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MANUFACTURING POSSIBILITY:

EXPANDING RESOURCES TO MEET GLOBAL CHALLENGES, PROMOTE ECONOMIC DEVELOPMENT, SUPPORT INNOVATION, AND PREVENT PROLIFERATION

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ACRONYMS

AAI	Allen & Associates International
AIDS	Acquired Immunodeficiency Syndrome
BCR	Bio-Chem Redirect
BII	BioIndustry Initiative
BSI	Byelocorp Scientific, Inc.
BTEP	Biotechnology Engagement Program
BW	Biological Weapon(s)
CDC	United States Centers for Disease Control and Prevention
CIS	Commonwealth of Independent States
CNP	Cooperative Nonproliferation
COM	Center for Optics Manufacturing (University of Rochester)
CRDF	United States Civilian Research and Development Foundation
CRO	Contract Research Organization
CW	Chemical Weapon(s)
DARPA	Defense Advanced Research Projects Agency
DFAIT	Canadian Department of Foreign Affairs and International Trade
DoD	United States Department of Defense
DoE	United States Department of Energy
EPA	United States Environmental Protection Agency
FDA	United States Food and Drug Administration
FSU	Former Soviet Union
G8	Group of Eight
GAO	United States Government Accountability Office
GLP	Good Laboratory Practices
GMP	Good Manufacturing Practices
HEU	Highly Enriched Uranium
HHS	United States Department of Health and Human Services
HIV	Human Immunodeficiency Virus
IAVI	International AIDS Vaccine Initiative
IPP	Initiatives for Proliferation Prevention
ISTC	International Science and Technology Center
LBNL	Lawrence Berkeley National Laboratory
LEU	Low Enriched Uranium
MRF	Magnetorheological Finishing
MVI	Malaria Vaccine Initiative
NCI	Nuclear Cities Initiative
NGO	Non-Governmental Organization
NIH	United States National Institutes of Health
NNSA	United States National Nuclear Security Administration
PAHO	Pan American Health Organization
PATH	Program for Appropriate Technology in Health

PPP	Public-Private Partnership
R&D	Research and Development
RFP	Request for Proposal
S&T	Science and Technology
SBIR	Small Business Innovation Research
STCs	Science and Technology Centers
STCU	Science and Technology Center in Ukraine
TB	Tuberculosis
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republics
WHO	World Health Organization
WMD	Weapon of Mass Destruction

PREFACE

Dear Reader,

On behalf of The Henry L. Stimson Center, I am pleased to introduce, "*Manufacturing Possibility: Expanding Resources to Meet Global Challenges, Promote Economic Development, Support Innovation, and Prevent Proliferation."* This report is the latest product in an ongoing series by the Center's Cooperative Nonproliferation Program aimed at identifying ways to modernize the traditional toolkit of arms control and nonproliferation by addressing the root causes of proliferation, leveraging other actors and foreign policy interests, and developing new, sustainable technical and financial resources. The year-long study was led by Brian Finlay and Elizabeth Turpen, both Senior Associates at the Center, with major contributions by Frederick Kellett, former Executive Vice-President of Byelocorp Scientific, Inc.

This report highlights the potentially pivotal role of the private sector in helping to translate world-class weapons expertise into marketable research and successful business enterprise. As many states of the former Soviet Union (FSU) become more stable, there is a unique window of opportunity for spurring business investment in the interest of both economic development and nonproliferation goals. Today, Russia has a large reserve of scientific expertise and capacity that remains untapped commercially and also vulnerable to terrorists seeking to misdirect this knowledge. This study provides a fresh look at how that scientific pool of proliferation concern can be permanently engaged in productive and sustainable employment. Its utility goes beyond immediate security concerns in that it outlines innovative approaches for building public-private partnerships that would demonstrate and implement new models for economic development in the FSU, while benefiting US-based and other companies worldwide.

The authors of the report want to acknowledge Foreign Affairs and International Trade Canada (DFAIT) for its financial support of this effort. In addition, Trevor Smith and Angela Bogdan of the Global Partnership Program at DFAIT provided invaluable insight and guidance during the project.

We trust that this report will be useful for those who are already engaged in nonproliferation endeavors, as well as for those in government and the private sector who are seeking new ways to enhance the impact of their contributions.

Sincerely,

Ellen Laipson, President
The Henry L. Stimson Center

FOREWORD

Since the advent of the cooperative nonproliferation programs (CNP) in 1992, the efforts dedicated to addressing the human dimension of the weapons of mass destruction (WMD) threat have been the least funded and most undervalued leg of the nonproliferation triad of weapons, materials, and expertise. Program managers in the Departments of Defense, State, and Energy had to answer to their political masters and to Congress, providing positive and readily quantifiable metrics of success. Weapons and materials could be counted and secured, but successful redirection of the scientific talent toward peaceful pursuits was far more difficult to quantify. In addition to the political challenges faced by these programs, some prominent nonproliferation experts maintain that the threat has ameliorated itself through a combination of scientist migration to the West, retirement, and death. More recently, they have asserted that Russian oil and gas revenues have obviated the need for threat reduction assistance—especially to former weapons specialists. As a result, US efforts to engage and redirect this scientific capacity were severely devalued.

We maintain, however, that these assumptions are misguided and reflect a dangerous lack of foresight into the nature and ultimate purpose of cooperative nonproliferation. The importance of engaging human capacity goes beyond the immediate nonproliferation concerns of the scientific community once involved in the Soviet offensive weapons programs. In the West, the nonproliferation industry rests upon a solid foundation of supporters inside, and significantly, outside of government, who both advocate and directly support US Government programming. Without the support of this constituency, nonproliferation programming would likely fall victim to competing demands on government resources. The "scientist redirection" programs in the former Soviet Union (FSU) therefore do much more than ensure the nonproliferation of a "target community." They are a critical component of a strategy of sustainability—building an industry of supporters who will advocate for and support nonproliferation once Western funding sunsets. Moreover, if configured appropriately, these programs can make substantial contributions to economic development in critical regions of the world.

The scientist redirection programs in the FSU do much more than ensure the nonproliferation of a "target community." They are a critical component of a strategy of sustainability—building an industry of supporters who will advocate for and support nonproliferation once Western funding sunsets.

In our analysis, the human engagement programs represent a cornerstone for the long term success of the cooperative nonproliferation agenda. Without nurturing local demand and building enduring trust within host countries, and after Western funding sources cease across the array of threat reduction activities—including those that secure weapons and bomb-grade materials—much of the US and G8 investment may be squandered. As program managers at the implementing agencies face target dates for completion of the US financed activities in the states of the FSU, they are discovering an unwillingness within the host countries to finance maintenance of the security and safeguards equipment installed, as well as insufficient buy-in for the procedures that US taxpayers have spent millions of dollars to institutionalize. Moreover, in our view, those who contend that the engagement

programs are no longer needed due to demographic shifts within the weapons complex during the last decade, and recent economic growth in Russia, fail to recognize the challenges associated with isolated future generations in the region, as well as the failure of the market system and global research networks to provide sufficient civilian research opportunities in the FSU. Most significantly, by continuing to discount the role of programs focused on the human dimension of the proliferation challenge, we risk replicating the mistakes of the 1990s in other regional contexts as the cooperative nonproliferation model is taken global.

In the face of the "mission accomplished" declaration by the nonproliferation community—both within and outside of government—the Cooperative Nonproliferation Program at The Henry L. Stimson Center launched a multiyear effort to highlight the importance of human engagement programs in the former Soviet Union and other remote locations. The program brings together new stakeholders to develop and promote effective and sustainable models of engagement that would support and advance a variety of foreign policy goals, beginning with nonproliferation, but also extending to such key areas as global public health, environmental remediation, cultivation of innovative energy sources, and economic development. At its core is a new market-based approach to proliferation.

This monograph articulates a feasible approach for engaging human capacity over the long-term in a more sustainable, effective way. It features a win-win opportunity for both the host country and donor government and also introduces new stakeholders with the means and motivation to assure tangible progress in this area. And most importantly, it challenges the simplistic view that – by locking up dangerous weapons and materials in the near-term – we will nullify the proliferation threat in the long-term.

The authors are grateful to the Government of Canada for its support of this study. The findings outlined herein are by no means solely our own. We are indebted to government officials on both sides of the border in the Department of National Defense and at the Pentagon, at the Department of Foreign Affairs and the Department of State. As important as the traditional national security agencies were to the development of this concept, the ideas contained herein are also forged from the vision of the global development, public health and scientific communities. We were pleased to work with the Canadian International Development Agency, the Canadian and US Institutes for Health Research, the International Development Research Center and the National Research Council. Perhaps most importantly, we partnered with many committed private sector companies who shared with us viable business strategies and engagement tactics that have been effective in the past. Domestic and international NGOs, including the Rockefeller Foundation, the Carnegie Corporation of New York, BioVentures for Global Health, the TB Alliance, the International AIDS Vaccine Initiative, the Malaria Vaccine Initiative, the Center for Global Development, the Civilian Research and Development Foundation, and the United States Industry Coalition also contributed valuable insights to this report. We are also grateful for the input of Anne Radcliff of the CUBRC Center for International Science and Technology Advancement, as well as for the advice of various representatives from the World Bank Group.

Finally, we would like to thank our research team, Alex Reed and Rita Grossman-Vermaas, for their dedication to this publication and to our Program. Alison Yost and Christine Harris edited the manuscript and Jane Dorsey formatted the final version. We also want to acknowledge Stimson Center President, Ellen Laipson, and Vice President, Cheryl Ramp, for their continued support of the Cooperative Nonproliferation Program.

This report is dedicated to the men and women who honorably operate the science engagement programs at the Departments of State and Energy and do so under increasingly trying and hostile circumstances.

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April 2008

EXECUTIVE SUMMARY

Over the past sixteen years, the US Government has invested approximately US$13 billion on an array of programs designed to secure, dismantle, or otherwise minimize the proliferation threat arising from the post-Soviet arsenal of nuclear, biological, and chemical weapons of mass destruction (WMD). Since their inception, these cooperative nonproliferation programs (CNP)—more commonly known as Nunn-Lugar—have proven to be the most cost effective tools by far for mitigating the threat of terrorist groups acquiring WMD capabilities.

Matched by massive reductions in the US arsenal, the international community led by the United States has cooperated with the Russian Federation, Belarus, Kazakhstan, Ukraine, Uzbekistan, Georgia, and others to dismantle the last vestiges of the Cold War. The comprehensive list of successes is striking in its breadth of accomplishment and impressive in its depth of engagement, including:

- more than 7,200 former Soviet nuclear warheads deactivated;
- more than 600 intercontinental ballistic missiles dismantled;
- 155 strategic bombers destroyed;
- 906 nuclear air-to-surface missiles eliminated;
- 30 nuclear submarines destroyed;
- more than 85 percent of Russian "nuclear weapon sites of concern" and 193 buildings containing weapons-usable fissile material have received security upgrades; and
- 325 metric tons of highly enriched uranium (HEU) from dismantled nuclear weapons have been blended down to non-weapons-usable low enriched uranium (LEU) for burning in civilian power reactors.[1]

Despite these impressive results, careful analysis suggests that success has been stunted, and as a result, many of the objectives remain unaccomplished. As currently configured, programs are beset by a lack of evolution and innovation due largely to a number of bureaucratic and structural obstacles, as well as remaining vestiges of Cold War-era hostility and distrust. Without an integrated approach to securing the large inventories of WMD materials and expertise around the world, the

[1] See: Office of Senator Richard G. Lugar, "The Nunn-Lugar Scorecard" (March 2008), accessed at: <http://lugar.senate.gov/nunnlugar/scorecard.html>; Robert L. Smolen and William Tobey, Statement before the House Armed Services Subcommittee on Strategic Forces (12 March 2008), accessed at: <http://www.nnsa.doe.gov/docs/congressional/2008/2008-03-12_Smolen_Tobey_HASC_FY09_Budget_Testimony.pdf >; DoE Office of the Chief Financial Officer, "FY2009 Congressional Budget Request," Volume 1 (February 2008), accessed at: <http://www.cfo.doe.gov/budget/09budget/Content/Volumes/Volume1a.pdf>; and USEC, "History: US-Russia Megatons to Megawatts Program" (March 2008), accessed at: <http://www.usec.com/v2001_02/HTML/Megatons_history.asp >.

