of June 2002, ISTC's S&T portal website receives a minimum of 70,000 hits per month and there were at least 3,000 unique visitors to the portal: For May the total hits were 71,763 and for June 74,833.[1] While it is difficult to know with precision the rationale behind each "hit," because data on ISTC's hits can be disaggregated to different components of the website, it is possible to track the

[1] [1] Web-based data metrics have some limitations but data provided by the Technologies Database program manager generated interesting initial data about the ISTC S&T portal and the ISTC website.

focus of primary interest. In total, the number of pages opened (hits) for Projects, Promising Research Abstracts (PRAs), and Technology Abstracts (TAs), represented approximately 70-75% of the total hits, a very high level of interest in ISTC-supported science. Website data by geographical area of Recipient and Funding Parties is as follows:

- RF/CIS: 33%
- USA: 20-21%
- EU: 16.6%
- Japan and Republic of Korea: 16.6%
- Other: 13%

This geographic representation appears to be relatively stable from month to month. As with the data on the hits for Projects, PRAs, and TAs, the geographic data suggests that the majority of visitors to the portal are interested in S&T and possibly collaboration.

As of Fall 2003, the proportion of visitors to ISTC's S&T portal is now greater than to the general ISTC site [www.istc.ru]. In March 2002, the relative proportions were 50%-50%, in April 2002 this changed to 70% S&T portal to 30% ISTC, and as of June 2002 it was about 80% S&T portal to 20% ISTC. The PRAs receive 10 times as many hits currently as TAs, for a number of specific reasons such as the size of the respective databases, the limited time the TAs have been posted, and the inclusion of the PRAs, but not TAs, in the Common Research Information System of the EU.

Challenges and Recommendations

Technologies Database (TD) is an important supporting program in ISTC's transition toward sustainable nonproliferation. TD represents RF/CIS S&T and ISTC's programs and activities and work worldwide.

Technology Abstracts

Technology Abstracts are very important documents that can either initiate, or not initiate, a continuing link between the RF/CIS researchers and the potential customer. The abstracts follow the standard ISTC outline of

- Full Title
- Technology Area
- Project Status and Development Phase
- Contact information for Project Manager
- Institutions/companies involved
- Project Description

Authors of this report have reviewed ISTC Technology Abstracts and they have worked to use these abstracts to transfer and sell particular RF/CIS S&T to potential customers in the U.S. The potential customers were experienced managers and technologists at mid- to large-sized US technology firms. During this exercise it determined that there was great variability in the clarity and usefulness of the abstracts. Some were fairly well written and some were not. Some were too long and complex to realistically review. Most went into elaborate descriptions of the technology and most did not present specific market applications. And in almost all cases the potential US customer was not able to determine potential market applications of the technology.

Recommendation. SPMs and PPMs and perhaps others at ISTC (e.g., workshops) need to spend more time with the PMs in crafting Technology Abstract documents that are clear, concise, and market oriented. To facilitate this process, as recommended in Section 4 (Economic Value), "revised" Records on Invention, Technology Implementation Plans, and Private Sector Supplement Forms could be:

(1) Submitted at the front end of the proposal review process,
(2) Updated during the research process so they would provide useful technology application and marketing information for resulting Technology Abstracts thereby facilitating technology transfer to successful commercialization.

With modest funding increases TD has the potential to become a much more important and more interactive showcase of RF/CIS S&T capabilities and ISTC programs and activities. It is recommended that ISTC redefine the TD Program as a technology "bourse" that would actively link RF/CIS S&T to customers with challenges/problems and market opportunities. In this way ISTC's TD could be viewed as a bank of solutions in search of problems and not simply as a database of available S&T.

6. Attracting Young Talent

Vector is a place where there is a generation gap. There are all the old WMD scientists and a lot of young technical guys and a few graduate students, but there is a 20-30 year gap. However brilliant this older generation may be it is a dinosaur on the brink of its death phase.

Senior Project Manager
ISTC Summer 2002

Building world-class research and scientific capacity takes many years of scientific work and mentoring – you need an integrated scientific system – during the Soviet time scientific education and research was a top level government priority – we established strong collectives of scientists – each year we had 100 new and capable recruits to our institute – now we get perhaps five and only one or two of these will become high level investigators.

Vedernikov Marat Victopovich
Project Manager
Ioffe Institute, St. Petersburg
Summer 2002

Key to the sustainability of any S&T System is the ability to attract young talent. Accordingly, an important challenge for RF/CIS research institutes is to find ways to:

(1) Attract, train, and retain talented young researchers

(2) Be able to recruit talent back from domestic and international industry and other careers

It is important to emphasize that these challenges are not unique to the RF/CIS as they also confront national research laboratories and universities in the EU and US. For over a decade, US university graduate programs and research institutes have depended on, and benefited from, the recruitment of research talent from China, Taiwan, Korea, India, and Russia. In short, in both developing and developed countries it is a challenge to train and retain sufficient numbers of the most qualified S&T technology researchers as this same talent pool is attracted by well paying jobs and exciting careers in domestic and foreign industry.

This report suggests that the attraction of young talent is indeed compatible with ISTC's central mission of sustainable nonproliferation. As noted by Maria Douglass, ISTC STIM-US (Summer 2002):

> *Clearly the current young RF/CIS researchers are not the WMD scientists of 20 years ago, but where are they going to be working related to their scientific and technical training if they are not going to do something commercial. The RF will continue to need specialists for Russian weapons systems. It is the excess capacity – the 30,000 to 40,000 that need to be sustained. We don't have much of a proliferation problem in the U.S. because the talent is in demand in the commercial sector – they have options.*
>
> *This gets more problematic as we move from the nuclear to the biological or nano areas. If you get a young talented biologists or nano-technician they can as easily apply their talents to weapons of mass destruction as to commercial purposes. We can't tell Russia stop training microbiologists or nano-technicians – people with these skills are graduating every year – where are they going. The important thing is to have them apply their S&T talent to civil purposes.*

And as observed by Professor Jean-Pierre Contzen, Past Chairman of the ISTC Governing Board (email correspondence January 13, 2003):

> Attracting Young Talent is essential. It brings, in my view, a most important message to the ISTC Parties: "Relax the rule about funding only Former Weapons Scientists and support young talent." Science and Technology are mostly dual use – you can't ignore it. The best path toward sustainable non-proliferation is to orient the research activities of young talent to civilian applications. ISTC will attain its proliferation objectives even more effectively by occupying young talent on "safe" projects than by solely working with older scientists who will soon retire.

In short, as the RF/CIS can be expected to continue to train world-class S&T talent, it is in keeping with ISTC's nonproliferation mandate to encourage the development of research environments that applies this young talent to civil and commercial applications rather than the development of weapons of mass destruction whether for the RF/CIS or some rogue nations.

Then there is the related concern of educating the needed S&T talent. And as noted by Dr. Christian Besson, Research Director, Schlumberger, Moscow (Summer 2002):

> *Is the Russian S&T System sustainable in terms of young talent that are getting a quality education and coming into the system? That is the big question.*
>
> *When I first came here I was very concerned about this. My main concern was whether the High Schools would survive because they were suffering even more that the universities. In the best universities, at least some groups managed to survive with Western funding and some researchers taught in Western universities during summers. Entire research groups survived with that money. But with the high schools it was really very difficult. And very few young people were entering universities to do science. I'm still very concerned about this. But I have been here about 4 years and I have not seen things deteriorate.*
>
> *The education system is still very strong. I have had lots of contact with the good universities and I think the good ones remain at the top. As I said, we came here for two reasons. One, as a matter of corporate strategy we like to develop technology in different places worldwide. Second, it is a way of helping our business by demonstrating that we're not a foreign company just selling stuff to take money out, but that we are part of the country.*
>
> *We have interns in our operations here from several Russian universities. We have special programs to help support students. And we place our Russian interns abroad. One of the things that slows us down is the challenge of getting visas for Russian students. Spending the summer working abroad is so terribly complicated in terms of the bureaucracy. We are doing this in good faith – of course it is also helpful for us – but there are hurdles on both sides to making it work.*
>
> *Schlumberger is currently hiring Russian engineers on the business side and we are recruiting heavily. Our business is to provide technical services in oil and gas and we now hire about 100 Russian engineers/year. Our research office in Moscow is still relatively small. We focus on industrial research. We have R&D in many different countries and we do regularly move people. On the business side almost all the Russian hires begin their careers with Schlumberger outside Russia.*

And then there is the important challenge of being attractive to young talent. As commented by an ISTC SPM (July 10, 2002):

> *Oh it's (being attractive to young talent) an issue – its an issue that the Russians are very, very, very concerned about. They are trying to bring in young talent. There are special programs promoting young scientists. And it is not just that Russian scientists are leaving the country it is that they are leaving their jobs – its not an external brain drain so much as an internal brain drain where the young scientists are leaving S&T institutes to become bankers or businessmen or whatever.*
>
> *In the central regions like Moscow and St. Petersburg the young talent have more options but in the remote regions there isn't any big business or big industry that is hiring and paying larger salaries – however we need to remember that 70% of all the key institutes are located in Moscow and St. Petersburg.*

In a review of 12 RF/CIS Institutes visited by IC2 Institute researchers it was found that young talent was most attracted to and retained by dynamic and enthusiastic PMs who were open and networked, exhibited research excellence, and had multi-sourced funding. Young talent tended not to be found in Science Projects that had unenthusiastic PMs that were not linked to the global scientific community and had little interest in commercializing their research results (see Appendix B). For example, Vladimir Vasilevich Kaminski, Project Manager at Ioffe Institute has about 34 people working on "Samarium Sulfide Semiconductors." Twenty-four work at Ioffe (including about 5 young researchers) and 10 researchers work at former weapons institutes in Moscow and St. Petersburg. Average salaries for researchers working on the project range from $33 to $11/month. The age distribution of the research team is indicated as follows:[1]

- 7 researchers (72-63 years old)
- 7 researchers (62-58 years old)
- 9 researchers (57-53 years old)
- 6 researchers (52-43 years old)
- 5 researchers (42-28 years old)

[1] During the following discussion of "Attraction of Young Talent" we focus on and cite the case of Ioffe Institute, St. Petersburg, Russia because we feel this case captures many of the important challenges and potential solutions to this sustainability pillar. Similar examples could be cited from many S&T institutes in the RF/CIS and some of these are reported in Appendix D.

Ioffe identifies potential student recruits from the St. Petersburg region in grades 8, 9, 10, and 11 – about 50 students in each class – and bout 50% of each class is selected to pursue scientific careers and about 50% of these students graduate Ioffe with PhD degrees. Unique features of this program are:

(1) The integration of Liberal Arts (e.g., history, the arts, and social studies) and technical courses, and

(2) The interaction among the high school students and graduate students from two of St. Petersburg's best technical universities: Polytechnical and Electrical Technical University

In the 1970s and 80s we staffed whole departments at regional technical schools in

- **Microelectronics**
- **Astrophysics**
- **Solid State Physics**
- **Plasma Physics**

Today, our researchers serve as professors at regional universities and technical schools and we have visiting scholars from around the world that give lectures also at the regional universities. We have a small hotel for 30 Visiting Scholars and we are planning a new dorm for competitively selected boys and girls from all over Russia. Currently we recruit students from St. Petersburg, but in the future we will recruit nation-wide. We need to produce more young scientists than we will use as many will decide to go abroad.

I have come to the realization that we can not and should not try and stop the movement of this Russian talent. Our only option is to increase the supply – so in Russia we are training and producing excellent scientists for ourselves as well as for the US and other countries. I feel very proud that other countries and other top universities want to hire our students.

Professor A. Zabrodskii, Vice Director,
Ieoff Institute
Interview July 2002

In order to further the nurturing and attraction of young talent, beginning in 1994 Ioffe Institute launched a yearly multistage scientific competition where a special board selects outstanding research projects to be awarded the Institute's top three prizes named for famous Russian physicists: Ioffe, Frenkel, and Konstantinov. A special award is also presented for outstanding research contributions by young scientists. The awards are

financially supported by the Baltiiskii Bank and the Industrial-Construction Bank. [www.ioffe.ru/winners_en/young.html}.

The RF benefits from an important, perhaps international, advantage in terms of nurturing and growing talent. If young Russian scholars get sufficiently high grades on national exams they can obtain a free education through doctoral levels. As noted by Vedernikov Marat Victopovich, Project Manager, Kamatsu Project, Ioffe Institute:

> Our physics and math education is among the best in the world and many of these "best and brightest" students are getting a quality education free to go abroad to live and work. Some return but perhaps, not always the most capable

This observation emphasizes the critical need to create science and business environments that are "magnets for Russian as well as global talent." The best research environments should expect to have their talent heavily recruited by domestic and international industry. The only reasonable strategy is to work to increase the supply of talent and to create research and work environment that encourages the return of "the best and brightest."

RECOMMENDATIONS

Being attractive to young talent is currently NOT a criterion for ISTC/SAC project selection, indeed the focus is precisely the opposite and centers on finding and funding older WMD researchers. Being attractive to young talent is also currently NOT a criterion for ISTC's Partner Program. Consequently, a significant change in ISTC project selection criteria would be needed to favour Science and Partner Projects that include and train young talent.

A recommended strategy to counter the "brain drain" to industry and to more developed S&T countries is to construct an environment in RF/CIS institutes that attracts and retains the desired talent. Such environments would rely on more than high salaries; they would

also focus on making contributions to the following sustainability Pillars of National Purpose and Public Interest as well as Societal Value.

Bringing the talent back home. There is always the attraction for researchers and entrepreneurs to build their career and/or a business in his/her native county. During the 1970-80s, after the Taiwanese government built Hsinchu Research Park, US educated Taiwanese talent was successfully recruited back home from Silicon Valley and other global technology centers. Many successful and world-competitive Taiwanese companies were founded though this effort (Chang, 2000). Bangalore, India used a similar strategy to bring home Indian talent that had been educated in US universities and had built successful careers in U.S. technology firms (Singhal, 1990). A central component of such environments is a robust economic system that focuses on technology innovation and entrepreneurship, wealth creation, and career development, including developing and maintaining:

- Being Open and Networked
- Research Excellence
- Economic value
- Creating S&T that contributes to public interest and societal value

Levels of Metrics: Attracting Young Talent

Level I – Counting the Basics

- Number young researchers, <30yr, involved in projects (man.days)
- Number young researchers, <30yr, involved in project management
- Number of young researchers recently recruited
- Number graduate and post-doctoral research team positions

Level II – Valuation of Knowledge (ROI)

- Attracting and training young talent
  - Quality and quality of young talent recruited from domestic universities
  - Quality and quality of young talent recruited from abroad
- Number of dissertations and theses resulting from project research
- Internship programs

Level III – Sustainability and Balanced Partnerships

- Career mobility for young scientists to travel abroad for experience and to be able to "come back home"
- Encourage and show a bias for Science and Partner Projects that include and train Young Talent.
- Support the development of science, business, and entrepreneurial environments that attract, retain, and bring back talent
- Support the development of alliances between RF/CIS S&T Institutes and domestic and foreign universities for faculty and student exchange and research collaborations
- Consider what S&T sectors are attracting and occupying young talent: are they all oriented to IT or Biotech or does a broader base of D&T competencies currently attract young talent

7. National Purpose and Public Interest

A main danger is that Russia has NO National Scientific Program. The U.S. does and so does Japan and the EU, including special grants for education focused to some targeted areas of research. We need to focus our R&D efforts and build our science base and link it to Russian industry.