United States will have failed to accomplish its primary—and bipartisan—security goal to keep the "world's most dangerous weapons out of the hands of the world's most dangerous people."[2]

The report's authors have also found that, while the provision of American equipment and expertise has gone far to achieve the nation's immediate security objectives, unless host governments in the former Soviet Union (FSU) "*indigenize*" these programs, US investments will not have produced a long-term return. Perhaps the most under-leveraged and therefore undervalued aspect of US CNP activities is that which focuses on the human dimension of the proliferation threat: the scientist engagement programs. Critical to building the requisite support and capacity for sustainability of the entire Nunn-Lugar agenda, these programs have long been a difficult political sell. But without them, donor governments are unlikely to build the requisite constituencies within the host countries that are willing to maintain Western security investments over the long term. This study describes the reasons why existing efforts must be complemented by a new model that is based on the creation of incentives for private companies to employ former Soviet weapons scientists, as opposed to the unsustainable government patronage that constitutes the current approach.

Support for and implementation of the public-private partnership model proposed in this paper would establish a complementary and contemporary mechanism to integrate and serve nonproliferation, economic development, and other broader foreign policy goals. Though existing programs focus largely on the states of the former Soviet Union, this model could ultimately be expanded to encompass any region of proliferation concern.[3] This mechanism would also ensure a return on the considerable investment that has been made by the US and other G8 nations to prevent the proliferation of expertise from the largest and best-trained repository of scientists in the world.

History of Post-Soviet Scientific Engagement Efforts

The scientist redirection efforts launched by the US—and subsequently adopted and expanded across the G8—were born in an era of extreme uncertainty for the former Soviet Union. Critical to programmatic success was the rapid engagement of a massive scientific community whose expertise, if proliferated, could have significant negative implications for advancing terrorist and rogue state WMD ambitions. In total, an estimated 50,000-60,000 nuclear weapons specialists, 65,000 biological weapons (BW) experts, and 6,000 chemical weapons (CW) specialists were thought to reside in the sprawling Soviet complex at the height of the Cold War.[4] Put crudely, these programs were designed to keep sensitive scientific capacity in place and provide some degree of accounting for the activities of these individuals of proliferation concern. Parallel programs were launched to shut down or eventually "graduate" legacy weapons research and production facilities. Under this emergency program, little thought was given to the concept of long-term sustainability. Provided that experts

[2] For a comprehensive analysis of the bureaucratic and structural obstacles preventing more effective implementation of the CNP programs, see: Brian Finlay and Elizabeth Turpen, *Cooperative Nonproliferation: Getting Further Faster* (Washington: Stimson Center, 2007).

[3] Scientist redirection programming was initiated in the immediate wake of the Cold War to engage former Soviet weapons specialists, but has since been extended modestly into Libya and Iraq under the Scientist Engagement Initiative at the Department of State.

[4] Amy E. Smithson, *Toxic Archipelago: Preventing Proliferation from the former Soviet Chemical and Biological Weapons Complexes*, Report No. 32 (Washington: The Henry L. Stimson Center, 1999): 10-11.

were not using their talents to advance weapons programs domestically or abroad, then the objectives of government nonproliferation program managers were being met. No comprehensive effort was undertaken to get specialists of concern out of their institutes, into productive, sustainable employment, and ultimately, off Western government support. Nor were sustained efforts made to systematically integrate and leverage these programs in support of the weapons dismantlement and materials security mandates of the Nunn-Lugar agenda.

Although the risks posed by know-how proliferation from the FSU have diminished, they have not been eliminated. While most of the redirect programs targeted the aging community of researchers that worked within the Soviet weapons complex before the USSR fell, recent analyses indicate that there is a growing threat from younger scientists in the FSU who have modern laboratory skills, greater financial ambitions and direct access to materials at the erstwhile weapons institutes. A lack of transparency due to isolation from global research networks is endemic across the states of the FSU, hampering transparency that is assumed with other states. But, without opportunities for sustainable employment, they pose equally daunting challenges to international security. This pool of scientific talent, if not wisely and sustainably engaged, represents a growing pool of expertise that could be targeted by state and sub-state actors who are intent on WMD development or acquisition.

To date, the US Government has spent approximately US$13 billion on programs designed to manage the enduring threat posed by the former Soviet Union's WMD legacy. Of that, approximately $1.3 billion has been appropriated for scientist engagement activities.[5] Though a critical near-term fix to an unprecedented proliferation challenge, the failure to realize enduring value from these significant investments would represent an appalling failure on the part of the US Government and present a potentially catastrophic blow to US national security in the form of widening proliferation. Moreover, where efforts to extend these types of programs beyond the post-Soviet context have occurred—as in Iraq and Libya—programs have replicated imperfect models developed more than a decade ago.

The FSU, while still a proliferation threat, also represents considerable potential for industry both in terms of innovation extraction and new market development.

This situation suggests an urgent need for the evolution of post-Cold War redirect programming to meet contemporary international challenges. Throughout the Cold War, the Soviet Union developed a massive state-owned WMD research and production capacity. Moscow recruited the most talented minds available to support an unparalleled offensive weapons development effort. While many experts believe that the remnants of the Soviet weapons complex continue to pose a serious threat, this residual capacity affords unparalleled opportunities to address current and pressing global issues, ranging from public health to energy alternatives and biodefense. The FSU, while still a proliferation threat, also represents considerable potential for industry both in terms of innovation extraction and new market development. To date, the failure to harness these talents to solve collective problems has been a result of perceiving the human dimension of proliferation as a threat to be "contained," as opposed to an opportunity that can be leveraged to achieve mutually reinforcing objectives.

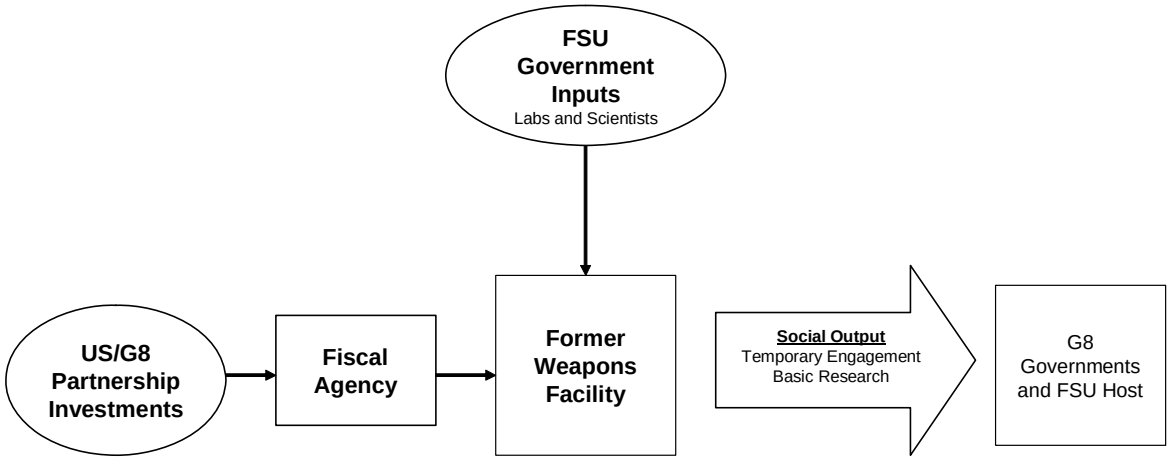
[5] Nuclear Threat Initiative, "Threat Reduction Budgets," Securing the Bomb (2007), accessed at: <http://www.nti.org/e_research/cnwm/charts/cnm_funding_interactive.asp>.

Improving Existing Models

During the past fifteen years, the US Department of Defense (DoD), Department of State and Department of Energy (DoE) have all initiated cooperative nonproliferation programs focused on scientist redirection; these efforts include DoD's cooperative biological research program, State's Global Threat Reduction Program, and DoE's Global Initiatives for Proliferation Prevention programs. In 2002, countries of the G8 developed their own CNP commitments and today, Canada, the European Union (EU), Japan, Norway, Poland, South Korea, and the United Kingdom also contribute in some form to scientific engagement and redirection. The stated objective of all current programs focused on the nonproliferation of expertise is to ***permanently and sustainably redirect*** former WMD specialists. Unfortunately, although well intentioned and effectively implemented at the time they were developed, none of the existing programs is likely to create sustainable job opportunities for the targeted scientists. Complementary new models must be developed.

Though multiple programs exist, each follows a general pattern whereby nonproliferation dollars are funneled through a fiscal agency and distributed in the form of grants to erstwhile weapons facilities in the states of the former Soviet Union in order to continue to employ weapons specialists. Below is a crude generalization of all existing redirection efforts:

FIGURE 1: EXISTING SCIENTIST ENGAGEMENT MODELS

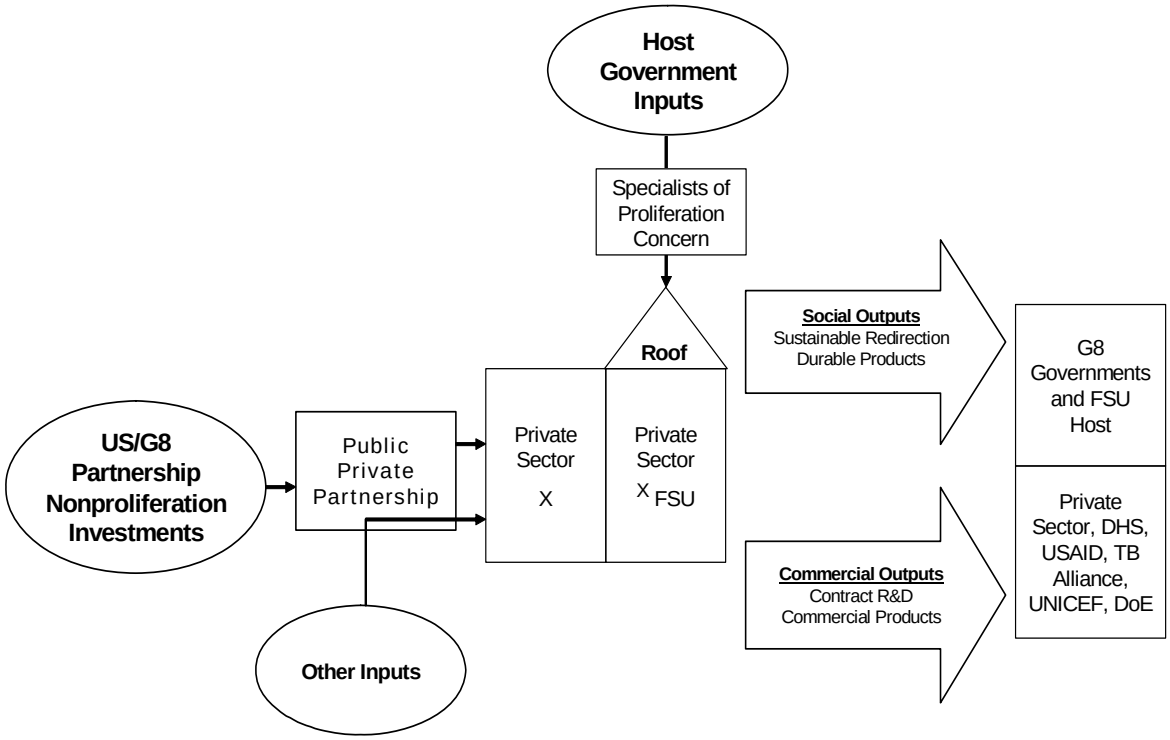


While legal, political, and bureaucratic impediments have complicated the effective implementation of existing programs and inhibited long term sustainability, it is equally worrisome that imperfect models are, and will continue to be, replicated in other regions of proliferation concern. If the lessons of the redirect experience in the FSU are not heeded, then not only will the US bear the consequences of replicating these models worldwide, but much of its billions of dollars and sixteen years of investments may ultimately be in vain.

The 2010 Initiative: Implementing a New Model for Sustainable Nonproliferation and Economic Development

Sustainable engagement ultimately necessitates a transition from government investments in redirect to private sector investments in business development. To ensure employment beyond the funding horizon of existing US and G8 programs, new models of engagement should be based on long-term partnerships with the private sector. This cannot be achieved without short-term incentives that motivate private sector interests and mitigate risks in the near term and also help secure financial investments in the long-term. With Western funding for many of the existing threat reduction programs in the states of the former Soviet Union nearing termination, and without sustained buy-in from some host governments, the likelihood that these investments will have provided only a temporary fix to the proliferation threat is highly probable. Unless existing programs can be reoriented to build a domestic constituency in the host state, then the feasibility of an exit strategy that is sustainable is unlikely. Below is a model that depicts the proposed concept.

FIGURE 2: PROPOSED MODEL OF SUSTAINABLE ENGAGEMENT



G8 Global Partnership Investments

The model is driven by the nonproliferation goals of the G8 Global Partnership. While under pressure, annual G8 redirect appropriations for scientific engagement are substantial. In the past five years, more than US$630 million have been appropriated for these engagement efforts across the Global Partnership.[6] A portion of these resources should be taken, possibly combined with matching

[6] Compiled from: Global Partnership Working Group, "GPWG Annual Report 2007: Consolidated Report Data, Annex A" (June 2007), accessed at: <http://www-pmg8.cea.fr/files/Rapport_GP_WG_2007.pdf>.

funds from host governments where possible and desirable, and then funneled through a discrete funding mechanism designed to temporarily subsidize targeted researchers for their work in the private sector.[7]

Public-Private Partnership

A new Public-Private Partnership (PPP) capacity should be established to manage government nonproliferation investments. This PPP would provide broad-based portfolio management by "investing" resources in those private companies that are willing to sustainably employ the target population. The PPP would be responsible for conducting due diligence on behalf of all government clients (i.e., State Department, Department of Energy, Department of Health and Human Services, Department of Agriculture, US Agency for International Development, etc.) to ensure the long-term integrity and viability of private sector participants and their research objectives, leveraging scientific capacity in the region. The partnership would also be responsible for interfacing with and coordinating the participation of industry, academic partners, and other contractors.

Other Inputs

While nonproliferation investments through this framework are critical, they are ultimately short-term because the Global Partnership will sunset in 2012. As such, the nonproliferation agencies must develop additional "clients" during the next five years to ensure a level of sustainability after nonproliferation funding evaporates. In the case of bioscientist redirect, for instance, that target community may range from other national governmental agencies (see above) and other international public health and development agencies—the World Bank Group, the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the Pan American Health Organization (PAHO)—to existing Public-Private Partnerships dedicated to mitigating the threats of neglected diseases, including the International AIDS Vaccine Initiative (IAVI), the TB Alliance, the Malaria Vaccine Initiative (MVI), and the Program for Appropriate Technology in Health (PATH). Additional private investment (venture capital) could also be sought to support the program.

Host Government Inputs

Coordination and matchmaking with domestic scientific talent would become the responsibility of the private sector under the supervision of the PPP, which would ultimately answer to the contributing government authorities. Therefore, the responsibility of the host government first becomes: a) the release of targeted scientists from state-run institutes; and, b) the provision of a "roof"— a clear sustained signal to lower levels of government and potentially corrupt local regulatory officials not to manipulate or harm the companies established under this program. In addition and where feasible, host government matching funds will be sought to ensure buy-in of the proposed PPP model. As economies have developed during the past decade, many countries are now better suited to become true financial partners in joint development and operation of the program.

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[7] While host government investment has been the exception rather than the rule, recent investments by the government in Kiev in the Science and Technology Center in Ukraine suggest that a reconfigured engagement effort based upon "collaboration" rather than "threat reduction" could stimulate joint investments in technology commercialization.

Private Sector X

Interested private sector firms would make a single application to the Public-Private Partnership. The PPP would coordinate funding from across the range of participating grantors to develop a targeted incentives package for each successful down-selected applicant. In exchange for defined incentives, the private sector company would be obligated to employ specific individuals who qualify for redirect support because of their WMD expertise. Due to the embryonic state of the private sector within the states of concern, in most cases we anticipate that industry within contributing states will form the lion's share of initial ventures. This does not, however, preclude local firms within the host state from successfully bidding on redirect funding from the PPP. In fact, financial contributions from host governments and potential host country industrial partners are presumed to increase throughout the life of the PPP's focus on any given target population.

Private Sector X_{FSU}

Recognizing that only a limited subset of the target population can be drawn out of the host country, and recognizing that various permutations of business models can be applied successfully, we anticipate that the majority of cases will involve establishing FSU subsidiaries of the US/G8 companies that hire the redirected specialists. Again, this initial likelihood would eventually give way to a competitive sector within the host country.

Outputs

- *Social*: Social outputs are the "goods" directly and indirectly produced by government incentives. The primary social output of these programs should be the permanent redirection of former WMD specialists into commercially sustainable jobs. Because this requires the introduction of new companies into the FSU, other "goods" should naturally emerge as a by-product of the effort: broader economic development, professional training, adoption of international quality control standards and management techniques, advocacy for additional economic reform and rule of law, increased demand for local goods and services, new business creation due to this increase in demand and to spin-off activities, and new technology development.

- *Commercial*: Commercial outputs are the real goods and services that ultimately justify and finance the long-term employment of redirected specialists. These outputs are critical to the success of this model. Without the provision of viable products to a paying client base, sustainable redirect will never be achieved. These products can also be marketed to a broad array of national and international agencies providing not only potentially discounted new sources (over time), but also expanded capacity for commercial research and consumer products.

Conclusion: Importance of the Private Sector

The emphasis on industry stems from the realization that only the private sector has the management capability and organizational capacity to make large-scale productive use of the target community over the long term. Apart from open-ended government patronage, no other approach can provide sustainable employment. Such employment, of course, requires employers—yet, "employers" are not part of the current program. While many projects involve private sector participants, their role is to

serve as clients for research and development (R&D) services provided by the scientists from within their erstwhile weapons institutes. It is rare that the scientists have an ongoing role to play once the proof of concept is achieved, and even rarer that they become employees of the private sector "partner." Shifting the focus to facilitating employment by the private sector may continue to involve collaborative research and technology development, but rather than being the central objective—as with existing programs—it will be a means to the end of creating sustainable employment. In addition, strengthening the technological and scientific infrastructure locally and with local talent is a critical component of the model. It serves the interests of all parties in terms of politics, ownership of projects, and economic growth. Moreover, the involvement of economic development, public health, and other public and private agencies would increase the resource base available for job creation and ensure that there are stakeholders involved who value the output that the company creates by employing the scientific capacity. This, combined with direct host government involvement, will increase the odds of success and reduce the risks to government and private sector employers.

It should be noted that existing human engagement programs have, and will continue to have, enduring nonproliferation benefits. We do not suggest that they be eliminated.

It should be noted that existing human engagement programs have, and will continue to have, enduring nonproliferation benefits. We do not suggest that they be eliminated. Rather, innovative new models that leverage a "whole of government" approach to science engagement should be developed to complement and build upon existing efforts. Much of the talent of proliferation concern cannot be commercialized. Others will be unwilling to leave their institutes. It is the remaining talent that should be more efficiently engaged by our proposal.

The US Government has committed substantial resources to redirection efforts in the states of the former Soviet Union. Moreover, the United States is recognized as a global leader in infectious disease research, nuclear science, space technology, technology development, energy, poverty alleviation, and global economic development. Despite the attention that the US Government has given to these issues, ensuring the long-term viability of redirect efforts, along with achieving the highest possible return on these social investments, has remained an elusive goal. This study proposes a pragmatic and contemporary model to help leverage existing resources, achieve sustainable security, increase scientific collaboration for the common good, and promote economic development.

— 1 —
INTRODUCTION

Throughout the Cold War, the Soviet Union developed a massive state-owned weapons research and production capacity. In the early 1990s when the government in Moscow dramatically scaled back funding to that complex, the United States launched a series of programs to ensure that the intellectual resources housed therein did not proliferate to rogue states and terrorist organizations. While this community continues to represent a proliferation challenge, it also presents tremendous—if poorly understood—opportunities for advancing biotechnology and public health, agricultural innovation, alternative energy development, environmental remediation, software development, waste management, economic advancement, rule of law, and a host of other commercial and foreign policy objectives. In the case of biotechnology for example, the former Soviet Union retains world-class capabilities in tissue culture and is a global leader in the identification and utilization of bacteriophages and in novel drug design and testing. These skills, if properly harnessed, could dramatically enhance global capacity to combat infectious diseases, while providing the necessary conditions for economic expansion in developing countries of the FSU. To date, the failure to channel these talents for the benefit of humankind has been a direct result of the inability of both Moscow and Washington to transform their contentious relationship of the past into mutually beneficial cooperation in the present.

In January 2005, The Henry L. Stimson Center, a private, non-profit public policy think-tank, launched an initiative to identify, analyze, and promote remedies to the legislative, regulatory, and attitudinal obstacles to successful implementation of the cooperative nonproliferation programs in the states of the FSU. That effort was underwritten by a variety of major private philanthropic foundations, including The John D. and Catherine T. MacArthur Foundation and the Ford Foundation. The study concluded, *inter alia*, that existing nonproliferation investments—particularly in the area of scientist engagement—are critical to the long term success of the broader nonproliferation agenda. It also concluded that this particular portfolio of programs is underperforming, due largely to Congressional encumbrances, and is at risk of premature elimination due to:

1. A widening strategic disagreement between Russia and Western donors over program-related priorities and non-program related tensions;
2. A burgeoning political frustration in the West over the perception of redirection efforts as “welfare science”; and,
3. A programmatic failure to successfully introduce innovative models of sustainability.