Professor A. Zabrodskii
Vice Director
Ioffe Institute, St Petersburg
Interview Summer 2002

ISTC currently supports S&T seed-corn wherever it can be developed in the CIS, but with time, as is now the case in the RF, we need to have more of a strategic focus – to help develop programs of research and technology and innovation clusters – a national S&T strategy. Closely linked to this challenge is the fostering of national and regionally-based systems of innovation capability that will foster the growth of technology-based companies within the RF and CIS.

Jean-Pierre Contzen
EU Member Scientific Advisory Committee (SAC)
ISTC, Interview Summer 2002

INTRODUCTION AND OVERVIEW

ISTC's central objectives of nonproliferation and conversion of Former Weapons Scientists (FWS) to civil R&D purposes including "contributing to solving national and international technical problems" support the sustainability pillar of National Purpose and Public Interest.[1] A nation's S&T system should be relevant to a range of purposes that justify its use of financial, human, and other resources such as contributing to:

- Economic competitiveness – contributing to wealth generation and economic success including new business formation and the development of regional technology clusters for both domestic and international markets

[1] The following section of this report – the sustainability pilliar of Societal Value - will disscuss these issues with a focus on global science and R&D programs. This section is more focused on CIS and RF national and regional interests.

- Critical Infrastructures: Water, energy, transportation and logistics, communications
- The environment and national disasters
- Health and quality of life – to fight disease and improve welfare for citizens
- National security

Supported by ISTC financial and programmatic activities RF/CIS FWS have, over the past 8 years, been redirecting significant research activities to areas of National Purpose and Public Interest, please refer to the following Case Profiles described in Appendix E for an overview of select Science Projects. ISTC's Science and Partners Programs as supported by Business Management Training, Workshops and Seminars, Patent Support, Communication Support, Technologies Database, and Transportation Support have all contributed to strengthening RF/CIS National Purpose and Public Interest.

Table 5. Case Titles of Select ISTC Science Projects in RF/CIS (See Appendix E)

PROJECT NUMBER	TITLE
1. Case 076	**Migration of Aerosol Effluents from Nuclear Power Plants**
2. Case # 079	**Condensed Carbon and Immunoderivatives**
3. Case 0101 A, B, C:	**Ocean Nuclear Database**
4. Case 201	**Aircraft Wake Safety Problem**
5. Case 204	**Silicon Carbide Semiconducting Material for Sensors and Electronics**
6. G-10	**Development of Building Blocks of Semi-conductors Based on GaAs and Related Compounds for Apparatus and Systems**
7. Case 767	**Low-Energy Positron Source**
8. Case A-122	**Superconducting Polymer Ceramics**
9. Case 254	**Research and Development of an Analog Microelectronic Component Basis for Radiation Detector Signal Processing**
10. Case 636	**Development and Investigation of Materials with Giant Magnetroesistance as Basis for Sensors and Devices Controlled by a Magnetic Field**
11. Case 737	**Optical Superradiance and Transient Processes in Extended Resonance and Optical Waveguide Media**
12. Case 781	**Development of the Technical Project of a Device for Fine Purification of Gas Flows from Particles**

The present discussion of National Purpose and Public Interest focuses on recommended strategies for accelerating RF/CIS Knowledge/Technology Transfer (K/TT) to successful applications in public and private sectors at home and abroad for balanced partnerships and sustainable nonproliferation. Effective K/TT is seen to be a fundamental requirement to getting RF/CIS S&T to benefit critical infrastructures, health and quality of life, and the environment as well as wealth and job creation. We will focus our discussion on strategies for accelerated regional economic development within the RF/CIS – strategies that we believe will also benefit the Funding Parties – and they include:

- Enhanced competitiveness of established firms
- New business formation, e.g., spin-outs and start-ups targeted for fast growth and/or acquisition
- Wealth and job creation

RF/CIS Institutes and their S&T talent and knowledge-base are important assets for technology-based regional job and wealth creation. Indeed, in many of the more isolated regions within the RF/CIS, the human/intellectual capital of their S&T institutes represents an especially important if not crucial resource for building wealth and jobs in the 21st Century knowledge economy. However, for the full development potential of S&T to be realized for any region or nation, effective and efficient Knowledge Technology Transfer (K/TT) from R&D to innovation is key.[1] In the following pages, the changing roles of PPMs/SPMs are discussed in terms of their becoming effective "transition advocates" for supporting technology commercialization to both established firms and SMEs including start-up ventures as well as technology adoption by the public sector.

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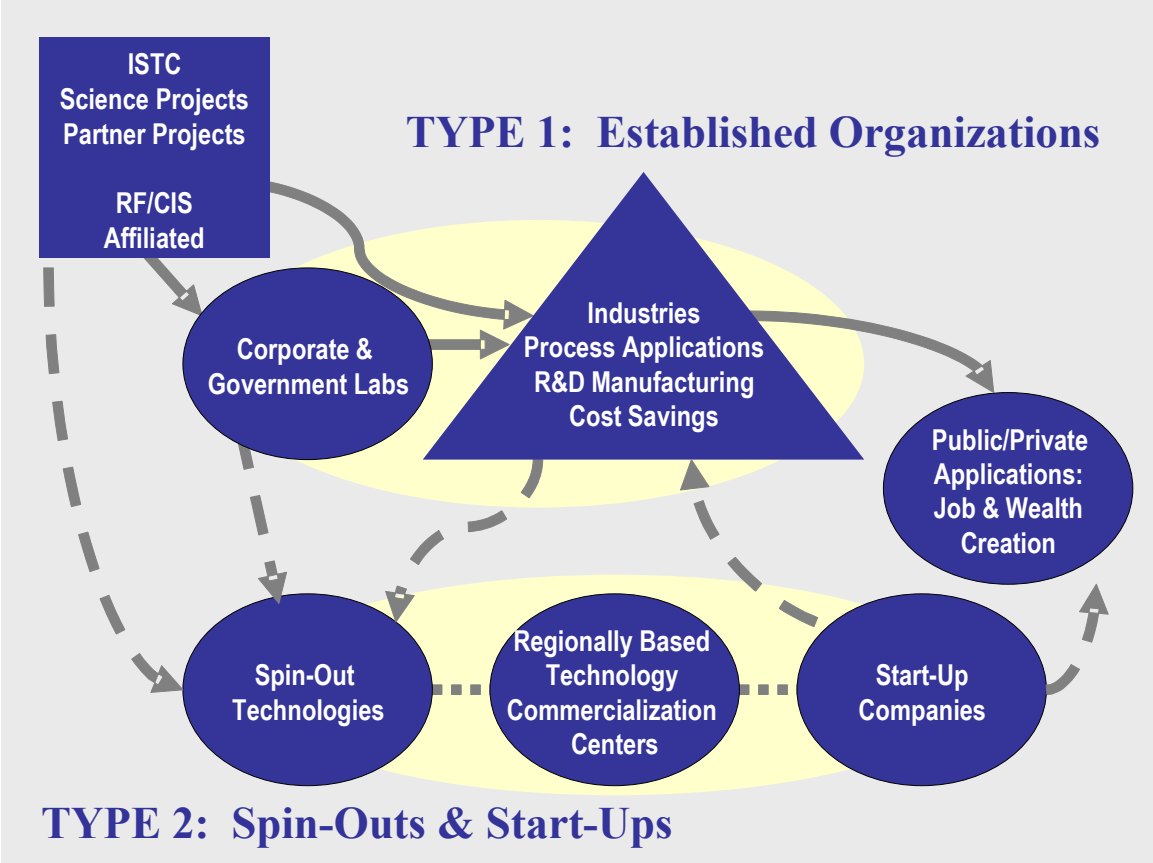
[1] Again it needs to be emphasized that effective and efficient K/TT within and across firms and research organizations (e.g., federal labs, universities, corporate) is far from being realized within the US, EU, Japan and other developed countries. Concerted effort on the part of a broad range of public and private sectors worldwide is targeted to improving K/TT to established firms and to foster entrepreneurial start-up activities (e.g. see www.cordis.int; www.federallabs.org; www.ars.usda.gov/is/AR; http://ipp.lanl.gov; http://www.sciteclibrary.com/cgi-bin/sitesearch/search.cgi; http://www.nctn.hq.nasa.gov; and www.mayallj.freeserve.co.uk.

KNOWLEDGE/TECHNOLOGY TRANSFER (K/TT) TO APPLICATION

Worldwide, two kinds of knowledge/technology transfer (K/TT)—from research to application—directly impact regional and national economic development and the creation of wealth and high-value jobs (Figure 13):

- Knowledge/technology transfer to established organizations (solid line)
- The spinning-out technologies and the formation of start-up companies (dashed line)

Figure 13. Two Basic Forms of Knowledge/Technology Transfer Leading to Public Sector Applications and Wealth and Job Creation



Source: IC² Institute, The University of Texas at Austin

Type 1 Knowledge/Technology Transfer
to Established Organizations

It is generally accepted that knowledge/technology transfer (K/TT) from S&T to application is not a linear, step-by-step process even when presented with the most favorable circumstances such as with well-funded and IP protected corporate R&D within highly innovative firms located within market economies. Transfers of S&T to successful applications are characterized by highly interactive processes with numerous feedback loops that benefit from on-going communication and personal contact among those involved in the transfer process. Transferring knowledge/technology from RF/CIS Institutes to existing public & private organizations within the RF/CIS or within the Funding Parties (including Government and Corporate Funding Partners) is a considerably more complex and challenging process given such intervening variables as diverse:

- Political regimes and perspectives (as reflected in ISTC Concurrence Processes)
- Time and distance
- National cultures complicated by significant political and language differences
- Ambiguous and at times conflicting
    - IP regimes
    - Models of finance including exit strategies
    - Management styles and metrics for success
    - Perspectives on trust and security

Much collaboration and cooperation is required to overcome these challenges. ISTC has the considerable asset of an 8-year track record of working on and overcoming many of these challenges and as of early 2003 the Secretariat has begun to implement critical organizational and personnel changes to accelerate the transition toward balanced partnerships and self-sustainability ("Reorganizing the ISTC Secretariat and Implementing Change," M. Kroning, January, 2003).

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To better understand critical components of successful K/TT it is important to consider both codified and tacit knowledge. Codified knowledge includes published research reports, documents, digital knowledge-bases, and patents. Tacit knowledge (or human capital), is the know-how that resides within experts minds and is often quite difficult to effectively transfer, especially across "heterophilious" environments as required by K/TT.[1] Tacit knowledge is commonly transferred as "learning by doing" and adds considerable value to creative and innovative processes and the successful application of new technologies. Human contact is usually required for the transfer of tacit knowledge and this is why technology transfer is often referred to as a "body contact" type of activity. While there is a need and value for published reports, journal articles, and directories of available research/technologies as well as for on-line databases (such as www.tech-db.ru) the transfer of such codified knowledge is usually not considered sufficient for successful S&T application.

With regard to the transfer of RF/CIS S&T to Funding and Recipient Parties, IC² Institute research suggests four levels of collaborative activity and four correspondingly different definitions of technology transfer success, Figure 14 (Gibson and Rogers, 1994). Level I success is commonly measured by the quality of research that is often determined by peer review, technology reports, research publications, and journal articles. Research strength is most important. The belief is that state-of-the-art ideas/technologies sell themselves. While Level I transfers to process and product applications do occur, such "trickle out" methods are generally considered inadequate for the fast paced globally competitive knowledge-based economy of the 21st Century.[2]

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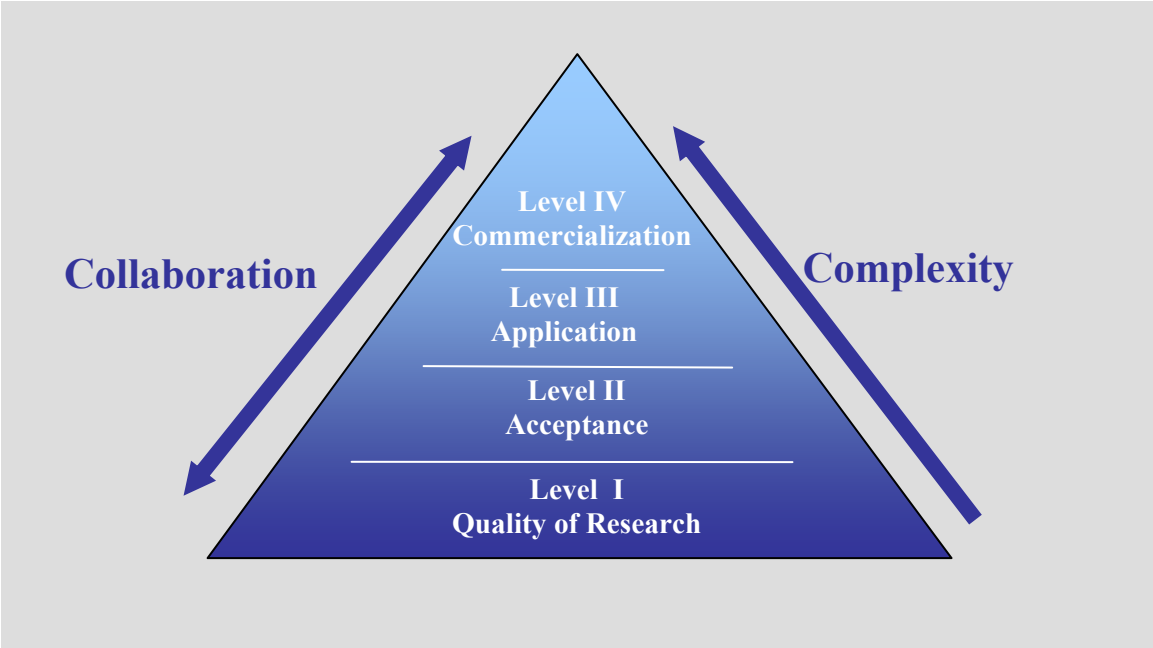
[1] Heterophilious environments are those where communication sources and recipients are different on a range of criteria such as education and training, functional orientation, metrics for success and including such characteristics as culture, language, and age. Homophilious environments are those where communication and sources are more alike and meanings are easily transferred and understood. Effective communication is relatively easy in such environments but less new knowledge is transferred because the communication source and receiver are so similar on key attributes.

[2] It is interesting that, for the benefit of their science, the researchers themselves often work in interactive teams that do cross organizational and national boundaries. But in important respects this is considered homophilious communication as it is within a common scientific or academic frames of reference and reward.