The Stimson Center project directors conclude that unless new and inventive models are introduced presently, redirection efforts will face continuing budgetary pressures and premature abolition. Elimination of the human engagement efforts will have a significant, deleterious impact upon global security from two standpoints. First, not only could a large subset of former weapons experts be lured abroad, potentially by nefarious opportunities, but the next generation of nuclear, biological, and

chemical scientists could continue to develop dual-use capabilities that would not be absorbed into peaceful global research networks. Elimination of engagement efforts with states of the former Soviet Union would therefore pose both significant near- and longer-term **proliferation threats**. Second, the scientific community in the FSU represents an expanded *capacity*, and in some cases, possesses unique *capabilities* across the sciences. Leveraging this large, well-trained scientific workforce could make these countries important contributors in addressing global challenges ranging from the spread of infectious diseases to the development of innovative energy sources. The failure to engage this community poses significant **opportunity costs** based upon the failure to leverage the significant scientific legacy resident within the FSU.

Under a contribution agreement with the Canadian Department of Foreign Affairs and International Trade (DFAIT), the Stimson Center launched a scoping study on ways to leverage existing investments in the redirection of former Soviet biological weapons specialists with international public health markets and global economic development resources. The project was led by Stimson Center Senior Associates Brian Finlay and Elizabeth Turpen and supported by Visiting Fellow Frederick Kellett. The following is a report on the findings of this project, along with a proposed model for sustainable redirection designed to expand the Global Partnership's social return on investment across a broad array of international priorities. While the initial scoping study focused exclusively on the enduring threat and potential of the FSU biosciences, the project directors concluded, based upon considerable evidence, that the model of engagement proposed herein is equally applicable to all former WMD specialties, as well as regions of proliferation concern beyond the FSU.

Central to this new model is the involvement of the private sector as an enduring employer of the target community within the states of the former Soviet Union.

Central to this new model is the involvement of the private sector as an enduring employer of the target community within the states of the former Soviet Union. Stimson's approach goes beyond the existing—and we believe limited—redirection efforts that focus on maintaining personnel within existing and often decrepit institutes and facilities. Moreover, while the International Science and Technology Center (ISTC), Science and Technology Center in Ukraine (STCU), Initiatives for Proliferation Prevention (IPP), and the Defense Threat Reduction Agency have made important contributions to reducing the likelihood that critical weapons know-how will proliferate from the FSU, the vast majority of these efforts has achieved only temporary redirection by providing short-term basic research grants to the region's weapons scientists and technicians operating within their erstwhile weapons facilities. Thus, these programs have been stymied in their attempts to help these individuals make the transition to sustainable long-term employment outside the WMD complex.

It is critical to note that this new model is not designed to replace current investments in scientist redirection through the ISTC/STCU, nor is it a substitute for critical infrastructure, safety, and security upgrades in the states of the former Soviet Union. Rather, this effort would provide a novel complement to existing efforts by sustainably engaging a subset of the target community of specialists. Because it is a diverse community, the assumption is that some will not possess skills that

can be readily transferred to the commercial sector, while others will not be prepared or permitted to leave their erstwhile weapons institutes. Where there is mutual interest in doing so, it is this subset of specialists that should be continually engaged through collaborative grants such as those offered by the Science and Technology Centers (STCs). The remaining community of experts, however, should be well suited for more sustainable and cost-effective redirection through this complementary new approach to engagement with the private sector.

This initiative aims to work around existing models by introducing a new paradigm in which nonproliferation funds are used as market-based instruments to "incentivize" the *private sector* and take the underexploited scientific capacity outside of the former weapons infrastructure for the development and production of marketable products. A survey of previous efforts suggests that this approach is not only novel, but that it removes the most significant impediment to each and every previous effort to redirect scientists into activities serving the public international good. In short, our concept builds upon the successes of existing conversion and redirection efforts while correcting for the shortcomings of these programs.

This report proposes a tailored pilot program designed to transition a subset of former weapons specialists in the states of the FSU from long-term Western government support by identifying viable companies and other stable employers to absorb and utilize this human capital effectively and sustainably. It is the culmination of a twelve-month study that surveyed dozens of private companies and more than one hundred experts in the fields of nonproliferation, business, international public health, and global economic development. Pertinent agencies and departments across G8 security, development, and public health sectors were systematically polled. In addition, dozens of outside specialists from Canada, the United States, and Russia have contributed their ideas to this cross-sectoral approach to the sustainable redirection of the post-Soviet weapons community.

This report is divided into two sub-sections: a background on current threats and a summary of existing efforts to redirect former weapons expertise, along with our key findings and conclusions; and, an outline of a new model of engagement and three targeted case studies that operationalize that model.

— 2 —
BACKGROUND

The Brain Drain Threat Today

The threat posed by excess weapons and materials at the end of the Cold War, while awesome in its scope, was dwarfed in its complexity by the problem of nefarious technology transfer by under- or unemployed FSU weapons experts. The plight of the former Soviet weapons community was indicative of the widespread inability of Russia and the other FSU states to support the massive Soviet weapons complex that they inherited. Within the first year after the collapse of the USSR, life for this once sacrosanct community of scientists, engineers, and technicians was irrevocably altered. Tens of thousands lost their jobs or went months without a paycheck. Even the brightest scientists and engineers were forced to seek work where they could get it—whether driving taxi cabs or selling their talents to foreign governments or terrorist organizations. All told, the Soviet Union employed 50,000 to 60,000 nuclear weapons experts. In addition, 65,000 biological warfare specialists and more than 6,000 chemical weapons experts were employed by the Soviets' massive WMD complex.[8] All were capable of spreading critical components of sensitive information to hostile groups and states. Given the poor economic performance of Russia and other FSU countries after the Soviet Union's collapse, many scientists who could not find jobs elsewhere faced a literal choice: go hungry or sell your expertise to the highest bidder.

Although the remarkable economic turnaround in Russia and elsewhere in the FSU has dramatically improved the quality of life across the region, intelligence analysis and anecdotal evidence suggests that there is a continuing risk of "brain drain" proliferation from the former Soviet Union. It is true that the abysmal conditions that stoked brain drain concerns through the 1990s have largely improved and that today, the number of Russian and other FSU scientists who represent a WMD proliferation threat is relatively small. Nevertheless, the community remains large enough to warrant continuing concern. Anecdotal evidence collected from scientists and private companies operating in the states of the former Soviet Union suggests that some portion of the region's former WMD talent is being siphoned off and re-circulated by so-called "rogue" states. Moreover, solid empirical evidence collected by a recent US Department of Energy study points out that while the majority of Russian scientists are unlikely to migrate to rogue countries or sell their WMD expertise to hostile governments, sizable minorities continue to pose a threat: 21 percent would consider taking a job that would require moving to one (or more) of four rogue states; 13 percent deem WMD work for an authoritarian government acceptable under some circumstances; and, 59 percent view dual-use work for a foreign firm as acceptable under certain circumstances.[9] Purportedly, the intelligence community maintains a list of several thousand individuals across the states of the former Soviet Union who are considered to be viable proliferation threats, should they decide to sell their knowledge to the highest bidder.

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[8] Smithson, *Toxic Archipelago*.

[9] Deborah Yarsike Ball and Theodore P. Gerber, "Russian Scientists and Rogue States: Does Western Assistance Reduce the Proliferation Threat?" *International Security*, Vol. 29, No. 4 (Spring 2005): 50–77.

More important than the overall numbers of specialists willing to work abroad are the technical capacities that they possess. Specialized know-how is difficult to come by. As one analyst wisely points out, the capacity to weaponize nuclear material requires both "explicit knowledge (information or instructions that can be formulated in words, symbols, formulas, or diagrams and can be easily transferred) and tacit knowledge (unarticulated, personally held knowledge or skills that a scientist or technician acquires and transfers through a practical, hands-on process and direct interactions with other scientists)."[10] Soviet and British scientists had difficulties replicating US weapons despite their respective insights into the design and development of the American bomb.

Perhaps more distressing, however, is the realization that former weapons scientists may not be the only threat—or for that matter, even the most acute one. Proliferation threats can emanate from sources far beyond the existing target list of institutes and individuals that were part of the massive Soviet weapons complex. According to a study by the US National Academy of Sciences, much of the research conducted in facilities that were never associated with defense programs is inherently dual-use. The study also found that a sharp bifurcation between former defense and non-defense scientists is inhibiting the exchange of information within Russia. More importantly, this has led to a lack of adequate attention to the proliferation potential of the historically civilian biological research sector. As a result, young FSU scientists with modern laboratory skills, direct access to WMD materials, and strong financial ambitions—whether inside the target institutes or beyond their walls—could present a proliferation threat.[11] While this subset of scientific talent is far beyond the mandate of existing nonproliferation programming, unless models of engagement can ultimately capture and integrate the scientific community of the FSU writ large, it is unlikely that the brain drain threat will ever be systematically addressed.

Science-Based Threats, Science-Based Solutions

As noted, empirical analyses reinforce anecdotal evidence suggesting that the lion's share of former WMD researchers in the states of the former Soviet Union are not predisposed to employment in so-called "rogue states." It is therefore logical to assume that if viable employment alternatives can be found in their home country, the target population will not become a brain drain threat. To date, the preponderance of unclassified evidence supports this conclusion.

It also follows that sustainable jobs for the target community would reduce the need for long-term government expenditures on existing redirect programs. While existing redirect efforts have generally succeeded in the near-term, they have ultimately failed to eliminate the threat in the long-term. Even those programs that have sought to build in the private sector as "clients" of government-funded research at the former weapons institutes have not succeeded at introducing long-term employers in industry as sustainable employment sources for the target community. As a general rule, when government funding has evaporated, weapons researchers are again underemployed or even unemployed, and thus pose a global proliferation threat.

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[10] Sonia Ben Ouagrham-Gormley, "Nuclear Terrorism's Fatal Assumptions," *The Bulletin Online* (October 23, 2007), accessed at: <http://www.thebulletin.org/columns/sonia-ben-ouagrham-gormley/20071023.html>.

[11] US National Research Council, *Biological Science and Biotechnology in Russia: Controlling Diseases and Enhancing Security* (Washington: NRC, 2005): 72.

Anecdotal evidence also suggests that the science retained within Russia and other states of the former Soviet Union remains valuable. Indeed, the value of Russian and other FSU scientific capacity has been validated most notably by the substantial investments made by major US corporate interests—Intel, Boeing, and Microsoft—in the computational, nuclear, and aeronautical sciences. Less publicized but equally compelling stories have been found in the biosciences and elsewhere.

Today, states of the former Soviet Union host some of the most accomplished laboratories in the world in critical scientific specialties. Thus, the expertise housed therein can be translated directly into benefits for global public health, environmental remediation, alternative energies, national defense, etc. In the biological sciences for example, the expertise housed within former and existing state-owned institutes can be translated directly into benefits for global public health. The Soviet BW complex successfully weaponized a broad range of highly infectious pathogens such as the filovirus Ebola. Today, these skill sets could be equally useful in devising new strategies for influenza virus culture, strain generation, and banking. If applied to influenza vaccine development, this knowledge base and additional capacity could revolutionize scientific practices in even the most developed countries of the world. The Russians, Georgians, and Ukrainians also remain world leaders in the identification and utilization of bacteriophages in human medicine. Additionally, legacy capacity in the states of the former Soviet Union could also be turned quickly to bioremediation, as well as novel drug design and testing.

Anecdotal evidence suggests that the science retained within Russia and other states of the former Soviet Union remains valuable. Indeed, the value of Russian and other FSU scientific capacity has been validated most notably by the substantial investments made by major US corporate interests—Intel, Boeing, and Microsoft.

The feasibility of the idea is illustrated by the commercial application of other WMD specialty research. The Boeing Company has reaped significant benefit from former Russian nuclear and missile scientists now working on peaceful technologies. Using its Moscow Design Center that opened in 1998, Boeing focused on the development of new titanium alloys and advanced manufacturing technologies. Other ambitious projects have looked at new cross-polar routes linking the United States with Southeast Asia via Russian and Chinese air space. Supporting existing design work in the United States, Russian researchers have redesigned and converted the 767 airliner from a passenger plane into a freighter to service new markets, improved the carbon brakes for the 777, and designed new manufacturing assemblies for the 747 and 767. All of this was done in collaboration with US researchers for a fraction of the cost that would have been incurred at other locations.[12]

Ultimately, to make human engagement programs sustainable, efforts should produce value beyond the nonproliferation of expertise, thus maximizing the government's return on investment. Scientist redirect funds can leverage—and be further leveraged by—other government interests including, *inter alia*: biotechnology, global public health, agricultural innovation, alternative energy development, environmental remediation, software development, waste management, and economic development. Encouraging innovation in the states of the former Soviet Union can become a

[12] Author's interview with Boeing officials (December 2006).

significant income-generating endeavor for the local economies. Aside from the clear scientific benefit, such an effort would also support the Global Partnership's global economic development efforts in the states of the former Soviet Union.

The Legacy of Post-Soviet Redirect Programming

The stated objective of all current programs focusing on nonproliferation of expertise is to permanently and sustainably redirect former WMD specialists from weapons-related R&D to peaceful activities. Unfortunately, as currently configured, none of the existing programs is likely to create the new jobs necessary to sustainably engage weapons experts and thus achieve this objective.

The scientist redirection efforts launched by the United States Government—and subsequently adopted and expanded across the G8 partners—were born in an era of extreme uncertainty for the states of the former Soviet Union. Critical to programmatic success was the rapid engagement of a massive scientific community whose expertise, if proliferated, could provide terrorists and rogue states with access to weapons of mass destruction. Put crudely, the programs were designed to keep sensitive scientific capacity in place and provide some degree of accounting for the individuals and their activities. Parallel programs were launched to shut down or eventually "graduate" legacy R&D and production facilities. Under this emergency program, little thought was given to long-term sustainability or other foreign policy objectives beyond nonproliferation that might be achieved through scientific engagement. Provided that experts were not using their talents to advance weapons programs domestically or abroad, then the objectives of the government nonproliferation program managers were being met.

A decade later, the environment in Russia and other states of the former Soviet Union has changed dramatically. With increased host state resources and ever restrictive budgets within the donor community, it is increasingly difficult for the existing programs to justify continuing support. Inventive new models are overdue and must be developed. At a minimum, the lessons learned through more than ten years of redirect programming should be taken into account. Such an analysis reveals that current and previous redirect efforts were designed to produce one of two outputs:

1. Collaborative research and technology development, or
2. Restructuring of state-owned weapons institutes and production facilities.

To understand why these approaches do not lead to sustainable employment and the lessons that can be drawn from them, we offer below a systematic accounting of previous and existing redirect efforts along with an assessment of their shortcomings.

Collaborative Research and Technology Development Approaches

These approaches to scientist engagement are based on the belief that the provision of short-term grants to develop collaborative ties between the scientific community of the US and that of the host country will lead to the development of productive and lasting relationships. In most cases, these efforts have gone far to develop a sense of trust and partnership between the US and host governments that has benefited CNP efforts across the board. These models are, however, experiencing difficulty in creating *sustainable* jobs for the target community because they have failed

to identify and engage *employers* for the redirected WMD specialists. Under these programs—which include the Science and Technology Centers and the Bio-Chem Redirect (BCR) Program, all managed by the Department of State, and the Initiatives for Proliferation Prevention at the Department of Energy—the moribund weapons institutes effectively "house" the scientists for employment by the donor governments through a collaborative grants process. Targeted researchers in the FSU serve as temporary workers to Western *clients* through the grant period. The former weapons institute continues to host and supervise the grantee. Rarely is the former weapons researcher hired by the client upon completion of the project, which means that the US or one of the other G8 governments must continue to support research through new grants. None of these governments are or want to be long-term *employers*.

KEY FINDINGS:

- ISTC, STCU, BCR and IPP were designed to produce research, not jobs.
- Research does not inevitably lead to sustainable redirection.
- ISTC and STCU fund research that is seldom valued by others.
- The Bio-Chem Redirect Program at the US Department of State has engaged US Government researchers as collaborators to ensure that the research is valued and to circumvent structural limitations at the Department of State, but has failed to systematically produce sustainable employment.
- The Initiatives for Proliferation Prevention program at the US Department of Energy has engaged the private sector as customers, but not employers.
- Moving new technologies from proof-of-concept to a commercially viable product is very difficult to achieve.
- Commercialization rarely involves more than a token number of the scientists and even more rarely leads to sustainable employment.

Science and Technology Centers

The International Science and Technology Center is an international organization founded in 1992 by the European Union, Japan, the United States, and the Russian Federation. Its purpose is to provide weapons experts in the Commonwealth of Independent States (CIS) with the opportunity to redirect their talents to peaceful activities. To date, the organization has funded 2,437 projects totaling US$744 million. More than 67,000 participants from over 900 institutes in Russia and the CIS have received ISTC funding.[13] Its smaller counterpart, the Science and Technology Center of Ukraine, has managed over 1,000 R&D projects worth over US$160 million since its inception in 1993.[14]

While funding has fluctuated over their history, the lion's share of international redirection funds for the states of the former Soviet Union has passed through the ISTC and STCU at an annual rate of over US$60 million. These monies have been used to pay salaries, cover the overhead costs of the

[13] International Science and Technology Center, *Annual Report 2006* (Moscow: ISTC, June 2007): 37, accessed at: <http://istc.ru/ISTC/sc.nsf/AR-2006-en.pdf>.

[14] Science and Technology Center in Ukraine, "Science and Technology Center in Ukraine," accessed at: <http://www.stcu.int>.

institutes, and purchase equipment and materials required for collaborative research. While there is nonproliferation value placed upon the act of scientific cooperation, there is often limited value realized from the results of the research itself. More importantly, even the most interesting research results do not, in and of themselves, lead to new jobs. As collaborative projects wrap up, the scientists involved must again look for state funding to initiate new research.

ISTC and STCU have recognized that this model of engagement is not sustainable and that support from their donors is unlikely to last in perpetuity. In fact, signals from the US Congress and White House have been unmistakably pointing to an American—and potentially wider G8—exit strategy from the STCs. Recent evidence suggests that this may come even sooner than the G8 Partnership funding horizon in 2012. Recognition of the structural flaws within the STCs is due in large part to the leadership of Canada in the early days of the STCU. At that time, Ottawa had insisted upon building sustainability into programming efforts, even going so far as to task the Canadian International Development Agency, rather than the Defense or Foreign Ministries, with the redirection portfolio. Regardless of these early efforts, structural challenges and disagreements within the donor community have prevented the adoption of more sensible and sustainable approaches.

Today, both the ISTC and STCU are attempting to develop new tactics that will lead to the institutional sustainability of the centers, as well as to more long-term sustainable employment for the target community. Unfortunately, as currently configured and legally mandated, neither organization is capable of accomplishing these goals because this would require a customer-oriented, efficiently managed operation that neither the STCs nor institutes that ostensibly employ scientists were designed to provide. Engagement of the private sector will be critical for any new model of sustainable redirection.

BOX 1

ISTC AND THE US GOVERNMENT ACCOUNTABILITY OFFICE

During the past five years, the ISTC has come under intense scrutiny by the United States Congress. In a report by the US Government Accountability Office (GAO), the Congress learned that:

- The State Department does not directly monitor the activities or results of the work of the scientists participating in U.S.-funded science center projects;
- The Department relies on the mostly Russian and Ukrainian specialists at the science centers, overseen by managers from the United States, the European Union, Japan, and Canada, to conduct routine monitoring of the senior scientists' progress;
- The terms of the project agreements do not allow auditors to track what the scientists are doing while they are not working on projects;

- In 2000, for example, 75 percent of the senior scientists worked four-and-one-half months or less on US-funded projects, and that some senior scientists worked as little as a few days on US-funded projects during an entire year; and that as a result,
- The Department of State knows little about the scientists' activities outside the program, which has failed to sustainably redirect the target community.[15]

The conclusions of the GAO have led to dwindling support for the STCs in Congress and the White House and increased budgetary pressures on the State Department's contributions to both ISTC and STCU.

In sum, the Science and Technology Centers have been limited in their ability to provide sustainable redirection because their structural focus remains scientific engagement, not employment. While STC-funded technologies have been commercialized, few have resulted in permanent new employment for the scientists involved. As such, it is unlikely that they will continue to secure future contract research work (per the current model) without the continuing international support of additional STC grants.

Bio-Chem Redirect Program

The State Department's Bio-Chem Redirect Program sponsors peaceful collaborative research between former biological and chemical weapons scientists from the FSU and American scientists at the US Departments of Health and Human Services (HHS) and Agriculture (USDA) and the Environmental Protection Agency (EPA). Under BCR, funds are passed through to, for example, the Biotechnology Engagement Program (BTEP) at HHS. BTEP then works to encourage collaboration between HHS and the former biological and chemical defense institutes and Ministry of Health institutes. In the US, BTEP support is available only to HHS scientists at the Centers for Disease Control and Prevention (CDC), the Food and Drug Administration (FDA), and the National Institutes of Health (NIH). At this time, non-HHS scientists—including the private sector—are not eligible for grant awards. Similar efforts are operated out of USDA and EPA.

For fiscal year 2007, BCR is believed to have received $17 million, which is slightly more than the 2006 allocation.[16] Examples of 2007 projects include: allowing health-related biological research to continue at Vector and Obolensk, two major Soviet biological research institutes housing large repositories of bacterial and viral diseases; continuing the USDA program to develop research opportunities in civilian agricultural disease detection, monitoring, and prevention; and providing support for EPA-led projects with former Soviet chemical weapons scientists in environmental contamination and remediation.[17]

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[15] See: US General Accounting Office, *Weapons of Mass Destruction: State Department Oversight of Science Centers Program*, GAO-01-582 (Washington, DC: GAO, May 2001).

[16] Isabelle Williams, "Preliminary Analysis of the U.S. State Department's Fiscal Year 2008 Budget Request for Global WMD Threat Reduction Programs" Partnership for Global Security (April 2007), accessed at: <http://www.partnershipforglobalsecurity.org/Documents/state_fy08_budget_request_analyses.pdf>.

[17] US Department of State, "FY 2007 Congressional Budget Justification for Foreign Operations" (2007), accessed at: <http://www.state.gov/documents/organization/60647.pdf>.