The distinction between excellent science and excellent technology for commercialization opportunities is well reflected in ISTC's report "Reorganizing the ISTC Secretariat and Implementing Change," where individual DEDs are responsible for the pursuit of excellence concerning Fundamental Science, Applied Technology, and Partners and Sustainability as well as ISTC operations. ISTCs new organizational structure gives recognition that these activities, while being complimentary, have distinct modes of operation and metrics for success. The challenge will be to establish and maintain effective horizontal links across all four of these activities so that:

1. Excellent science (the "seed corn") will transfer to applied technologies and partners programs, and
2. Public/private applications will feedback "user" knowledge to Fundamental Science.

Figure 14. Knowledge/Technology Transfer from Research to Commercial Application at Four Levels of Involvement



Source: IC² Institute, The University of Texas at Austin

Level II transfer, technology acceptance, calls for shared responsibility between RF/CIS S&T developers and partners. It is important to emphasize that K/TT from research to commercialization (Levels I to IV), does not imply that RF/CIS scientists need to become transfer experts, but that consideration be given to how best to facilitate and accelerate transfer of S&T across diverse environments. Level II success (Acceptance) occurs when knowledge/technology is transferred across organizational and functional boundaries to champions in partner organizations, that the S&T meets users needs, and that there is technology pull. Moving from Level I to Level II is especially difficult when the organization conducting the research is at "arm's length" from the organization that is the prospective user of the technology. These challenges are exacerbated, as in the case of ISTC, when both physical, cultural, and perceptual distances are great. Worldwide many prestigious R&D organizations have failed to operate effectively by simply limiting their knowledge/technology transfer to passive Level II type of activity, i.e., "we sent out our technical reports," "we published the database," "they have the right information and it is 'their' responsibility to commercialize." What is considered as the "right" information depends on the perceptions of who is sending and receiving the knowledge. Institute scientists may champion their most "exciting and advanced" technologies while other "less cutting-edge" technology or processes may provide a partner with the best and most immediate and useful application. In short, is (1) "state-of-the-art" science (Technology Push), or (2) appropriate technology to meet a market need (Market Pull) driving the transfer process? [1]

For Level III transfer success (application) to occur, ISTC partners or "customers" must have the commitment to take the technology to application or industrial strength. It is at this stage where the partner organization provides additional financial and other organizational resources (value added) to the transferred technology. For Level III to

[1] Are the best ISTC knowledge/technology transfer champions in partner companies the researchers, or are they product development, marketing, or sales personnel that are closer to the market? And is the technology being transferred to the "right" people at the "right" time when it fits with existing or planned corporate and industry product development cycles. In Section 5 of this report we offer the use of Technology/Market Intermediaries (Opportunity Recognizers) to serves as bridges between PMs, SPMs/PPMs, and ISTC customers within Funding and Recipient Countries.

occur the RF/CIS S&T must successfully compete with other S&T championed by those within and outside the firm. Often champions of "established" technologies within the partner organizations have vested interest in keeping "things as they are" (the "Not Invented Here Syndrome"), or in being "innovation assassins," e.g., "why not fund research and related product development in our own company and/or country closer to our markets and not in Russia." There are ample cases of where a superior S&T is "blocked," externally or internally, so that it never "sees the light of day."

Level IV K/TT centers on successful product/process commercialization which is a crucial component of RF/CIS sefl-sustainability. Success is measured in terms of return-on-investment (ROI) or market share. For Level IV success, there needs to be on-going relationships among K/TT participants across organizational boundaries and where both codified and tacit knowledge are exchanged.

In ISTCs "New Organization," PPMs and SPMs will be crucial to facilitating K/TT from Levels I to IV. In Section 5 (Multi-Sourced Funding) of this report we introduced the concept of Technology/Market Intermediaries to help bridge the gaps between RF/CIS Project Managers and their PPMs/SPMs and market applications within the Funding Parties. An example of Type 1 Market Pull K/TT facilitated by an SPM follows:[1]

> Company A, located in the US, makes car parts for Ford Motor Company and foreign firms like Fiat. They were in search of a technology that could uniformly apply pressure so that it could condense at the same rate keeping maximum strength in all directions while also enhancing the parts durability. The company tried and could not find a supplier in the US to help them design and build such a vessel.[2]
>
> A manager at Company A had a colleague in another company that had worked with ISTC and a phone call was placed to the US STIM who was able to locate several RF institutes that were interested and that seemed to have the capability. The lead Institute of Metal Super Plasticity Problems is located where the FSU

[1] This case is based on interviews with Maria Douglass, former ISTC STIM and Gill Suh, ISTC SPM (July 10, 2002 and March 25, 2003).

[2] There is a US patent on a similar technology that Company A cannot use, so they decided to work and develop a superior alternative.

concentrated aircraft manufacturing and the participating The Makeyev Design Bureau, State Rocket Center, had used similar technology to design rockets.[1]

Currently, Company A, the participating institutes, and ISTC are exploring next steps:

- The first stage involving a feasibility study and testing of the parts will be funded by the US State Department
- The second stage will involve design and production and will be funded by Company A and will involve the production facilities of The Makeyev Design Bureau, State Rocket Center .

In late July an ISTC SPM flew with the Russian researchers and technicians to the US to work out project plans, financial agreements and the structure of the deal including:

- How the tasks were going to be divided
- How the deliverables were going to be identified
- IPR issues

The goal is to have the manufacturing and production work done in Russia. If the technology "takes off" it could find additional manufacturing applications in Eastern Europe as well as the US. Looming challenges include the realization that the Makeyev Design Bureau is a former military S&T site for rocket technology so there are considerable IPR control issues involving RF bureaucracy.

[1] This is not the Institute's first ISTC project as they also have a Funded Project with General Electric involving super-plasticity challenges for forming certain metals like titanium at high temperatures.

PPMs/SPMs As Transition Advocates

Project Managers too often think in technological terms and not in terms of users needs. They are often so enamored with their own research projects that they don't see the commercial shortcomings of their "babies." In my own K/TT activities I have "technology brokers" take over from Project Managers at a certain stage.

Jean-Pierre Contzen
EU Member of ISTC's
Scientific Advisory Committee
March 22. 2003

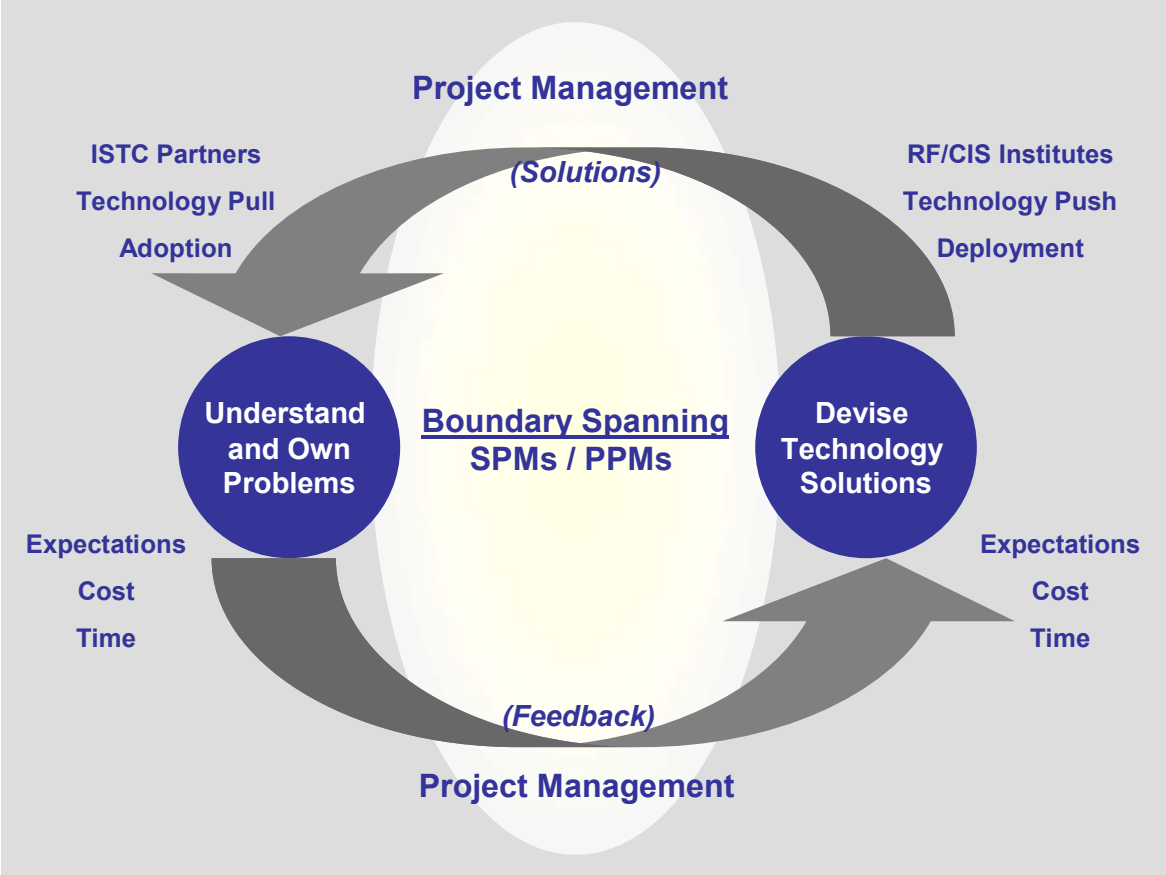
Despite all the challenges discussed in terms of crossing K/TT Levels I, II, II, and IV, the ISTC has considerable assets -- experienced staff, programs, and activities -- to facilitate K/TT processes leading to balanced partnerships sustainable nonproliferation. Many SPMs/PPMs have worked to be effective and trusted transition advocates bridging the K/TT gaps between RF/CIS scientists and the Funding Government and Non-Government Partners, Figure 15.[1] Over years of collaboration with Institute-based PMs and Science Project and Funding Partners, networks of know-how, support, and trust have been built. These personal and professional networks are important assets that should be carefully nurtured during the evolution of SPMs/PPMs from "proposal" to "transition" advocates. Trust is an essential ingredient in the transfer of tacit Know-How and such trust comes with incremental successes that benefit all participants in K/TT processes.

In the "New ISTC" PPMs/SPMs are to "focus their efforts in areas of technology competency for both business and science communities within the Funding and Recipient Parties." They are to "maintain long-term strategic partnerships in key sectors of ISTC's activities" and "provide economic evaluations of Science Projects." The

[1] Section 5 (Multi-Sourced Funding) also recommends the use of Technology/Market Intermediaries to help bridge the gap between RF/CIS PMs and S&T commercialization partners within the Funding and Recipient Partners.

objective is to "accelerate the movement of FWS off dependence on ISTC funding to being self-supporting."

Figure 15. Interactive Model of Knowledge/Technology Transfer Leveraging SPM/PPM Networks and Relationships



Source: IC² Institute, The University of Texas at Austin

Following is a list of the stated objectives for RF/CIS Project Proposals for the "New ISTC Organization):[1]

- To present specific technical objectives and an analysis of the state-of-the-art
- To demonstrate the competitive advantage of the proposed technology or novel idea
- To describe areas of potential applications for results

[1] "A New ISTC Organization," GOV-XXIX-011, Attachment 1, p. 12.

- To provide a schedule for project development including deliverable milestones and management structure
- To provide a market analysis including indication of potential customers and expected worldwide markets for a full exploitation of the technology

In working to accomplish the above, PPMs/SPMs will face considerable challenges as will Project Managers at RF/CIS institutes. For example, there needs to be an awareness of global and national markets and competitive technologies as well as the most important S&T needs of Partner Organizations for successful technology public/private applications. Indeed, to accomplish such technology assessments would be expecting a lot of the public (e.g., universities and federal labs) sectors within the EU, US, and Japan. At the very least, to be effective "transition advocates," PPMs/SPMs will need targeted training to have the required know-how and they will need the active support of ISTC's Secretariat including:

- Adequate CIT support for database searches
- Sufficient budgets for travel
- Support staff to allow for needed time to build and maintain personal relationships and to be knowledgeable technology experts.

A key challenge will be how best to leverage ISTC programs and activities to assist the PPMs/SPMs and the PMs with these complex partnering and marketplace assessments.

Of considerable concern is how the PPMs/SPMs will be able to develop and leverage the needed national and global business networks that will be essential to providing realistic market analyses and application opportunities of proposed technologies.

One of the current authors has researched and written about the effectiveness of such K/TT "boundary spanning" (the role expected of PPMs/SPMs) and found that to be effective a hard-to-find set of skills was needed even when operating within the U.S. and bridging the K/TT gaps between a research organization and "shareholders" of that research. The effectiveness of these "boundary spanning transfer agents" increased if:

(1) They had an extensive and deep knowledge of the companies existing R&D efforts and market applications,
(2) They had an equally extensive and deep knowledge of research activities at the consortium (above and beyond what was published in research reports and that existed in databases), and
(3) They were effective and frequent communicators with both the S&T research and the S&T users.

The most successful transfer agents spent half their time at the research site and half their time at the users location. Their salaries came from the private sector user organizations.[1]

We provide one example of a highly motivated and effective SPMs as a "transition advocate" to provide an overview of the challenges and assets, to greater and lesser degree, faced by all 40 or so PPMs/SPMs.[2]

This talented and engaged Senior Project Manager had worked for ISTC for four years and currently had 45 active Science Projects. The total number was closer to 90, but some of these were completed, some were inactive, and some were not yet funded. Included in his active file were 40 projects with the European Aerospace Research and Development Office for the US Air Force. These projects alone necessitated weekly coordination. The SPM had an assistant to help him manage his workload and keep things moving at ISTC while he visits RF/CIS Institutes and partners within the US, EU, and Korea.[3] As noted, such "face-to-face" communication is considered essential for effective K/TT. It is realistic to consider that being an effective "transition advocate" will involve considerably more travel time and K/TT know-how than being a "proposal advocate."

The SPM had considerable assets for being an effective "transition advocate." He has a PhD in materials science, he understood marketplace economies and business needs and he was an effective communicator. He had been in Russia for 8 years and spoke and understood Russian. He was a talented, engaged, committed, and highly motivated and respected SPM. As he stated,

I have a lot of projects with business people. I like to visit and work with business types but to organize and conduct a customer visit with a group of RF scientists,

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[1] The current example is taken from R&D Collaboration on Trial, D. Gibson and E. Rogers, Harvard Business School Press, 1994. In this report we offer the notion of Technology/Market Intermediaries to help bridge the significant gaps between S&T development at RF/CIS Institutes and market applications within the Funding and Recipient Parties.
[2] Based on interviews conducted July 10, 2002 and March 25, 2003.
[3] Interesting to note if this SPM traveled within the RF/CIS to visit each of his ISTC projects once each year, as required, he would need to visit about 5 institutes/month.