Though BCR has ostensibly developed a cadre of government "clients" for State Department FSU research, evidence from the collaborating US Government agencies suggests that these relationships will not endure past the funding horizon of the BCR program. Like the STC model, though the near-term nonproliferation benefits to BCR are clear, it is unclear how this collaborative research approach ultimately leads to sustainable employment for the former weapons scientists. Under this current model, the US Government is creating demand by paying for the research. After these subsidies end, it is unlikely that the other US Government agencies involved will continue to commission research in the FSU because these efforts fall far outside of their departmental missions.

BOX 2

VECTOR AND BCR

Under a partnership between HHS and the Department of State's BioIndustry Initiative, a novel vaccine platform technology was identified at Vector, the Soviet Union's premier bio-weapons lab. A BTEP project to validate the technology was created. The State Department organized this validation of the HIV-1 vaccine in collaboration with Massachusetts General Hospital/Center for Integration of Medicine and Innovative Technology, Duke University Medical Center's Human Vaccine Institute, and Johns Hopkins University. According to the State Department, the initial results of the study are promising, "indicating broad reactivity to HIV-1." Following these initial findings, State facilitated contact between the vaccine platform technology's creators and Western pharmaceutical companies. [18]

While the potential value of this research is evident, it remains unclear how this ultimately leads to sustainable employment for the researchers. By definition, Vector is not the desired long-term employer (this is the foundational reason for the existence of these programs) and it is unlikely that the pharmaceutical companies will hire more than a couple of the scientists after they achieve effective control of the intellectual property. Furthermore, if the patented approach is commercially successful, it seems counter-productive to have provided a new revenue stream to a former bio-weapons lab that remains closed to the program funders.

In conclusion, BCR has wisely sought to leverage the unique talents of the target community in support of other US Government activities. However, existing models of engagement fail to turn government agencies into paying clients. Instead, government entities are relied on as pass-through funding agencies for the continuation of engagement with the former institutes in scientific collaboration and technology development. Funding limitations in the US Government agencies will ultimately end even the most fruitful of collaborations.

Initiatives for Proliferation Prevention

The Initiatives for Proliferation Prevention program is run by the US Department of Energy and works closely with the ISTC and the STCU. IPP, however, was designed to ensure that someone does value the results of the research it underwrites by systematically involving private sector companies as "sponsors" of technology development. These companies do not actually pay for the

[18] US Department of State, "Fact Sheet: BioIndustry Initiative" (September 2003), accessed at: <http://www.state.gov/t/isn/rls/fs/24242.htm>.

FSU researchers' work themselves—that is done by the DoE—but they do match the government's investments and act as collaborators with, and ultimately as clients for, the research performed by former weapons scientists.

The program is managed in large measure by the US National Laboratories. Laboratory personnel often retain long ongoing relationships with individual institutes and scientists in the FSU. Program managers at the US Laboratories are tasked with recruiting the corporate participants, managing the application process, and then overseeing the work undertaken by the scientists at the institutes. In most cases, the private company retains no control over the activities of the individual scientists involved. The value of the Laboratories' contributions varies widely and depends largely on the competence and interest of the principal investigator, who manages daily interactions with the DoE bureaucracy and the FSU researchers.

A successful IPP project will produce a "proof of concept" for a technology or, in some cases, a prototype with commercial potential. The next step is to demonstrate this potential by engineering a commercially viable product, at which point it is often the case that few if any members of the original FSU research team are needed. Therefore, the incidence of projects leading to new, sustainable jobs in the states of the FSU is low. After a new technology is produced, the technology (and potentially a target scientist or two) is brought to the United States, where the product can be manufactured and sold with no need for an ongoing relationship with the host institute.

BOX 3

WIND-SAIL

Wind-Sail is an almost textbook example of a successful IPP project. It began in 2000 with the invitation from a senior scientist at the Lawrence Berkeley National Lab (LBNL) to a private sector company, Empire Magnetics, Inc., to consider an IPP project. Empire Magnetics designs and manufactures specialized motors and alternators, has an ongoing collaborative research relationship with LBNL, and during the late 1990s, established a small Russian engineering firm to support its product development. After surveying the field of Russian institutes and proposed technologies, Empire and LBNL settled on the Makayev Design Bureau at the Russian State Rocket Center to develop a commercially viable vertical axis windmill that would be able to use Empire's alternators.

A project proposal for US$2 million to be spent over three years was prepared by Empire, LBNL, and the Rocket Center, and submitted to the Department of Energy under the IPP program. After a typically lengthy (more than two years) application process, the project was launched. Thirty percent of the US Government funds were allocated to LBNL with the remaining 70 percent going to support the Russian team. The funds were channeled through the ISTC, which also handles procurement of equipment and consumables. In principle, this ensures transparency and accountability, but according to those familiar with the effort, ISTC involvement proved to be inefficient in this case.

Five years later, Empire Magnetics is nearing completion of its project. Two prototype windmills have been shipped to the United States for testing and possible commercialization. The central

problem is the lack of investors willing to offer the start-up capital necessary to refine the windmills for commercial launch and build a production facility in Russia or elsewhere to manufacture them.

According to those familiar with the program, investors quickly concluded that investing in Russia is a high-risk, low-return option. The more knowledgeable among them have added that if they did build the factory in Russia, it would be only a matter of time before the Russians would force them out. Such barriers to entry in the Russian market must be overcome before private enterprises are likely to invest their resources in such a potentially challenging region.

QED TECHNOLOGIES

QED Technologies is a more complete example of technology transfer leading to successful commercialization and the permanent and sustainable redirection of scientists. From basic research in magnetically controllable fluids, a commercially viable optics finishing technology was developed. It was not, however, a result of the IPP program, but an entirely commercial undertaking. Ultimately, QED did benefit from defense technology programs in the United States, but only after the strategic decision was made to launch this effort.

Byelocorp Scientific, Inc. (BSI), a privately held American company established to develop business opportunities in the former Soviet Union, identified magnetorheological finishing (MRF) as a promising new technology at a state-owned laboratory in Belarus. The company then surveyed the US for potential markets, which led to a collaborative relationship with the University of Rochester's Center for Optics Manufacturing (COM). COM had previously received substantial funding from the federal government to develop new optics manufacturing technologies that would ensure that the United States did not fall behind or become dependent upon foreign countries for specialized optics in defense applications.

Initial collaboration with COM ultimately produced a patented application of the technology. BSI then set up a new enterprise, QED Technologies, to develop a commercially viable machine using the technology that could be sold to commercial optics manufacturing companies worldwide. Additional government support was then secured through the US Department of Defense Small Business Innovation Research (SBIR) program, which funds staged defense technology development at small businesses throughout the United States. The Civilian Research and Development Foundation, a non-governmental organization (NGO) established by Congress to facilitate a variety of basic science, nonproliferation, and threat reduction activities in the former Soviet Union, also provided funding for travel grants and exploratory research to assess the ability of former weapons scientists to contribute to new innovations in QED's optics manufacturing technology.

It took two years for BSI, COM, and the laboratory in Belarus to develop a patented application of the magnetically controllable fluid for optics finishing, plus an additional two years for QED to develop a commercially viable machine for optics manufacturers.

While IPP has led the way in engaging the private sector, its focus is on commissioning research that will provide "proof of concept" for commercializing new technologies developed at the institutes. Only a small proportion of the researchers have secured permanent employment with the companies, which have tended to take the technology to market without the involvement of their FSU counterparts. The program deserves to be unshackled to permit broader engagement.

In conclusion, the research and technology development approaches to WMD scientist engagement—including the STCs, BCR, and IPP—are experiencing difficulty in creating sustainable jobs for the target community because they have failed to identify and engage industry as employers, rather than as customers. Put simply, employment in the long term requires sustainable employers. This is not to suggest that they are not effectively serving near-term nonproliferation goals. But these programs remain at best a band-aid solution to an enduring national security challenge. As noted, the science-to-science programs remain important for reasons beyond the near-term nonproliferation benefits, including, but not limited to, the wealth of scientific capability and expanded capacity that the target community provides. Under these existing programs, however, the moribund weapons institutes continue to "house" the scientists for employment by the donor governments. However, neither the governments nor the STCs are employers—nor do they want to be. Seemingly, the US Department of Energy has tried to address this shortcoming with the IPP program by involving private sector companies as partners in technology development. Alas, being a company is not the same thing as being an employer. In short, industry "partners" and government research collaborators are customers of the research, not employers of the scientists.

Restructuring of State-Owned Enterprises

Parallel to models of engagement that seek to develop collaborative ties between the scientific communities in the United States and the FSU are a series of programs that have worked to manage the legacy infrastructure of former weapons facilities—and by extension, the individuals employed by those facilities. Under these programs—the terminated Defense Conversion Program at the Pentagon, the BioIndustry Initiative (BII) at the Department of State, and the recently defunct Nuclear Cities Initiative (NCI) at the Department of Energy—the US Government sought the mutually reinforcing objectives of eliminating a specific weapons production line, creating sustainable jobs, and introducing new technology and industrial capability to the region.

FINDINGS

- Restructuring is a challenging path to commercially sustainable employment.
- State enterprises are not capable of restructuring themselves into commercially viable businesses.
- Commercial restructuring provides the greatest total return on investment for governments because the benefits far exceed the core nonproliferation goals.

National Defense Conversion Program

The National Defense Conversion Program was the first attempt at restructuring former weapons facilities in the FSU. The program exemplified the mixed results of this approach with sporadic success amid widespread failure. The program was administered by the US Department of Defense

and focused on weapons production facilities rather than scientific institutes. Approximately sixteen joint ventures between US companies and the "former" weapons plants were funded through grants of up to US$5.8 million each.[19] Of these, only a handful succeeded (see the case study box below). The lessons from the defense conversion experience were extensive, but were neither well understood at the time nor widely disseminated for the benefit of future engagement efforts.

At a macro level, success was achieved only when the projects went beyond the core nonproliferation rationale of the initial conversion grant. In addition to the primary objective of eliminating a specific weapons production line, successful projects created commercially sustainable jobs and introduced new technology and industrial capability to the region. They also provided extensive training in business management, quality assurance, and quality control. While other nonproliferation programs have tried to engage in similar skills transfer, immediate and productive application of the training for commercial purposes was achieved in only a handful of cases. In one case, as the converted factory grew, it created demand for goods and services that supported other companies in the local economy, thus broadening the economic development impact of the program. Because of the hostile nature of the local business environment, management was constantly advocating for changes in both the laws that affected their operations, as well as how those laws were enforced. Ultimately, in an unforeseen but fortuitous twist, the plant fabricated virtually all of the equipment needed to close a local plutonium-producing reactor in a subsequent nonproliferation project undertaken by the US Department of Energy. Ideally, this sort of synergistic activity should be designed into all nonproliferation programs. Amid widespread programmatic failure of the defense conversion program, the return on investment from one relatively modest US$3 million project grant has been extraordinary.

To replicate the success of this model while avoiding its shortcomings, a number of key issues should be considered. Above all, successful conversion requires a business structure with clear ownership and the managerial expertise and organizational capacity to ensure that the facility's human and material resources are being efficiently engaged in producing value for a reliable stream of paying customers.

As a practical matter, this means recruiting companies that have a strategic reason for entering the former Soviet Union and that make *existing* products or services that can be competitively produced for an *existing* customer base. They must also be assured sufficient ownership of the restructured facility to manage it on a commercial basis. Joint ventures and partnerships with state-owned enterprises or institutes have consistently failed for this reason.

Ownership has proven to be critical on a number of levels. Without complete commercial control, it is not possible for the existing company to operate the venture competitively and therefore have some assurance that the jobs created will be sustainable. Ownership is also important in that the foreign company has something to gain or loose. Ultimately, the greatest value realized by establishing a business is not through its operation but its sale. A company that is building equity is likely to be much more committed to overcoming myriad obstacles to ensure success.

[19] US General Accounting Office, *Cooperative Threat Reduction: Status of Defense Conversion Efforts in the Former Soviet Union*, GAO/NSIAD-97-101 (Washington, DC: GAO, April 1997).

A major challenge for the US Department of Defense team was distinguishing between companies with the requisite capabilities and commitment from those seeking short-term financial gain. When the companies met the criteria above, not only did DoD succeed in taking a weapons plant off the global arms market, but it created strategic value for meeting other foreign policy objectives in nonproliferation and economic development.

BOX 4

BYELKAMIT

Byelkamit is one of the US Government's most successful redirection efforts and is a case study rich in lessons for ongoing and future programs. Conceptually it followed a very simple approach as compared to previous efforts. The US Department of Defense issued an open request for proposal (RFP) to industry for proposals of up to US$5.8 million to establish new business operations in a defined list of former Soviet weapons plants.

Byelocorp Scientific, Inc. was awarded a US$3 million contract in 1995 to convert a Kazakh weapons factory that produced nuclear-armed torpedoes into a factory that would make cryogenic storage vessels for the European industrial gas industry. Unique among all of the Defense Conversion projects, BSI negotiated a 75% ownership stake in the joint venture that was formed between BSI, its Italian subsidiary, Supco Sr., and the Kazakh State Property Committee. Over the next two years, BSI and Supco Sr., which had a long history of fabricating equipment for and erecting refineries in challenging environments such as Iraq and Libya, completely restructured the factory both physically and culturally to produce Western code certified products for existing European customers.

Because of the chaotic nature of a region in steep economic decline following the collapse of the Soviet Union, and the lack of Western code certified materials on the local market, everything that Byelkamit used to fabricate its products had to be imported from Western Europe. To do this, BSI and Supco established their own trucking companies to ensure that materials actually made it to the factory and subsequently, that finished vessels made it back to Italy.

However, BSI did not choose to establish a new factory in remote Kazakhstan in order to export heavy industrial products to Europe. Although labor costs were significantly lower than in Italy, they were not lower than in Belarus, where Supco had another workshop. More importantly, transportation costs (even with its own fleet of trucks) and the endless problems and inefficiencies of establishing a factory in such a hostile business environment made the savings much less than would justify a high-risk venture of this sort. The strategic reason for BSI/Supco to take over the Kazakh factory was the promise of significant growth in Kazakhstan's oil and gas sector due to massive inward investment by multinational oil companies. Restructuring the plant to produce the existing cryogenic product line for European customers prepared the plant to manufacture the more complex and varied vessels for oil and gas processing, and also made it possible to survive long enough to develop this new market, which Byelkamit has done very successfully over the ensuing decade.

These hard-earned commercial accomplishments were only the beginning of Byelkamit's success. From the US Government's perspective, the return on investment achieved went far beyond redirecting the former weapons plant. In an unexpected development, Byelkamit became the primary supplier of equipment for a US Department of Energy nonproliferation project in Kazakhstan, in which a breeder reactor that produced large amounts of plutonium was permanently shut down, while significant volumes of plutonium-bearing fuel assemblies were secured in canisters fabricated at the new factory.

In terms of local development, Byelkamit broke new ground in Kazakhstan. As a large consumer of goods and services, it created demand for local companies that gradually replaced Byelkamit's European suppliers. To ensure quality and efficient production, the company invested heavily in training, creating a cadre of westernized business managers and skilled workers. To mitigate the negative effects of a government in transition, Byelkamit managers organized industry associations and lobbied for legal reforms as well as proper enforcement of existing laws and regulations. In the end, the company became a model of industrial reform and development for the whole region.

BIOMEDPREPARAT AND ALLEN & ASSOCIATES

In stark contrast to Byelkamit is the US$2.7 million Defense Conversion contract awarded to Allen & Associates International (AAI) to form a joint venture with and convert a small part of the Soviet Union's largest bio-weapons production facility, Biomedpreparat, located in Stepnogorsk, Kazakhstan. The plan was to manufacture and distribute vitamins, pharmaceuticals, antibiotics, and pharmaceutical supplies. A few months *after* the contract was awarded, AAI representatives made their first visit to the facility and concluded that neither the existing buildings nor the associated infrastructure were suitable for pharmaceutical production due to previous bio-weapons contamination.

Given the inherent difficulty in renovating the facility to meet international pharmaceutical production standards, AAI decided that there would be no on-site pharmaceutical production. Instead, the converted facility would import and then package the pharmaceutical products produced elsewhere. More than a year after undertaking the project, AAI brought in a third party, ICN Pharmaceuticals, Inc. to provide the technical expertise necessary to carry out the conversion. ICN's role was to prepare a full technical design, provide training in pharmaceutical methods and standards for the Biomedpreparat employees and procure pharmaceutical products for packaging. After this plan was outlined, AAI shipped US$1 million dollars worth of pharmaceutical manufacturing equipment, such as pill presses and packaging lines, to Stepnogorsk. Funds were drawn from the original DoD conversion grant.

However, disagreements between AAI and Biomedpreparat caused continuing problems that made it virtually impossible for AAI to meet its contractual obligations to the US Government. The failure to diversify and break free from the complex partnership doomed the conversion effort. By the spring of 1997 (at which point Byelkamit was fully converted and operating on a commercial basis), the US Government decided to terminate the AAI-Biomedpreparat contract.

The National Defense Conversion Program, launched in the early 1990s, produced a wealth of lessons that can be applied to future sustainable engagement efforts. Regrettably, few of these lessons were absorbed by governments working to develop the redirect programs. Without complete commercial control of the venture, American partners could not operate the ventures competitively, and therefore create sustainable jobs.

Nuclear Cities Initiative[20]

The Nuclear Cities Initiative was established by the United States and Russia in 1998. Until its expiration in 2007, its mandate was to help Russia downsize its nuclear weapons complex by introducing commercial enterprises and redirecting employment in Russia's ten closed nuclear cities. NCI was jointly implemented by the National Nuclear Security Administration (NNSA) and Russia's Ministry of Atomic Energy, which became the Federal Atomic Energy Agency.

Working with the US National Laboratories, NCI attempted to convert large defense production facilities to civilian applications. Developing private industry in these remote regions where access is never assured proved to be extremely challenging. That aside, the goals of NCI were laudable: Both the Russian and US Governments wanted to consolidate weapons-related institutes while avoiding social dislocation and unrest. Unless the underlying financial and employment problems were addressed jointly, the proliferation threat would remain. As noted above, other programs have attempted to freeze nuclear scientists in place by funding them to perform basic science tasks, many of which have no applicability to real-world needs or demands. By contrast, the Nuclear Cities Initiative sought to bring together a variety of commercial activities with other pursuits more familiar to Russia's nuclear sector, including increasing the amount of analytical and development work related to nonproliferation and the environment. Unfortunately, these efforts were doomed to failure as they were forced to engage the target community within their erstwhile weapons laboratories, where they could not benefit from global business leadership. Teaching scientists to become businessmen has never proven to be a viable strategy and is unlikely to bear fruit in the future.

BOX 5

FRESENIUS-AVANGARD TECHNOPARK

In 2001, German-based Fresenius Medical Care, the world's largest provider of dialysis products and services, signed a joint venture agreement with the Avangard Technopark. Under this agreement, a dialysis equipment plant was to be located within the walls of the declassified Technopark. According to the company, Fresenius required invasive access to the facility during the construction phase, and short-term access for maintenance personnel. The company also agreed to provide equipment while Avangard would provide the workforce and the building itself. The Nuclear Cities program at the US Department of Energy agreed to provide funding for infrastructure conversion and upgrades.

After extended delays, the project ultimately failed to launch for three reasons: (1) the Russian Government could not fulfill its access promises to Fresenius because regular, intensive access

[20] The NCI program was subsequently canceled in September 2006 after the agreement authorizing the program had expired.

could not be arranged and short-notice (i.e., 24 hour) access was untenable for the Russians; (2) unknown to Fresenius at the time of the agreement, Russian law prohibits foreign ownership or leasing of property and companies in the nuclear cities. Thus, the joint venture agreed to by all the parties ultimately required a special exemption from the Russian prime minister; and, (3) Fresenius lost its confidence in Russia's ability to meet its commitments and thus terminated the arrangement. In retrospect, Fresenius managers believed that working outside of the fence within commuting distance of the nuclear city of Avangard may have been a workable alternative. Regrettably, Avangard Directors lacked the necessary stature and contacts within the Russian Government to push the project forward.

In sum, despite an innovative approach, due to structural challenges and political difficulties with the program, the Department of Energy's Nuclear Cities Initiative remained a subsidy program for Russia rather than a stimulus for economic conversion and development.

The BioIndustry Initiative

The BioIndustry Initiative was created by Congress after September 11, 2001 in an attempt to engage the private sector and provide effective new models of sustainable job creation. Its mandate is focused solely on biological threats and it works to transition large-scale FSU biological weapons production facilities, their technology, and associated expertise to commercial uses. It also seeks to partner with US researchers and former Soviet biological and chemical weapons scientists to develop and accelerate the production of vaccines for infectious diseases that affect the FSU and the world.[21] The central priority of BII is the long-term transformation of existing facilities into viable research and production institutions. BII's approach is to engage specific institutes, assess their core capabilities and the appropriate domestic and international markets, and then pair Russian laboratories with American researchers in both academic and industrial sectors. It is anticipated that, in 2008, major commercial reconfiguration projects such as the dismantlement of biological weapons production buildings and conversion to an animal feed mill at a former weapons facility in Georgia will come to fruition, thus testing the viability of the BII model.

BOX 6

JOINT-STOCK COMPANY VOSTOK AND THE BIOINDUSTRY INITIATIVE

Since the establishment of BII, the initiative has met with some success. Whether this success is commensurate with the sizable financial investments made by the US Government remains an open question. Created in 1969 under the authority of Biopreparat, Joint-Stock Company Vostok was designed with a large fermentation capacity for the production of industrial enzymes, pharmaceuticals, and infusion products. "To achieve long-term sustainability of this facility, BII and Vostok began a joint effort to analyze the marketing environment to determine how to best utilize its manufacturing capabilities and resources."[22] Vostok is currently working with BII, the ISTC, and an

[21] BioIndustry Initiative, "About the Initiative: History," accessed at: <http://biistate.net/docs/about.php>.
[22] US Department of State, "Fact Sheet: BioIndustry Initiative."

American biotechnology company to enhance its capacities to produce and extract enzymes, and to make those enzymes more stable.[23] The early successes at Vostok indicate the benefits of *private sector market analyses* at the front end of collaborative scientific efforts. Still, the expense of upgrading existing facilities to redirection efforts—particularly for pharmaceutical production—can be exorbitant and thus result in the ultimate failure of the project.

In sum, BII has taken largely positive steps toward private sector engagement and sustainability. However, it continues to focus on collaborative research and restructuring former institutes to become commercially sustainable enterprises. Previous efforts have shown, and major pharmaceutical manufacturers agree, that both political and technical hurdles to conversion are far more substantial than even "green fields" efforts. In addition, it is not yet clear how engaging in joint research or marketing former BW scientists and institutes to Western companies will systematically produce sustainable jobs.