> *say to a US partner, takes about 4 weeks – including at least one week of travel. In addition there is the needed follow-up. It takes a lot of time and a lot of effort. And when I return to ISTC my other work is backlogged. But these trips and face-to-face meetings are needed to structure and close the deals. I take work home and work on the weekends, trying just – you know – to keep up with the work.*
>
> *It's great working with US government and US business and with my Korean contacts as well. You have to bring in business. Governments are governments. They may start things but the eventual goal has to be to bring in business. Once there is a need business will bring the funding and do it themselves. And if you can be part of that, helping out, that's just great. Just trying to build the networks and make things happen, I mean scientists from UFA and MIAS in Siberia working with entrepreneurs in Alabama, can you imagine?*

Most of the Russian SPMs have strong educational and technical backgrounds and careers of working at RF/CIS Institutes. Some have established corporate networks with Russian ministries/institutes. However, very few have established networks with Russian businessmen and they are seriously challenged to build effective network links with businesses located in the US, EU, Japan, and Korea.

> A lot of them (Russian SPMs) bring good networks from the Institutes where they worked but they do not have established networks in the Funding Party countries. And it is difficult for them to think about sustainability in terms of commercialization…Even for those that speak English making a phone call to a funding Party in the US or Europe is extremely difficult. *Foreign SPM, Interview Summer 2002.*

Most foreign SPMs (from Japan, Korea, EU, and the US) also have strong educational and technical backgrounds and a few have established corporate networks with Funding Parties within their technical areas of expertise. But they have the additional challenge of establishing effective networks with their Project Managers often at distant locations and with associated RF/CIS institute, government, and technical participants within. Most don't fluently speak and understand Russian.

This report recommends the pairing of Russian and Foreign PPMs/SPMs together as they work to become effective "transition advocates." The objective is to maximize the benefit of their respective national and international business networks and personal

relationships as well as to benefit their "learning-by-doing" training. As previously noted, this report also suggests a new position of "Technology/Market Intermediaries" be "hired" from the Funding and Recipient countries. These added staff would be paid from commissions of successful K/TT transfers to commercial applications.

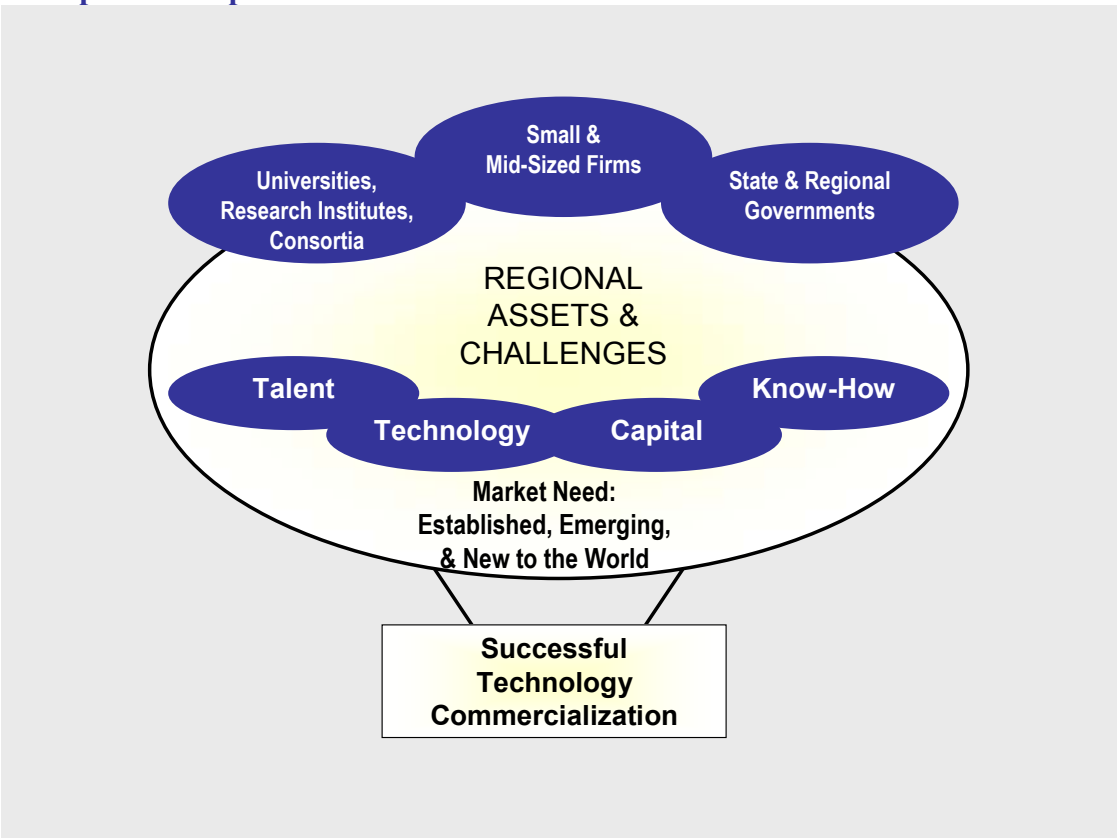
Type 2 Spin Out/Start up Knowledge/Technology Transfer

It is the experience of IC² Institute, The University of Texas at Austin that it is most likely that "incremental K/TT" – relatively small improvements to an existing technology – can be most effectively achieved through Type 1 transfer to established firms. But for "radically new technology," Type 2 on spin-out and start-up K/TT is most common. Spin-out firms often originate when a particularly innovative technology or process does not make it to Levels II, III, or IV within an established firm, see Figure 1, page ?.

Entrepreneurs are often the ones who see a technology application that others don't, and this awareness comes from a broad range of motivations, experiences, and networks. To a large degree the success of regionally-based entrepreneurial activity involves

- A supportive "Innovation System" (e.g., business environment and regulatory framework that supports spin-out and start-up and entrepreneurial activities)
- "Smart infrastructure" including experienced management, legal, finance, manufacturing, sales and distribution talent
- The effective linking of talent, capital, and business know-how with an innovative technology and business model
- Large accessible markets for established, emerging, or new to the world products and services, Figure 16.

Figure 16. Networking of Critical Resources for Regionally-Based Technology Entrepreneurship



Source: IC² Institute, The University of Texas at Austin

While having a marketable technology, adequate funding, and entrepreneurial talent is important, management "know-how" is considered the crucial determinant of new business success."[1] Know-how includes expertise in management, marketing, finance, accounting, manufacturing, and sales and distribution --- all needed to cross technology transfer gaps between R&D and business diversification, expansion, and new formation.

[1] Entrepreneurial talent results from the perception, drive, tenacity, dedication, and hard work of special types of individuals---people who make things happen. Where there is a pool of such talent, there is opportunity for economic growth, diversification, and new business development. Talent without ideas is like seed without water. When talent is linked with technology, when people facilitate the push and pull of viable ideas to commercialization, the entrepreneurial process is underway. Every dynamic process needs fuel, and here the fuel is capital. Capital is the catalyst in the technology venturing chain reaction. Know-how is the ability to leverage business or scientific knowledge by linking talent, technology, and capital for fast growth enterprises. This know-how is often referred to as "smart infrastructure" and is considered the most critical component in achieving success in start-up and spin-out processes.

Source: IC² Institute, The University of Texas at Austin

Know-how finds and applies expertise in a variety of areas and ways during technology venturing, often making the crucial difference between venture success and failure.

While an RF/CIS Institute-based spin-out or start-up may have an exciting technology that is globally competitive and the company may benefit from exceptional entrepreneurial talent, it is also likely to lack sufficient capital and business know-how to commercialize and market the innovative product/service nationally and/or globally. This lack of a management track record also makes it difficult to acquire needed capital. For these reasons (in the following) we recommend an expanded role for the ISTC, that of being a network hub within the RF/CIS and linked to the Funding Parties to facilitate access to know-how, finance, and markets to "fill in the technology commercialization gaps" to accelerate the growth and perhaps acquisition of RF/CIS SMEs.

RECOMMENDATIONS

Two activities are recommended for ISTC to facilitate transitioning to sustainable nonproliferation and S&T Systems and for fostering technology applications for National Purpose and Public Interest within the RF/CIS. These recommendations are:

1. ISTC as a catalyst for structuring and conducting regional benchmark studies in SELECT RF/CIS regions key S&T of assets and challenges for:
    a. Accelerated regionally-based technology growth
    b. Contributing to the development of National S&T Strategies.

    Initial benchmark studies would be targeted for regions that are most likely to have the required assets for S&T based economic development in particular clusters of activity, and to provide "successful role models" and "lessons learned" for other regions and institutes. These benchmark studies would provide "roadmaps" or action strategies for the development of regional technology innovation clusters that would be linked to relevant national and international S&T Programs.
2. ISTC as an advisor and mentor for the successful management and networking (nationally and globally) of select regional Technology Commercialization

Centers (TCCs) that would be affiliated with S&T Institutes. ISTC's programs and activities and national and global networks could be leveraged to the benefit of the TCCs in RF/CIS and to the benefit of the Funding and Recipient Parties.

Technology-Based Benchmarking and Roadmaps
for Select Regions within the RF/CIS

ISTC could be a catalyst for providing the expertise and objective analyses to conduct regional technology-based benchmarking and roadmap reports to facilitate the successful development of regional innovation clusters within the RF/CIS. A main objective of these regional benchmark assessments would be to provide objective data for:

1. Targeted global recruitment of key R&D, manufacturing, and service companies
2. Assisting in the retention and expansion of existing regional enterprises and assisting them to become more entrepreneurial, technology focused, and globally competitive
3. Assessment of assets and challenges for incubating regionally-based, globally-competitive companies
4. Leveraging regional, national, and international resources and assets to facilitate #1 to #3

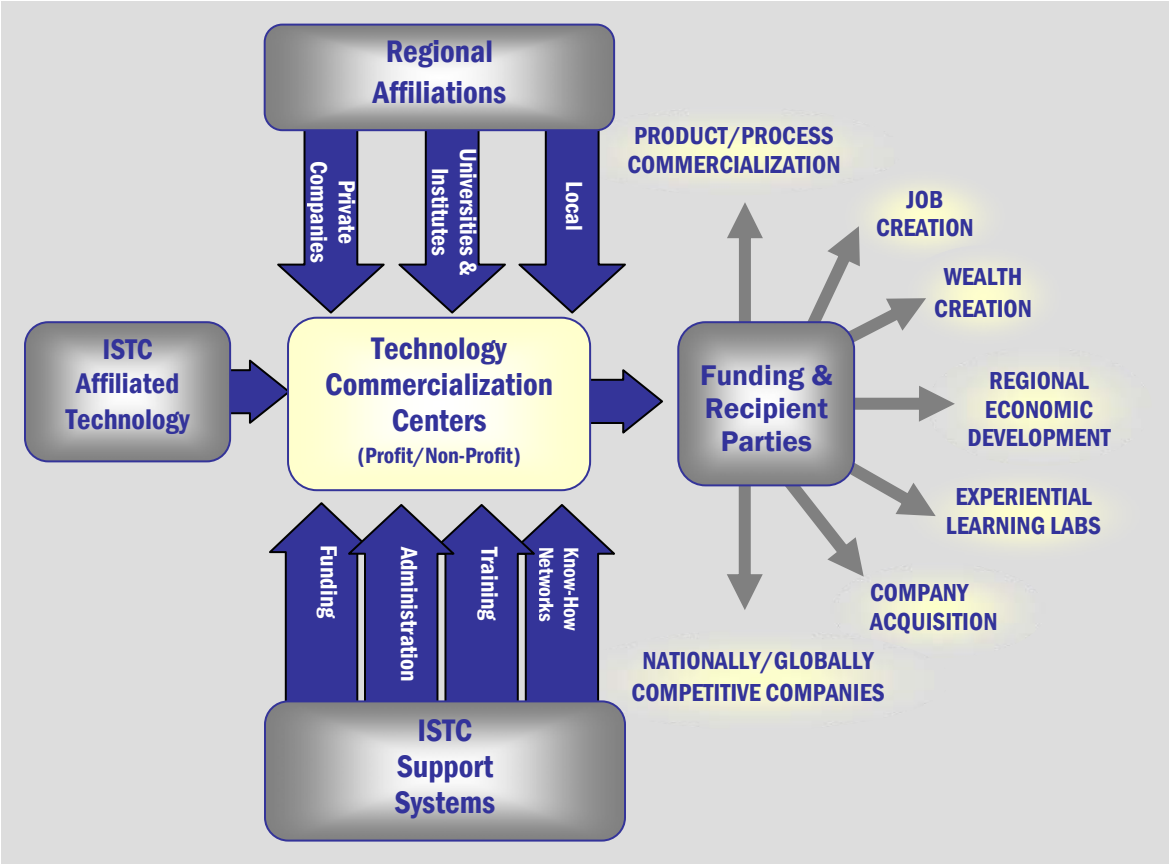
Such regional technology benchmark studies would be an excellent resource to provide:

1. Useful and needed strategies for regional development in terms of incubating and growing strategically targeted regional innovation clusters and start-up and spin-off firms based on existing assets of regionally-based S&T Institutes, academic facilities, and business enterprises.
2. S&T information concerning facilities, educational capacity, and existing knowledge capacity that will contribute to the formation of a National Scientific Program that it linked to regional strengths

Leveraging & Assisting Regional Technology Commercialization Centers (TCC)

To facilitate regional economic development as well as public application of S&T for National Purpose and Public Interest, the ISTC could be a valued support mechanism for partnering with select incubators within the RF/CIS to help them transition to become effective Technology Commercialization Centers (TC^2). Over the past 8 years numerous incubators have been launched by TACIS, EURASIA, USAID and other international organizations. Most have had limited success in being sustainable and in producing regional wealth and jobs. Criteria for selecting and partnering with existing incubators would focus on existing regionally-based S&T assets (RF/CIS Institutes) as well as potential regional affiliations with private companies, universities and institutes, and local government, Figure 17.

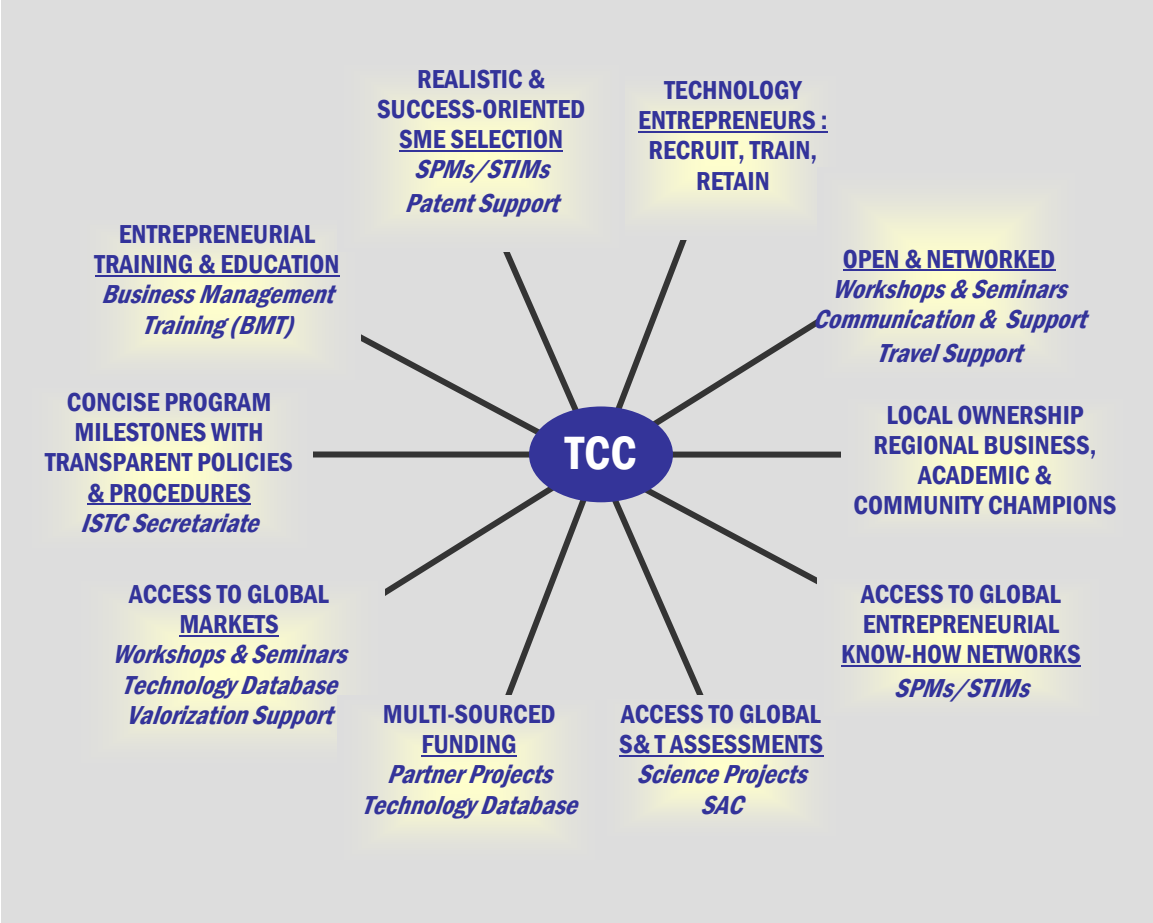
Figure 17. Critical Components of Successful Regionally-Based Technology Commercialization Centers within RF/CIS



Source: IC² Institute, The University of Texas at Austin

Existing ISTC programs and activities could support the TCC's in terms technology and business plan assessments, global market access, training, and linking with know-how networks in the Funding Parties, Figure 18.

Figure 18. Ten Success Factors and Relevant ISTC Program Support for Regionally Based Technology Commercialization Centers (TCCs)



Source: IC² Institute, The University of Texas at Austin

For select RF/CIS Institutes, ISTC could foster the development of globally networked teams that would include technologists and entrepreneurs as well as managers, finance, legal, sales, and distribution expertise. Such international collaborations are seen to be important for overcoming challenges of local language, culture, legal, and policy differences, challenges that can quickly overwhelm and defeat an SME. The objective is

to solve problems faster, shorten learning curves and minimize costly business and marketing mistakes.

The challenge is to foster the global linking of cutting-edge research and technology with venture financing, quality management, and the realities of the international marketplace. Whereas technology reports, patents, and technology licenses are often the output of S&T institutes, they are considered inputs to the due diligence and business plans required for the Globally Linked Technology Commercialization Centers that could:

- Foster the creation of high value jobs and accelerate economic development
- Be models for "best practices" to accelerate the rate and increase the likelihood of spinout and start-up venture success
- Act as "lightening rods" at the regional level linking talent, technology, capital, and business know-how to market needs
- Shorten learning curves and facilitate access to the "right knowledge at the right time" Serve as "experiential learning laboratories" and "models for success" for fostering public/private collaboration at the regional level to:
    - Promote partnerships and acquisitions between large companies and entrepreneurial firms regionally and globally
    - Foster collaborations across academic, business, government sectors: regionally, nationally, and globally
    - Promote and support regional entrepreneurial vision and leadership
    - Develop innovative ways to regionally and globally leverage capital, talent, technology, and "know-how" resources
    - Leverage R&D to achieve early success, and contribute to newer industries and smart infrastructures for the 21st century

Levels of Metrics: National Purpose & Public Interest

Overall success in terms of Type 1 and 2 K/TT is difficult to measure by traditional cost-benefit analyses, since (1) it is often difficult to quantify cause and effect relationships and financial and other impacts of innovation processes over time, and (2) depending on

their unique perspectives, different participants in K/TT processes commonly hold different expectations concerning metrics for success. For example, some value quality research and reports, while others value market-strength technology.

Level I – Counting The Basics

- Number of S&T projects and amount of funding contributing to National Purpose and Public Interest including:
  - Regional and National Economic Development
  - Critical Infrastructures: Water, Energy, Transportation and Logistics, Communications
  - Health and Quality of Life
  - The Environment and National Disasters
  - Defense

Level II – Valuation of Knowledge and Return on Investment (ROI)

- Type 1 K/TT - Knowledge/Technology transferred to established firms to:
  - Level II (Acceptance)
  - Level III (Application)
  - Level IV (Commercialization)
- Type 2 K/TT – Knowledge/technology transferred to spin-outs and start-ups
  - Shorten learning-curves
  - Shorten time for product development and commercialization
  - Minimize Risk: technology, marketing, IP
  - Accelerate process and product commercialization
    - Size of market share and amount of sales

Level III – Balanced Partnerships and Sustainability

- Success in leveraging ISTC programs and activities for
  - Firm recruitment
  - Retention and Expansion
  - New firm formation
  - National and Global Partnerships
- National and regional economic development: wealth and job creation
- Regional business, academic, institute, and local government cooperation
- Success in recruiting, training, and retaining entrepreneurs
- Growing globally competitive companies
- Increased taxes generated regionally and nationally

8. Societal Value

Even our most advanced theoreticians and astrophysicists benefit by being part of international networks of scientists and programs and are actively using U.S. satellite communications to keep in contact with their colleagues and peers internationally and by participating in the use of supercomputers from different countries online using US satellites.

Professor A. Zabrodskii
Vice Director
Ioffe Institute, St Petersburg

It is unquestionable that technological progress has driven the overall improvements in the standards of living across the globe, it is also clear that many countries and many people have been excluded from the benefits of new technology and innovations… The need to promote "inclusive development" has become a problem that goes beyond the creation of conditions to generate knowledge… The most important problem concerns the sharing and diffusion of knowledge.

The rationale for the 7th Sustainability Pillar of Societal Value is that

(1) Any nation's science and technology should contribute to worldwide knowledge for the 21st Century, and

(2) It is important to increase public awareness of the role of S&T for the well being of nations including:

- The funding of knowledge exploration for its own sake as a contribution to human endeavour including the dissemination of scientific methods and results
- Working with academic, government, and business institutions worldwide to solve global challenges
- Working the international science community for well-being of nations and regions --- for shared prosperity at home and abroad

It is the position of this report that many of ISTCs programs and activities have contributed to the Sustainability Pillar of Societal Value. By its very nature of being a global multilateral organization that networks across developed and developing regions,

the ISTC provides an unique "experiential learning laboratory" to be at the forefront of best practices for knowledge creation, dissemination, and adoption across a broad range of environments. As ISTC moves toward greater concerns of balanced partnerships and self-sustainability within the RF/CIS this multilaterial organization may well provide an important model to using S&T for accelerating economic development and an improved quality of life.

It suggested that the ISTC is, or could be, at the center of a form of "transformational management," as a multilateral organization that facilitates national and international knowledge creation, sharing, diffusion, and application for the advancement of society. As George Kozmestky states, "Transformational management is the process of moving from one state and level of activity and commitment to another. It requires a focus on higher aspirations and longer-range views that not only benefit individual firms and corporations but at the same time help provide for the general welfare. Transformational management is focused on social consciousness… It deals with monitoring, delineating, and clarifying the possibilities for business success in conjunction with the hopes for a better future for society."[1]

The foundation for a new economic world order has been laid – one based upon knowledge, innovation and international collaboration. This is a new landscape where ….the world is experiencing unprecedented change in applications of knowledge in every dimension of development, growth, revitalization, and organization. The demands and opportunities of an interdependent global economy have implications for private and public decision making by enterprises and communities…

Debra M. Amidon,
The Innovation SuperHighway:
Harnessing Intellectual Capital for Collaborative Advantage, 2002

As noted by Lester C. Thurow, "The old foundations of success are gone. For all of human history, the source of success has been the control of natural resources – land, gold, oil. Suddenly the answer is "knowledge…..Knowledge is the new basis for wealth. This has never before been true. In the past when capitalists talked about their wealth,

[1] G. Kozmetsky, Transformational Management. Cambridge: Ballinger. 1985. p. 1

they were talking about their ownership of plant and equipment and natural resources. In the future when capitalists talk about wealth they will be talking about their control of knowledge…..The concept of "owning" is clear. But one cannot talk in the same ways about "owning" knowledge. Owning knowledge is a slippery concept. The human beings who possess knowledge cannot be made into slaves. Exactly how one controls (owns?) knowledge is in fact a central issue in a knowledge-based economy (L. C. Thurow, Building Wealth: The New Rules for Individuals, Companies, and Nations in a Knowledge-Based Economy, Harper Business, 2000, p. xiii)

The ability and desire to access knowledge and to be able to learn and put knowledge to work is central to regional economic development and for globalization to be a force for drawing the world together. The objective is to accelerate regional economic development and shared prosperity. As Lester Thurow (2000, p. xiii) states, "traditionally wealth creation, in developed and developing nations, has emphasized physical assets. The capital stock of a nation was thought to be a measure of national prosperity, and the attraction of foreign direct investment became a prime strategy of less developed regions. As the world moves into the 21st Century, however, the emphasis is on knowledge transfer, accumulation, adoption, and diffusion as being critical to economic development"

As the World Bank noted in its 1998 *World Development Report:*

> It appears that well-developed capabilities to learn—the abilities to put knowledge to work—are responsible for rapid catch-up...The basic elements [to develop these learning abilities] appear to be skilled people, knowledge institutions, knowledge networks, and information and communications infrastructure.

Knowledge transfer, adoption, accumulation, diffusion, and application are key to sustainable economic prosperity in the emerging global economy of the 21st century. As stated by Abramovitz and David in a 1996 OECD report, "The expansion of the

knowledge base…[has] progressed to the stage of fundamentally altering the form and structure of economic growth." Rapid advances in information and communication technologies and declining costs of producing, processing and diffusing knowledge are transforming social and economic activities worldwide (The World Bank, 1998).

The current knowledge revolution is based upon a shift of wealth creating assets from physical things to intangible resources based on knowledge (Stevens, 1996). Knowledge-based economic regions tend to be located near leading universities and research centers in the most advanced regions of the world (Smilor, Gibson, and Kozmetsky, 1986; Quandt, 1998). Lucas (1988) argues that people with high levels of human capital tend to migrate to locations where there is an abundance of other people with high levels of human capital. Indeed, the importance of the physical proximity of talent, technology, capital, and know-how or "smart infrastructure" has been argued to be crucial to fostering regional wealth and job creation (Rogers and Larsen, 1982; Gibson, Smilor, and Kozmetsky, 1991; Audretsch and Feldman, 1996; and Audretsch and Stephan, 1996).

Today, the really substantial gains in wealth are to be found in the use and diffusion of knowledge. However, without skills, ideas may be irrelevant. Similarly without ideas, there may be no need for new and better skills. In short, it is important to stress that the accumulation of knowledge leads to the creation of wealth only if the knowledge is effectively transferred, adopted, and diffused. [1]

[1] History is full of examples where the producers of an innovative technology by not using and diffusing it were surpassed by others who did. Two examples serve as illustrations: One at the grand scale of the history of civilization; The other at the much smaller scale of contemporary corporate warfare. China developed what was, after the invention of writing, one of the most important ideas for the progress of humankind-the movable type printing press. This technology dramatically increased the possibilities of codifying knowledge. However, Imperial China restricted the use and diffusion of this technology to the affairs of the Emperor and his court. As a result it was Europe that benefited most from this invention by promoting its widespread use and diffusion (Landes, 1998). A more contemporary example is provided by Xerox PARC, a state-of-the-art R&D facility located in Sunnyvale, California. In the 1970s, housing some of the world's most brilliant researchers, PARC discovered many of the fundamental computer and software concepts and technologies that have become the basis of today's computer industry. Apple Computer, at the time a Silicon Valley start-up, used PARC developed knowledge and technologies in its innovative and successful Macintosh computer generating considerable wealth and jobs. In the 1980s it was Seattle-based Microsoft that benefited from the software technologies developed years earlier at PARC.

Recommendation

It is recommended that ISTC consider staffing and funding a Research Initiative to focus on study processes and mechanisms for accelerated, effective, and efficient knowledge transfer and adoption for Societal Value:

- Within and across firms and research organizations (e.g., federal labs, universities, corporate)
- Within and across multi-cultural environments
- Given a variety of technology platforms: biotechnology, nano-technology, nuclear, aerospace, software, etc.
- To solve such global challenges as
    - Healthcare: aging, AIDS, SARS, diabetes, etc.
    - The Environment: Energy, Water, Arid Lands
    - Global Security
    - Critical Infrastructures
    - Shared Prosperity

Figure 19. ISTC Networking Funding and Recipient Partners to Foster Knowledge Creation, Diffusion, and Application for Global Challenges

9. Concluding Observations & Recommendations

Since beginning operations in Moscow in March 1994, The International Science and Technology Center (ISTC) has instituted and evolved a range of programs and activities designed to redirect Weapons of Mass Destruction (WMD) research to peaceful purposes thereby minimizing if not preventing the threat of proliferation. ISTC's primary mandate has been reflected in related objectives that include contributions to:

- The preservation of RF/CIS science and technology (S&T) research capabilities and the integration of Former Weapons Scientists (FWS) into international scientific communities
- Supporting the transition of FWS research to civil purposes and market-based economies

In January 2003 the ISTC launched a major reorganization of the Center and its staff with the goal of accelerating RF/CIS transition toward sustainable nonproliferation by emphasizing: [1]

- Evolution to Partnership (E2P) to encourage institutes to transition into business-scientific relationships that are independent of ISTC and lead to "graduation" and self-sustainability
  - Assisting researchers, institutes, and regions within the RF/CIS to be self-sustainable in wealth and job creation through the civil use of science and technology regionally, nationally, and globally
- The emergence of a programmatic approach which will enable "science and technology targeting" to more comprehensively address developmental needs in conjunction with national scientific and economic priorities
  - An emphasis on mission-focused programs having no national boundaries or allegiances

[1] "Ways to Partnership," ISTC paper approved by ISTC Governing Board at it's XXVII Session; "A New ISTC Organization," Governing Board Meeting XXIX-011, Attachment 1; and "Reorganizing the ISTC Secretariat and Implementing Change," Michael Kroning, January 2003.

In order to evaluate evolving ISTC programs, objectives, and metrics we used the organizing framework of 7 Pillars of Sustainable Science and Technology. While it is emphasized that ISTC Programs and activities are not, and should not be, viewed as isolated and independent activities we have discussed each of 10 ISTC programs in relation to one of four sustainability pillars as follows:

1. **Internationally Open and Networked**
    a. Travel Support Program
    b. Seminar and Workshop Programs
    c. Communications Support Program
2. **Research Excellence**
    a. Science Project Program
3. **Economic Value of R&D**
    a. Business Management and Training Program
    b. Valorization Support Program
    c. Patent Support Program
4. **Multi-sourced Funding**
    a. Partners Program
    b. Technologies Database Program

It has also been emphasized that all 10 of ISTC's programs have contributed to the important and remaining Sustainability Pillars of **Attracting Young Talent, National Purpose, and Societal Value.**

This report has suggested new programs, activities, and metrics to be considered by ISTC to accelerate the transition toward balanced partnerships and self-sustainability in RF/CIS regions. A key objective is to promote "evolution to partnership" and S&T commercialization at the regional level at RF/CIS Institutes, while at the same time enabling the national scientific base to be strengthened through partnerships that develop the capacity of existing resources within systems of innovation. In general it has been suggested that industry-science partnerships be emphasized and directed toward the following challenges:

- Increasing the degree of technology application in strategic public and private sectors within both the Funding and Recipient Parties.
- Developing the capacity of RF/CIS industry to commercialize new knowledge and improving the capacity to create technology-based products and services
  - Including facilitating the development of new technology-based firms as potential promoters of innovation leading to wealth and job creation
- Promoting the recruitment of young researchers within RF/CIS S&T institutes as well as learning to leverage and benefit from inter-institutional mobility --- nationally and globally --- between universities, research centers, and firms
- Promoting the diffusion and dissemination of cultures of science excellence, innovation, and entrepreneurship
- Promoting S&T research and development in matters of National Purpose and Societal Value

In particular, the actions to be considered by ISTC should be designed to foster links between the S&T system and the productive sector within the RF/CIS and Funding Parties while at the same time enabling the scientific base to be strengthened particularly through alliances that develop the capacity of existing resources within a system of innovation. Based on the experience gained in many OECD countries and the US it is has been suggested that the industry-science relationships and partnerships be established towards the following challenges:

- *Increasing the degree of technology R&D in strategic sectors, or innovation clusters, including industry which involves developing the capacity to commercialize new knowledge and improving the capacity to create new technology-based products and services*
- *Facilitating the development of new technology-based firms as potential promoters of innovation and job creation in these emerging industry clusters*

KEY OBSERVATIONS & RECOMMENDATIONS [2]

We begin this review with three key observations of the ISTC that underpin all the following concluding observations and recommendations.

Underpinning Observation #1 ISTC is an important creative and innovative experiment on how to organize and implement a multilateral consortia of scientific, political, and business interests that represent developed and developing regions to foster wealth and job creation through the civil use of science and technology. **In contrast to military intervention, ISTC provides an important alternative model for dealing with the threat of proliferation of Weapons of Mass Destruction.**

Underpinning Observation #2 The general awareness and understanding of ISTC programs and activities is minimal within Funding Party large, mid-sized, and small start-up companies; universities and R&D organizations: and cities and regions interested in fostering regionally-based S&T growth. This is a missed opportunity in that many of these same entities are searching for world-class technologies to stimulate S&T excellence (academic) and business growth (regional economic development).

To enhance ISTC's visibility and support the Secretariat should consider:

- Publishing and broadly disseminating a newsletter in electronic and hard copy form. The newsletter should be easy to read and feature partnering success stories and innovative technology commercialization programs and activities.
- Publish articles about ISTC in academic and popular press within the Funding Parties
- Organize a professionally developed ISTC "Road Show" to visit Funding and Recipient Parties as well as other emerging and established technology regions

[2] See Appendix A Part II for an overview of Key Observations, Challenges, and Recommendations and Part III for the recommended Fast Track Action Plan.

worldwide and to "market" RF/CIS S&T as a force for regional economic development.

- Select target RF/CIS institutes to partner with select regions within the Funding Parties to champion balanced partnerships to successful commercialize select S&T leading to wealth and job creation within the RF/CIS and Funding Party regions. (Please refer to the following overview of Fast Track Action Plan)

Underpinning Observation #3 A centrally important and limiting reality at the Secretariat is that since its founding ISTC has been working with and supporting increasing numbers of Science Projects and Public and Private Partners as well as increasingly complex and time consuming supporting programs and activities.[3] This increased workload has not been matched with corresponding increases in qualified staff and physical facilities. Adding to the challenges of being under staffed, lacking qualified staff, and key staff being overworked is the Secretariat's current and major organizational change efforts of:

- Evolution to Partnership among Funding and Recipient Parties
- Accelerated self-sustainability of RF/CIS researchers and institutes

Recent organizational change activities that include the formation of a Science Department, Technology Department, Partnering and Sustainability Department, and Operations Department will necessitate increased time and resources to collaborate and coordinate across these functional areas to better serve the Funding and Recipient Parties. This should include the structuring and coordination of ISTCs programs and activities to support the SPMs and PPMs so that they can better meet the needs of the Institute-based PMs and Science and Partners Projects. This report has been structured to offer action oriented recommendations to facilitate such structuring and leveraging of ISTC resources and assets to achieve these objectives.

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[3] In 1994 ISTC supported 48 Science Projects that grew to 88 in 1996. In 1997 ISTC supported 128 projects including Science Projects AND Government and Non-Government Projects. The number of signed projects grew to 211 in 1999 and 314 in 2002.

To facilitate a "quick look" overview of the results of ISTC 2012: Toward Sustainable Global Security, we now review KEY observations and recommendations organized by each ISTC Program starting with Science Projects and Partners Program and followed by the eight supporting programs. These brief overviews are then followed by a fast track and targeted action plan toward balanced partnerships and self-sustainable RF/CIS researchers, institutes and regions.

Science Projects

Key Observation: The Science Projects Program is ISTC's initial and most comprehensive nonproliferation activity. This program of "engagement" directly targets the funding of Former Weapons Scientists (FWS) through the solicitation of project proposals. FWS serve as Project Managers and on project teams and are provided with funding support to transition their research activities to civil purposes. In addition, over the years the Science Project Program, working in consort with the **Travel Support** and **Seminar and Workshop Programs,** has provided crucial networking opportunities with key FWS and their respective research institutes to be **Open and Networked** and to enhance **Research Excellence.** As ISTC accelerates the transition to balanced partnerships and sustainable nonproliferation, as discussed in the following pages, it is important to encourage the recruitment and involvement of **Young Talent** in ISTC funded Science Projects and to facilitate Knowledge/ Technology Transfer (K/TT) for **Public Interest** and **Societal Value** as well as **Economic Value** within Recipient and Funding Parties**.**

Key Recommendations: To accelerate the transition toward balanced partnerships and self-sustainability of RF/CIS Former Weapons Scientists and institutes, it is suggested that clear and objective feedback, on evaluation criteria, be given to the PMs, SPMs, and PPMs during the Concurrence Process and Funding Party reviews of Science and Partner Projects. It is also suggested that ISTC facilitate feedback, on potential private and public use of the of the S&T, throughout the duration of the research project. Funding Party-based Research Collaborators should assist PMs with targeting public and private S&T applications and these Collaborators should also receive financial compensation for

this effort. Such early and on-going feedback on potential public and private applications of Science and Partner projects would increase the realization of **Economic and Societal Value** as well as **Public Interest** of RF/CIS S&T.

Partners Program

Key Observations: RF/CIS Institutes in general, and Project Managers and project teams in particular, have benefited in numerous ways from ISTC's **Partner Program** including:

- Obtaining diverse sources of funding **(Multi-Sourced Funding)**
- Expanding research and technology commercialization networks **(Open and Networked)**
- Meeting customer expectations including project management and providing deliverables that satisfy market applications **(Economic Value)**

However, while 50% of the Funding Corporate Partners report uniformly positive comments concerning their relations with the ISTC; 50% were critical with several partners very dissatisfied. At the top of the list of critiques is: **The high complexity of ISTC processes coupled with infrequent and poor communication about the reasons for and logic of these processes.**

A Note of Urgency: RF/CIS's S&T institutions and their related public and private organizations have a window of opportunity that is being increasingly challenged by global competition. Excellent S&T capabilities exist and are increasing in other developing countries. For example, Chinese and Indian S&T and support systems are attracting growing EU, US, and Asian participation and investment in terms of R&D, manufacturing, and market development. In short, there is an urgent need for RF/CIS government and private sectors to:

- Promote and support their regional S&T assets linked to stable business environments
- Minimize bureaucratic obstacles that inhibit the competitive capability of RF/CIS researchers and institutes and regional economic development

Key Recommendations: For **Increased Partner Satisfaction** it is suggested that the Secretariat (1) create an ISTC Partner Advisory Board composed of Funding and Non-Funding Partners, and (2) establish a "Help Desk" that is easily accessible by, and targeted to the needs of, Funding and Non-Funding Partners. It is also suggested that the ISTC conduct regular and systematic data collection on existing partners, potential conversion partners (collaborators, non-funding partners), and government partners to determine how they value ISTC and RF/CIS Institute S&T capabilities in relation to RF/CIS and international competitors (Please refer to Appendix C on the survey of Corporate Funding Partners).

ISTC SUPPORT PROGRAMS – These programs are NOT listed in order of importance, but rather reflect a flow to facilitating S&T applications.

RF/CIS S&T Application [4]

Key Observation: As demonstrated by ISTC's Valorization Program (1997-2002), it is extremely difficult to achieve successful transfer and commercialization of even superior RF/CIS technology with identified market applications with firms in the U.S., EU, Japan, Korea or other nations from ISTC's Moscow-based location.

Key Recommendations: Technology/Market (T/M) Brokers, resident in the select Funding Party region, should be used by ISTC as one way to overcome many of the K/TT challenges discussed throughout this report. These "Brokers" would assist PMs/SPMs in identifying specific market applications and business partners and in bridging the communication and cultural gaps during the commercialization process between Project Managers and the "customer." These T/M Brokers would be hired based on their deep and broad knowledge of technology areas as well as market needs and

[4] This section includes observations, lessons-learned, and recommendations based on ISTC's Valorization Program that was re-organized during in early 2003.

business networks. Initially they could be paid out of regional economic development funds of the partner region and in the longer-term they could be paid based on commission. In addition, in order to increase the "Market Pull" of ISTC S&T, the Secretariat should consider:

- Being a catalyst for structuring and conducting benchmark studies in select RF/CIS regions to assess key S&T assets and challenges for accelerated regionally-based growth of targeted S&T clusters
- Forming partnerships between select RF/CIS S&T institutes and select regions within the Funding Parties
- Establishing ISTC affiliated Technology Commercialization Centers (TCCs) with SELECT Regional Partners within the Funding Party countries

ISTC could act as an advisor and mentor for management and networking of select Regional Technology Commercialization Centers (TCCs) that could be affiliated with specific RF/CIS Institutes. ISTC could assist these TCCs by networking and leveraging existing:

- Programs and Activities
- Networks with Funding and Recipient Parties
- Corporate and Government Partners

These select TCCs could shorten learning curves for SMEs and serve as "experiential learning laboratories" and "models for success" for fostering public/private collaboration at the regional level within the Funding and Recipient Parties.

Technologies Database

Key Observation: Technology Abstracts are at the front end of a "GO' or "NO GO" decision for a customer in deciding whether to pursue RF/CIS S&T to application. ISTC provided Technology Abstracts are overly complex, technology focused, and extremely difficult to assess in terms of potential market and public sector applications within Funding and Recipient Parties.

Key Recommendation: SPMs and PPMs and perhaps others at ISTC (e.g., workshops) need to spend more time with the PMs in crafting Technology Abstract documents that are clear, concise, and application oriented. To facilitate this process (as recommended), "revised" Records on Invention, Technology Implementation Plans, and Private Sector Supplement Forms need to be:

(1) Submitted at the front end of the proposal review process
(2) Updated during the research process so they will provide useful technology application and marketing information

With modest funding increases ISTC could redefine the Technology Database Program as a technology "bourse" that would actively link RF/CIS S&T to customers with challenges/problems and market opportunities as well as a list of S&T abstracts.

Patent Support

Key Observation: Lack of successful ISTC patent activity including any meaningful royalty payback are main reasons that RF/CIS scientists don't file patent requests with ISTC. Instead, they elect to not do anything or to go it alone with their IPR needs. Balanced partnerships (E2P) centers on the issue of protecting IPR rights for RF/CIS scientists and institutes as well as ISTC Partners and the Funding and Recipient Parties.

Key Recommendations: The Secretariat should support efforts to clarify where the legal regimes of the Parties pose different if not contradicting responses to various IPR scenarios as well as where the legal regimes are harmonious. IPR training is needed across the ISTC Secretariat and Funding and Recipient Parties to ensure that RF/CIS institutes and researchers, over time, will be up to the challenge of managing and obtaining fair commercial value out of their knowledge assets.

Records Of Invention (ROI), Technology Implementation Plan (TIP), And Private Sector Supplement (PSS)

Key Observation: When PMs complete these forms (usually at the end of the research project) they usually have inadequate market knowledge – "they don't know what they don't know" – and they focus on what they do know which are the S&T characteristics of their research project.

Key Recommendations: Records on Invention, Technology Implementation Plans, and Private Sector Supplement Forms need to be revised so they are more realistic in requests of the PMs and so they facilitate technology transfer to successful commercialization and PM and RF/CIS institute self-sustainability. And it is suggested that these forms be reviewed and augmented by the Recipient and Funding Parties, research collaborators, and by the Scientific Advisory Committee for possible S&T applications during the research proposal review process AND on-going as the research project progresses and not wait until the project is largely complete.

Business Management Training

Key Observation: The emphasis of Business Management Training (BMT) has been on introducing FWS to the realities of market economies. Future ISTC Training needs to be more integrated with ISTC program activities and with the needs of ISTC staff especially as the Secretariat evolves toward balanced partnering, technology commercialization, and sustainability objectives and as SPMs and PPMs move from being "proposal to transition advocates."

Key Recommendations: Offer courses to SPMs/PPMs on such topics as Knowledge/Technology Transfer (K/TT) (1) leading to ROI in established firms within the RF/CIS and Funding Parties including training in IPR, technology assessment, marketing, and (2) fostering the growth of start-up and spin-out companies including venture financing and business plan development with regional and international partners.

It is also suggested that ISTC work with established providers to leverage the capability and resources of the best existing local and international training programs and talent to the benefit of ISTC staff. Distance Computer&Internet-Based Training is well suited to the needs and challenges of the RF/CIS. Accordingly, ISTC should work to become a "model and leader" in results oriented distance training for RF/CIS S&T institutes and perhaps including regional leaders from academic, business, and government sectors. Such training should focus on "learning by doing" using national and international networks for commercialization and regional economic development.

Communication Support

Key Observations: With existing staff and equipment ISTC's Communication Support Program (CSP) is challenged to effectively identify, analyze, and implement needed and desired IT technologies, maintain adequate Computer and Information Technology (CIT) equipment and training, and provide reliable and continued IT connectivity for the Secretariat and the broad range of RF/CIS Institutes located across vast geographic distances. ISTC's Secretariat is challenged by IT "communications that don't communicate."

Key Recommendations: Because of limited funds and staff (1) outsource contracts with RF/CIS-based companies to provide needed CIT support services for the ISTC Secretariat and for RF/CIS institutes, and (2) when possible use the services of SPMs/PPMs who have experience in and could be trained in needed areas of CIT expertise. Since CIT is also crucial to effective communications with clients/customers within Funding and Recipient Parties, have Science and Partner Project proposals budget for needed CIT and projected institute IT connectivity costs. Effective IT communications is also crucial to leveraging ISTC programs and activities that are supportive of successful partnering.

Seminars and Workshops

Key Challenge: More complete and systematic pre-seminar and workshop planning and follow-up is considered important fro facilitating evolution to partnership and self-sustainability.

Key Recommendations - Seminars: Have SAC seminar program committees be more representative of the broad base of RF/CIS and international S&T experts in targeted fields of interest. Collect more data on potential new science and follow-up research activities including feasible commercial applications. Increase dissemination of seminar presentation through publications and use of ISTC's web to increase the national and international impact of SAC seminars.

Key Recommendations - Workshops: Work to achieve better selection and use of "idal type" presenters for "selling" the applications of RF/CIS S&T. Also consider the selection of "ideal type" workshop attendees who have the desire and resources, either within established firms or start-ups, to champion the S&T to successful application. Use "Technology/Market Brokers" selected from the host country to represent and champion the RF/CIS S&T with follow-up activities.

Travel Support

Key Observation: ISTC's Travel Support Program (TSP) was launched to assist FWS in meeting with international collaborators and organizations to help develop Science Project proposals that met global standards. Different considerations need to be stressed in light of ISTC's accelerated Evolution to Partnership (E2P) and self-sustainability.

Key Recommendations: The costs (time and funding) of travel needs to be evaluated in light of examples where large research funds are dedicated to S&T development while inadequate funds and time are dedicated to support key personnel for travel and other forms of communication that would dramatically benefited the research project in terms of improved science and/or commercial applications. Consequently, it is recommended that ISTC fund more frequent and longer visits within the RF/CIS and to Funding Parties for PPMs/SPMs and RF/CIS researchers especially for those with a clear and realistic

focus on value-added results for balanced partnerships and sustainability. In addition, to facilitating the success of these visits, those who travel (e.g., PPMs, SPMs, and PMs) need adequate time and staff support for pre-travel preparation, writing detailed trip reports, and follow-up activities after the travel is completed.

FAST TRACK ACTION PLAN
Toward Balanced Partnerships and Self-Sustainable RF/CIS Researchers, Institutes and Regions

The following scenario is suggested for ISTC to obtain early focus, success, and significant international and positive PR within existing financial and staffing limitations. The recommendations offered in this report's Executive Summary would apply to ISTC overall, but the activities described below would be focused on a limited number of select ISTC/RF S&T institutes and a limited number of select Partner Regions. Main goals are to increase the personal know-how and market-pull aspects of knowledge/technology transfer to established and start-up firms within select regions of the RF/CIS and Funding Parties. ISTC and regional efforts would employ selection criteria that would be focused on attaining early successes.

Select RF/CIS Institutes as Role Models for Success

Conduct a "quick look" of candidate regions and S&T institutes within the RF/CIS to determine the assets and challenges for being a successful role model for building globally competitive innovation clusters in targeted technology areas, e.g., bio-sciences, nano-technology, chemicals, manufacturing. The focus is not just high-tech but technology areas that can create wealth and jobs in the short term and be globally competitive in the long-term.

Based on the above exercise, the ISTC Secretariat would select several (perhaps 3-to-5) RF/CIS Institutes to work on a self-sustainability task list. Institute selection would focus on criteria for early success including:

- Track record of accomplishing successful Science and Partner Projects

- Desire to pursue successful IP regimes for domestic and foreign markets
- Technology for targeted market applications – areas selected by ISTC and Funding Parties in an attempt to encourage market pull

Perhaps there could be an ISTC organized competition to select Partner Institutes and to include runners-up on a waiting list. These activities would be transparent to encourage other "challenged" institutes to follow these emerging models of success. These activities should also be on ISTC's web to help disseminate "best practices" and "lessons learned" by these Partner Institutes/Regions.

Select regions within each Funding Party to be a Regional Partner with a select RF/CIS Institute

A key objective is to encourage the market-pull of RF/CIS technology to regionally-based businesses within the funding parties. These would not necessarily be the most technology advanced regions (e.g., Boston or Silicon Valley in the US) but emerging regions that are easier to access (e.g., less Not-Invented-Here) but that still have the required "smart infrastructure" (e.g., finance, market access, management talent, technology absorptive capacity including large, mid-sized and small technology firms).

Have candidate Partner Regions, within the Funding Parties, do "quick look" studies of their strengths, weaknesses, opportunities, and threats (SWOT) for partnering with select RF/CIS S&T Institutes for **accelerating the growth – wealth and job creation – of regional innovation clusters within the select regions of BOTH the RF/CIS and the Funding Parties**.[5]

If the select regions in the Funding Parties have established incubators they would be invited to house an ISTC affiliated Technology Commercialization Center (TCC) to facilitate:

- Business start-up activity

[5] IC² Institute has suggestions for candidate regions within Japan, Korea, the EU, and the US, regions that would be highly motivated to champion ISTC technology with regionally-based firms and financial resources.

- Partnering opportunities

These Funding Party-based TCCs could have partner ISTC-related TCCs located in the RF/CIS near their partner S&T institute.

ISTC would have the Funding Party Partner regions select Technology/Market Intermediaries to bridge the gaps between the targeted RF/CIS Institute and the firms, markets, finance, and talent in the partner region of the Funding Party. These "bridges" and related activities could be funded from regional economic development funds of the Funding Party regions and commissions for establishing successful partnerships.

ISTC Programs and Activities Should Provide a Coordinated Approach to contribute to success and also gain important "lessons learned" for broader dissemination

Travel Support would focus on facilitating travel of (1) researchers and managers focused on growing a business, and (2) for partner region academics, government, and business support people that will facilitate these regionally-based activities.

ISTC Workshops and Seminars would be focused on target technology/market areas and would be held in both RF/CIS and Funding Party regions. They would involve participants from both regions as well as a broader range of industry, government, and academic attendees.

Patent Support would use these "experiential learning laboratories" to educate RF/CIS institute researchers and administrators as well as enlighten the Funding Party partners.

Education and Training would be targeted on the needs of these RF/CIS Institutes and Funding Party Partners and they would use the current and real examples of bringing ISTC S&T to the region and to international and national (RF/CIS) markets.

Selection of S&T for Partnering Activity. Translated Technology Abstracts have been reviewed by the IC² Institute Research Team and they are usually too S&T focused and ambiguous for meaningful next steps. To facilitate the success of the above scenario the select and targeted technologies would initially receive "Quick Looks" from RF/CIS businesspeople and perhaps business and law students from local RF/CIS universities as well as Professional Educational institutions within the RF/CIS (e.g., The Academy of National Economy teaches masters students in S&T commercialization). Soon after this exercise these "refined Technology/Business Abstracts" would be translated in the language of the Funding Party and reviewed by market-oriented professionals within the Funding Party Partner region including local business managers, venture capitalists and business angles, and professors/students in the local university. Intellectual property issues would not be the focus; the focus of activity would be market applications. Nondisclosure agreements could be signed but the bias would be to get as many creative and innovative insights on any given technology. Regions that violate IP interests of the RF/CIS or Funding Party Partner would be denied further support. This would be an iterative process where, over time, RF/CIS and Funding Party Partners would become more skilled is assessing S&T and making successful market connections. **The world is overflowing with excellent S&T: The key challenge is getting the "right" technologies moving downstream to successful market applications.**

Source Documents

Amidon, Debra. "Knowledge Economies: US State Department – Problems/Promises for Russia." Entovation International. 2001.

Amidon, Debra. The Innovation Superhighway: Harnessing Intellectual Capital for Sustainable Collaborative Advantage. Butterworth Heinemann, 2002.

Atkinson, George. "Trip Report: Moscow Russia, March 7-17, 2002 to Intelligence and Research Bureau and European Bureau for Europe and Eurasian Affairs, U.S. Department of State" Draft. June 13, 2002.

Bell, Elizabeth, Leonid Gokhberg, Klaus Schuch. Dialogue on S&T Between The European Union and the Russian Federation. Moscow-Vienna 2002.

Borzo, Jeanette. "Russian Start-ups, Western Capital Find Ways to Meet: A Nascent High-Tech Sector Develops Its Pitch." WSJ.com.

Bukharin, Oleg, Harold Feiveson, Frank von Hippel, Sharon K. Weiner, Matthew Bunn, William Hoehn, an Kenneth Luongo. "Helping Russia Downsize its Nuclear Complex: A Focus on the Closed Nuclear Cities." Report of an International Conference held at Princeton University. March 14-15, 2000.

Bulychev, B.M., and Yu. A. Klyachko. Russian Chemical Journal: Journal of Mendeleev Russian Chemical Society. Vol. XLV. Moscow: Russian Chemical Journal, 2001.

Business Information Service for the Newly Independent States. BISNIS Bulletin. Department of Commerce, USA. April 2002.

Chazan, Guy. "Cool Air From Cold War Wafts Into Disarmament." The Wall Street Journal. May 29, 2002. International, A19.

Committee on Small Innovative Firms in Russian Nuclear Cities. Successes and Difficulties of Small Innovative Firms in Russian Nuclear Cities: Proceedings of a Russian-American Workshop. National Academy. Washington, 2002.

Conceicao, Pedro, David V. Gibson, Manuel V. Heitor, Giorgio Sirilli. "Beyond the Digital Economy: A Perspective on Innovation for the Learning Society." Technical Forecasting and Social Change. 67, 115-142 (2001).

Consten, Jean-Pierre. "The participation of the Republic of Kazakhstan in ISTC projects: what future? An outside view." ISTC, Moscow.

Dezhina, Irina and Loren Graham. "Working Papers: Russian Basic Science after Ten Years of Transition and Foreign Support." Carnegie Endowment for International Peace: Russian and Eurasian Program. Number 24, February 2002.

Douglass, Maria, and Irina Roslova. "Commercializing Russian Technologies: Five Years of Valorization at the International Science and Technology Center." Moscow, January 2003.

Douglass, Maria. "STIM Activities Briefing." Moscow, 01 November, 2000.

Douglass, Maria. "Success Stories in Progress: Context, Partnering, Valorization." Moscow, April 18, 2001.

Douglass, Maria. "Sustainability Strategy Model." Moscow, 2001.

European Commission. Cordis Focus. 24 March 2003, No. 217. 20 May 2002, No. 197. 6 May 2002, No. 196. January 2002, No. 32.

European Commission. Innovation and Technology Transfer. February 2003.

Fallows, James. "Councils of War." The Atlantic Monthly. February 2002.

General Accounting Office, U.S. Weapons of Mass Destruction: State Department Oversight of Science Centers Program. GAO-01-582. Washington, May 2001.

Gerber, Theodore P., Deborah Yarsike Ball. "From Crisis to Transition: The State of Russian Science Based on Focus Groups With Nuclear Physicists." UCRL-JC-146574. Preprint December 2001.

Gibson, David V. "Transfer of R&D Results from Public Research Centers: Lessons Learned in the U.S. and Applied to Russian/CIS Research Centers." Paper presented at the 3rd SAC/ISTC Seminar, Volga River, June 18-23, 2000.

Gibson, David V. and Everett Rogers. R&D: Collaboration on Trial. Boston: Harvard Business School Press,1994.

Gibson, David V. and Pedro Conceição. "Incubating and Networking Tehcnology Commercialization Centers among Emerging, Developing, and Mature Technopoleis Worldwide." International Handbook on Innovation. Edited by Larisa V. Shavinina. Elsevier Science Ltd., 2003.

Gibson, David V. and Raymond Smilor. "Key Variables in Technology Transfer: A Field Study Based Empirical Analysis. Journal of Engineering and Techynology Management. 8:287-312. 1991.

Gibson, David V., George Kozmetsky and Laura Kilcrease. NASA (Field Center Based) Technology Commercialization Centers: Value-Added Technology Transfer for U.S. Competitive Advantage. Austin: IC² Institute, 1993.

Gokhberg, Leonid and Irina Kuznetsova. Technological Innovation in Russia. Moscow: Centre for Science Research and Statistics, 1998.

Gokhberg, Leonid and Alexander Sokolov. "Sustainability Data Collection Project." Center for Science Research & Statistics. ISTC: Moscow, April 2002.

Gokhberg, Leonid and Natalia Kovaleva and Irina Kouznetsova. Innovation Management in Russia: A Review of Training Needs and Opportunities for Growth. The British Council. 2001.

Gokhberg, Leonid, Gunnar Westholm. Science an Technology Indicators in Russia an the European Union. Luxembourg-Moscow: Eurostat-Centre for Science Research and Statistics, 2002.

Gokhberg, Leonid, Merton J. Peck, and Janos Gacs, eds. Russian Applied Research and Development: Its Problems and its Promise. Laxenburg: International Institute for Applied Systems Analysis. 1997.

Gokhberg, Leonid, N. Gorodnikova, L. Mineli, and I. Zinovyeva. Government Budget R&D Funding. Moscow: Centre for Science Research and Statistics, 1999.

Gokhberg, Leonid. Russia: A Science and Technology Profile. The British Council, 1999.

Golovnina, Maria. "Sticky Image, Piracy Brake Russia's Software Future." Reuters. Moscow, September 30, 2002.

Gottemoeller, Rose. "Beyond Arms Control: How to Deal with Nuclear Weapons." Carnegie Endowment for International Peace Newsletter. 23 February 2003.

Hauber, Jane. "Draft Report of Subcommittee on Valorization." Moscow, September 15, 1997.

Horowicz, Leon. "Business Trip Technical Report: Tbilisi, Georgia, 21-22 November 2001."

Iannuzzi, Giovanni. "International Cooperation Towards Russian Nuclear Cities and a Potential European Role." International Form on "Energy and Environmental Opportunities in the Russian State Research Centers and Nuclear Cities." Como, Italy. 9-10 April 2001.

IC² Institute. "ICT Master Strategy for Republic of Armenia." IC² Institute: Austin, 2002.

Institute for Operations Research and the Management Sciences. OR/MS Today. February 1998.

Institute of Crystallography/Russian Academy of Sciences. "Shubnikov Institute of Crystallography." Moscow, 2000.

International Science and Technology Center Scientific Advisory Committee. Towards More Efficient Utilization of Research Results from Russian/CIS Research Institutes: Proceedings from the 3rd SAC/ISTC Seminar, Volga River June 18-23, 2000. Moscow.

International Science and Technology Center Secretariat Moscow. "Evaluation of Commercial Potential of ISTC Projects in Nuclear Cities." Moscow, February 2002.

International Science and Technology Center, ISTC Governing Board XXV. "Roadmap for ISTC's Evolution to Partnership;" "Terms of Reference for ISTC Secretariat Staffing;" "ISTC Project Proposal Processing Flow;" "Quality Management System: ISO 9000 Action Plan." GOV-XXV-014. Moscow.

International Science and Technology Center, ISTC Governing Board XXIX. "A New ISTC Organization." GOV-XXIX-011. Moscow.

International Science and Technology Center, Siberian Branch of Russian Academy of Science, and Budker Institute of Nuclear Physics. "Proceedings of IV ISTC Scientific Advisory Committee Seminar on 'Basic Science in ISTC Activities.' Akademgorodok, Novosibirsk April 23-27, 2001" Novosibirsk, November 2001.

International Science and Technology Center. "Coordination Committee/Governing Board: Year 2000 Review of the ISTC." GOV-XXIII-103. Moscow, 2000.

International Science and Technology Center. "ISTC Activities in Biotechnology and Life Sciences: On-going Programs." Tokio, April 16, 2002.

International Science and Technology Center. "ISTC: Growing Small Enterprises." Moscow, 2002.

International Science and Technology Center. "Joint Statement of the Governing Board Meeting of the ISTC: Moscow, Russia, 30 June – 1 July 1997." Moscow, 1997. "Joint Statement of the 14th Governing Board of the ISTC: Moscow, Russia, 5 - 6 November 1997." Moscow, 1997. "Statement of the 15th Governing Board of the ISTC: Moscow, Russia, 5 - 6 March 1998." Moscow, 1998. "Statement of the 16th Governing Board of the ISTC: Moscow, Russia, 1 - 2 July 1998." Moscow, 1998. "Statement of the 17th Governing Board of the ISTC: Yerevan, Republic of Armenia, 8 - 9 November 1998." Moscow, 1998. "Statement of the 18th Governing Board of

the ISTC: Moscow, Russian Federation, 2 March 1999." Moscow, 1999. "Statement of the 19th Governing Board of the ISTC: Moscow, Russian Federation, 30 June – 1 July 1999." Moscow, 1999. "Statement of the 20th Governing Board of the ISTC: Moscow, Russian Federation, 27 October 1999." Moscow, 1999. "Statement of the 21st Governing Board of the ISTC: Moscow, Russian Federation, 16 March 2000." Moscow, 2000. "Statement of the 22nd Governing Board of the ISTC: Tbilisi, Republic of Georgia, 26 – 27 June 2000. Moscow, 2000. "Statement of the 23rd Governing Board of the ISTC: Moscow, Russian Federation, 3 November 2000." Moscow, 2000. "Statement of the 24th Governing Board of the ISTC: Moscow, Russian Federation, 15 March 2001." Moscow, 2001. "Statement of the 25th Governing Board of the ISTC: Moscow, Russian Federation, 22 October 2001." Moscow, 2001. "Statement of the 27th Governing Board of the ISTC: Bishkek, Kyrgyz Republic, 7-9 April 2002." Moscow, 2002. "Statement of the 30th Governing Board of the ISTC: Moscow, Russian Federation, 31 March 2003." Moscow, 2003.

International Science and Technology Center. "KPMG Task Force Phase I Analysis and Recommendations (Support Functions)" Moscow. February 26, 2002.

International Science and Technology Center. "Management and Organization Diagnostic Review." Moscow, 29 December 2001.

International Science and Technology Center. "Organizational Realignment and Efficiency Enhancement." Moscow, 29 December 2001.

International Science and Technology Center. "Overview of EU workshops in 2000." Moscow, 2000. "Overview of EU workshops in 2001." Moscow, 2001.

International Science and Technology Center. "Projects Approved for Funding by ISTC Governing Board at the 30th Funding Session." Moscow, 31 March 2003.

International Science and Technology Center. "Proposed Activities for the ISTC Seminar Program in 2003." Moscow, 18 October 2002.

International Science and Technology Center. "Request for Proposal: Technology Valorization Support Services VSS-3, 2002 Program." Moscow, 2002.

International Science and Technology Center. "Results from Questionnaire to Project Managers of ISTC Projects." Moscow, 25 March 1998.

International Science and Technology Center. ISTC Annual Report. Moscow. Volumes 1997, 1998, 1999, 2000, 2001.

International Science and Technology Center. ISTC Project Proposal forms. "Concurrence and Commitments;" Instruction for Proposal Preparation;" "Project Proposal;" "Role of Foreign Collaborators." Moscow.

International Science and Technology Center. ISTC Project Summaries: 0215, 0277, 0488, 0589, 0717, 0722, 0908, 1752, A-177, B-104, 0138 & 0138-2.

International Science and Technology Center. Promising Research Abstracts Database. www.tech-db.ru/istc/db/pra.nsf/htm/index.htm.

International Science and Technology Center. "Radiation Legacy of the USSR." Press Release. Moscow, 31 March 2000.

Ioffe Institute. Ioffe Institute 1918-1998: Development and Research Activities. St. Petersburg: Information Services and Publishing Department, 1998.

Kakhiani, Kakha. "Protecting Intellectual Property Rights." Moscow News. 16-22 October 2002.

Karelin, Yevgeny A. "Catalogue: Radionuclide Sources and Preparations." State Scientific Center of Russian Federation "Research Institute of Atomic Reactors." 1998.

Keller, Bill. "Nuclear Nightmares." The New York Times on the Web. New York, May 26, 2002. www.nytimes.com/2002/5/26/magazine/26NUKES.htm.?pagewanted=...

Kozmetsky, George, and Piyu Yue. Global Economic Competition: Today's Warfare in Global Electronics Industries and Companies. Kluwer Academic Publishers, 1997 .

Kozmetsky, George, and Piyu Yue. New Constructs for the 21st Century. Austin: IC² Institute, 2003.

Kroning, Michael. "Reorganizing the ISTC Secretariat and Implementing Change." Moscow, January 2003.

Kuritz, Tanya. "How to Turn a Russian Invention into a Utility in the USA." OakRidge National Laboratory, US Department of Energy. Washington: National Academy, 1998.

Kuznetsov, Yevgeny. "Paradox of the Critical Mass: Instruments and Mechanism to Implement the Knowledge Agenda in Russia." World Bank, 2002.

LaMontagne, Stephen. Nonproliferation Status Report 2001: Briefing Book on Nonproliferation. Council for a Livable World Education Fund. September 2001.

Landabaso, Mikel and Benedicte Mouton. "Towards a new regional innovation policy: Eight years of European experience through innovative actions." European Commission. 2002.

Leifer, Richard, and Christopher M. McDermott, Gina Colarelli O'Connor, Lois S. Peters, Mark P. Rice, Robert W. Veryzer. Radical Innovation: How Mature Companies Can Outsmart Upstarts. Boston: Harvard Business School Press, 2000.

Livian, Michael. "Incubators: Dead or Alive?" European Investment Forum. Milan, April 27, 2001.

Lubbock Fine Chartered Accountants, Registered Auditors. "International Science and Technology Center 1997 Financial Statements." Moscow, 1997.

Luongo, Ken, Raphael Della Ratta. "Commercially Viable Businesses and Russia's Nuclear Cities: Obstacles and Opportunities." RANSAC, October 19, 2001.

Malherbe, Didier. "European Business Summit: Brussels 6-8 June 2002, Congress and Networking." Brussels, 17 April 2002.

Martellini, Maurizio. "Key elements of a future international strategy in favour of Russian Nuclear Cities and of a European Nuclear Cities Initiative (ENCI)." International Forum on "Energy and Environmental Opportunities in the Russian State Research Centers and Nuclear Cities." Como, Italy. 9-10 April 2001.

Ministry of Trade and Industry. "Helsinki Seminar on Innovation Policy and the Valorisation of Science and Technology in Russia." Hotel Serena Korpilampi, ESPOO, Helsinki, Finland, 1-2 March 2001.

Moody, R. Adam. "The International Science Center Initiative." Dismantling the Cold War. Cambridge: MIT Press. 251-289.

Myers, Steven Lee. "Russia adopts new legal code." Austin American-Statesman. July 1, 2002. World & Nation, A7.

Nastas, Thomas D. "New Directions for European Private Equity." European Venture Capital Journal. August/September 1992.

National Nuclear Security Administration, Office of Defense Nuclear Nonproliferation. Initiatives for Proliferation Prevention: Annual Report, Fiscal Year 2001. U.S. Department of Energy: Washinton, September 30, 2001.

O'Toole, Tara, Michael Mair, and Thomas V. Inglesby. "Shining Light on 'Dark Water.'" Confronting Biological Weapons. Clinical Infectious Diseases 2002:34:000-000 (1 April).

Organisation for Economic Co-operation and Development. "Bridging the Innovation Gap in Russia: The Helsinki Seminar." OECD Proceedings. March 2001.

Organisation for Economic Co-operation and Development. Russian Federation: OECD Economic Surveys 2001-2002. Paris, 5 February 2002.

Pfirrmann, Oliver, and Gunter H. Walter (Eds.). Small Firms and Entrepreneurship in Central and Eastern Europe. Heidelberg: Physica-Verlag, 2002.

Pronina, Lyuba. "Tank: Transport Limits Russia's Growth." The Moscow Times. 28 February 2002. Business, 5.

Ramusino, Paolo Cotta, Didier Gambier, Antonio Lantieri, and Maurizio Martellini. "The European Nuclear Cities Initiative (ENCI), The International Working Group and the Debt-for-Security Swap Concept: A View from Italy and the European Commission." Carnegie Non-Proliferation Conference, Washington, D.C. 18-19 June 2001.

Rodriguez, Alex. "Russia's stockpile of chemical weapons still unsecured." Austin American-Statesman. April 12, 2003., World & Nation: A19.

Rodriguez-Pose, Andres. "Innovation Prone and Innovation Averse Societies: Economic Performance in Europe." Growth and Change. Vol. 30 (Winter 1999), pp. 75-105

Rogalev, Nikolay. Technology Commercialization in Russia: Challenges and Barriers. Monograph. Austin: IC² Institute, 1998.

Russian Foundation for Basic Research. "Russian Foundation for Basic Research: Ten Years of Devotion to the Russian Science."

Russian Foundation for Basic Research. General Information about RFBR. June 23, 2002. http://intra.rfbr.ru/rffi/enabout.htm.

Russian Foundation for Basic Research. Russian Foundation for Basic Research: Ten Years of Devotion to the Russian Science. Moscow, 2002.

Russio-British Chamber of Commerce. "Russian IT Sector: Realistic Prognoses." Bulletin: The Bridge between British and Russian Business. October 200-1, Issue 9.

Schenker, Jennifer L. "High Tech, Hard Sell: Russia has great scientists but it needs markets to match all the knowhow." Time. April 2, 2001. p. 66-67.

Schulte-Sasse, Linn. "Working Paper: An Analysis of U.S. Defense and Economic Adjustment Programs in Russia." July 2001.

Schweitzer, Glenn and Lev Tocheny. Nuclear Perestroika: TechnoBusiness in Russias Atomic Cities/New Perspectives from a Two-Year Pilot Study in Three Russian Cities. MacArthur Foundation, Rockefeller Foundation and the Lawrence Livermore National Laboratory. December 2000.

Schweitzer, Glenn E. Moscow DMZ: The Story of the International Effort to Convert Russian Weapons Science to Peaceful Purposes. M.E. Sharpe: March 1996.

Schweitzer, Glenn E. Swords Into Market Shares: Technology, Economics, and Security in the New Russia. Washington, D.C.: Joseph Henry Press, 2000.

Scientific Advisory Committee of the International Science and Technology Center. Nanotechnologies in the area of physics, chemistry and biotechnology. Fifth ISTC Scientific Advisory Committee Seminar: May 27-29, 2002. St. Petersburg: 2002.

Smilor, Raymond and David V. Gibson and George Kozmetsky, eds. Creating the Technopolis: Linking Technology Commercialization and Economic Development. Cambridge: Ballinger, 1988.

Smilor, Raymond and David V. Gibson and George Kozmetsky. "Creating the Technopolis: High-Technology Development in Austin, Texas." Journal of Business Venturing 4, 49-67. 1998.

State Scientific Centre of Russian Federation. Research Insitute of Atomic Reactors: Brief Information. Moscow, 2000.

Sukhodolsky, A.T. "Introduction in Motive Thermo Dynamics of Light." General Physics Institute of Russian Academy of Sciences. Moscow, 2002.

Sukhodolsky, A.T. "Introduction into Active Spectroscopy of Elastic Light Scattering." General Physics Institute of Russian Academy of Sciences. Moscow, 2002.

The Economist. "Thanksgiving for Innovation." Economist.com. Internet accessed September 2002. www.economist.com/displayStory.cfm?Story_ID=1324709

Thurow, Lester C. Building Wealth: The New Rules for Individuals, Companies, and Nations in a Knowledge Based Economy. Harper Business, 2000.

Tikhonov, Valentin. Russia's Nuclear and Missile Complex: The Human Factor in Proliferation. Washington, 2001.

Tucker, Jonathon B., and Kathleen M. Vogel. "Preventing the Proliferation of Chemical and Biological Weapon Materials and Know-How." The Nonproliferation Review. Spring 2000, 88-96.

U.S. Department of Energy: Office of Defense Nuclear Nonproliferation. "National Nuclear Security Administration: Initiatives for Proliferation Prevention: Annual Report Fiscal Year 2001." September 30, 2001.

Universal Press Syndicate. "Science Center Provides Successful Model of Cooperation." Washington. March 11, 2003.

Varjoranta, T. "Road-map for Strategy: Attracting More Partner Projects from EU Private Industry." Memorandum to M. Kroening, 3.7.2002.

Watkins, Alfred. "From Knowledge to Wealth: Transforming Russian Science and Technology for a Modern Knowledge Economy." World Bank. April 1, 2002.

Weiner, Sharon K. "Preventing Nuclear Entrepreneurship in Russia's Nuclear Cities." International Security. Vol. 27, No. 2 (Fall 2002), pp. 126-158.

Wiggins, Joel and David V. Gibson. Overview of US incubators and the case of the Austin Technology Incubator. International Journal of Entrepreneurship and Innovation Management. Vol. 3, Nos.1/2, 2003.

Woelk, Darrell and Erik Larson, Wayne Allen, Sumit Taank. "Focused Knowledge for Multi-Disciplinary, Multi-Sector Decision Making." IC² Institute, The University of Texas at Austin. 2003.

World Bank. "From Knowledge to Wealth: Russia's Role in the Global Knowledge Economy." Roundtable Discussion. Moscow, May 16, 2002.

World Bank. "Paradox of the Critical Mass: Instruments and Mechanisms to Implement the Knowledge Agenda in Russia." Moscow, 2002.