In conclusion, as with the research and technology development approach to scientific engagement, the US Government restructuring programs—Defense Conversion, NCI, and BII—yield important lessons for future (sustainable) engagement efforts. First and foremost, they have shown that ownership is a critical element for success. When it is not clear and sufficient to ensure full commercial control of the enterprise's activities, then restructuring projects will quickly fail, frustrating the sustainable redirection goal. In addition, previous efforts show that there must be sufficient managerial expertise and organizational capacity to ensure that the facility's human and material resources are efficiently engaged in producing value for paying customers. Moreover, there must be strategic reasons for Western companies to establish operations in the FSU if they are to employ former WMD scientists locally. This is a critical element in isolating truly committed corporate partners from those merely interested in lucrative government contracts in their own right. Finally, companies entering the FSU should have existing products for existing customers in order to reduce the challenges associated with restructuring state-owned enterprises and increasing the likelihood of long-term success.

The Role of the Private Sector

While these programs continue to serve legitimate nonproliferation goals, they are no longer able to fully address evolving challenges or take advantage of new opportunities.

Existing engagement programs have largely succeeded in their immediate goal of nonproliferation, but have failed in their attempts to restructure state-controlled institutes to provide for sustainable employment. These existing programs were developed in an era of national crisis across the FSU. To meet the emerging "brain drain" threat, the international community developed a patchwork of programs whose immediate intent was to account for the whereabouts and activities of former weapons specialists. Prior engagement efforts were designed to keep specialists at their laboratory benches in their former weapons institutes, not to create sustainable jobs in the private sector that would also allow for the gradual rationalization of the bloated infrastructure of state-owned institutes. Unable to provide enduring solutions, these programs were not capable of

[23] BioIndustry Initiative, "Joint-Stock Company Vostok (JSC Vostok)," accessed at: <http://biistate.net/docs/profiles/vostok.pdf>.

addressing the systemic problems in the host states that ultimately drove the proliferation threat at the time of program inception. Efforts were conceived and launched amid the crisis of a crumbling WMD empire. Questions of sustainability were not—and could not—be systematically addressed in the face of this immediate threat. Immediate attention had to be paid to engaging the target community. Today, the effort to build sustainability into existing programs has been a challenge because of structural inflexibilities within the ISTC, the STCU, and the bilateral programs of the US Government (IPP, BCR, and BII). While these programs continue to serve legitimate nonproliferation goals, they are no longer able to fully address evolving challenges or take advantage of new opportunities.

Sustainable redirection necessitates a transition from government investments in scientist engagement to private sector investments in business development. To ensure sustainability beyond the funding horizon of existing US/G8 programs, new models of engagement must seek to build long-term partnerships with the private sector. This cannot be achieved without market-based incentives that motivate private sector interests in the near-term and help secure their financial investments in the long-term.

To gain the collaboration of the private sector, the risks to entrepreneurs must be mitigated to a sufficient level. In short, industry must be coaxed into participation during the early stages of project/business development.

Given the limits of existing instruments, a model of engagement must be developed that identifies industry as an "employer," rather than a customer. Sustainable employment cannot be achieved until the private sector is convinced of the enduring value of the target community's talents and skills. By making this critical link, governments can ultimately begin to transition the target community from state grants to private sector payrolls. Existing efforts fail to introduce industry and other stable employers, seeking instead to pair private companies or government researchers with former weapons scientists in client/researcher relationships.

While studies have shown that the scientific community in the FSU possesses skills and capacities of commercial interest to the private sector, barriers to business development in the region are significant. Furthermore, the perception in private industry of Russian Government obstructionism in particular has further inhibited economic development and foreign investment. In light of recent high-profile cases of government interference in Russia, such as the Aerostar Hotel affair, motivating private sector involvement will become increasingly challenging.[24] To gain the collaboration of the private sector, the risks to entrepreneurs must be mitigated to a sufficient level. In short, industry must be coaxed into participation during the early stages of project/business development.

[24] The Aerostar Hotel was owned by AeroIMP, a joint-venture between IMP Group, a Canadian company, and Aeroflot Airlines. In 2004, AeroIMP management was evicted by a private, armed security force hired by Aviacity, a Russian company that alleged it had property rights to the building. See: Kim Murphy, "Russian Capitalism Has Muscle Behind It," *The St. Petersburg Times* (July 5, 2005), accessed at: <http://www.sptimesrussia.com/index.php?action_id=2&story_id=141>.

Some of the most successful and sustainable redirect efforts have occurred when scientists from the former weapons institutes were drawn out of these state-run facilities and absorbed into Western private sector companies (see QED case study above). Due to personal and political sensitivities, as well as global economic development needs, programs that promote peaceful brain drain to the West are infeasible. The introduction of private sector companies based in the region is the next most cost effective model for sustainable redirection outside of the former weapons institutes. But market conditions for domestic industry in the region have yet to develop a robust private sector capable of absorbing sufficient numbers of scientists from the target community. Nor do many existing companies in the FSU possess sufficient markets to provide an existing client base for sustainable redirection. While this remains a long-range strategic goal, the needs of near-term sustainable redirect cannot be fully met by *incentivizing* existing private sector companies in the FSU. As such, foreign companies must be introduced into the region to ensure viable, sustainable redirection, while encouraging incremental improvements in the rule of law and global economic development.

The proposed model of engagement is not, however, a panacea. Innovative and sustainable redirection models will only address a portion of the target population. Research capacities in the states of the former Soviet Union, like the West, span a broad range of skill sets and applications. Similarly, the target community is composed of a wide array of individuals whose interests, both personal and professional, vary greatly. Many of these individuals will not be interested in seeking sustainable employment outside of their home institutes. And while some will be valued to such an extent by the host government that they will not be allowed to leave, others will not possess any talents that are directly marketable by private sector companies.

Ultimately, the process of down-selecting individuals from the target community whose skills and talents are readily transferable to commercial application will promote an additional benefit to ongoing redirection programming. Step one will involve the categorization of skills into commercially “employable” and “non-employable” groupings. Those that are not readily attractive to the private sector will remain within the existing STC system, provided their skills remain of proliferation concern. Those that are considered “employable” should, in turn, have the option of exiting their institutes to seek work within the private sector. If, as is anticipated, some individuals are not permitted to leave their home institutes by their host government, Global Partnership contributors can then offload these individuals from the target list and concentrate their resources on those that remain a proliferation threat.

Leveraging the Legacy of the Soviet Weapons Complex

All of the programs and participants surveyed agreed that the universal failing of prior and existing redirect efforts is the indelible connection of redirect funding to existing government institutes. The goals of redirection at government-operated institutes and the development of commercially sustainable efforts are mutually exclusive. Russian law and institute structures provide no effective legal mechanism for spinning off these efforts into viable sustainable enterprises and in the absence of ongoing government funding, sustainable engagement with the West is unlikely.

The principal impediment to the successful conversion of former weapons facilities in Russia remains structural. The Russian Federation inherited from the Soviet Union the world’s most militarized

economy, which for almost half a century planned and prepared itself for a protracted world war. War plans demanded massive material resources, including an unmatched and redundant nuclear infrastructure and a well-planned, colossal mobilization capacity for biological weapons. The Soviet nuclear complex comprised ten so-called "closed cities" across Russia with hundreds of thousands of inhabitants living amid questionable environmental conditions. The BW infrastructure consisted of a network of highly specialized and vastly oversized facilities that faced no expectation of meeting pharmaceutical production standards. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) govern all aspects of Westernized production and, therefore, far exceed the kind of standards used in former BW facilities.

Throughout each prior effort to convert *existing* facilities in Russia, critical elements of the above-mentioned system have continued to dominate state and institutional thinking in Russia. Mobilization requirements engrained in existing institutes have prevented the conversion of existing premises. Across all state-owned weapons institutes, privatization efforts based upon conversion of existing state-owned machinery and equipment, the labor force, and facilities more generally have been prevented from using military technology for civilian purposes. Furthermore, many facilities remain remote, far from potential markets and often inaccessible to profitable modern commerce. In addition, the leadership at Russian institutes is not accustomed to solving problems of distribution of products and marketing. Building on existing facilities not only requires investments that generally far outstrip that required for "green fields" efforts, it further requires a sea change in attitudes at the leadership level in the Russian institutes. Commercialization outside of the complex would eliminate the overhead garnered by the leadership at these institutes from existing programs. While defense conversion in most Western countries meant that land, premises, machinery, labor force, etc. was sold or moved, this has not been the case in Russia. Finally, an additional problem faced by previous efforts is the inability to guarantee that there was no residual contamination from previous production that could give rise to onerous liability claims. This is particularly important in the case of former BW facilities.[25]

Learning the Lessons of Scientist Redirection

The model of engagement builds upon the concepts developed by previous efforts and avoids the obstacles that ultimately prevented their realization. From a business perspective—one that is critical for any sustainable nonproliferation job development strategy—the authors drew the following five lessons to shape future engagement efforts from previous (successful) redirect efforts:

Minimize legal hurdles within the host state by avoiding engagement through traditional employers in the region: It is generally understood that the existing complex of former weapons institutes is in excess of current and projected government demand. Existing engagement efforts, despite an occasional focus on "graduation" of facilities, has not promoted either by design or as a by-product, the rationalization of this bloated infrastructure. To the extent possible, employment should be encouraged outside of the government-funded complex.

[25] Sonia Ben Ouagrham and Kathleen M. Vogel, "Conversion at Stepnogorsk: What the Future Holds for Former Bioweapons Facilities," Cornell University Peace Studies Program, Occasional Paper #28 (February 2003).

Develop a new mechanism for the sponsoring governments by which resources can be used to "incentivize" local commercial initiatives more directly, thereby encouraging matching investments from the private sector both in the region and in the West: Even where the US and other governments have attempted to involve the private sector, industry participants generally have agreed that collaboration with the United States and other Western governments—to say nothing of FSU governments—is bureaucratic, expensive, and seldom worth the time, energy, and resources. Under these circumstances, it is extremely difficult to encourage a significant investment of private resources. A new streamlined approach is necessary.

Tap existing private sector markets to ensure prompt access to capital, rather than expending government resources to create new markets and products: The vast majority of new businesses fail. This idiom is as true in the United States as it is in the states of the former Soviet Union. Tapping existing markets will help elevate success rates and avoid costly and potentially disastrous "market fishing" schemes.

Recognize that emerging markets mean high risks and low returns and that, therefore, new markets must be guaranteed through long-term government contracts (or other market guarantees) with the goal of evolving into other commercial products: Businesses, like governments, are naturally cautious. To increase the likelihood of success, any suitable government program or instrument should be leveraged. Using incentivized businesses in the FSU to provide goods and services being purchase by other government agencies is a logical step toward cutting costs and promoting success.

Transfer management of the emergent venture as quickly as possible from a state's parties to commercial players, allowing for appropriate but not restrictive levels of government oversight: Government program managers, more often than not, are bureaucrats, not businesspeople. Time and again, redirect efforts have failed due to an unwillingness to tap appropriate expertise to meet targeted challenges. While oversight is necessary to protect against fraud, as quickly as is practicable, business specialists should be overseeing the operation of the business.

— 3 —
A NEW APPROACH: EXPANDING RESOURCES TO MEET GLOBAL CHALLENGES, PROMOTE ECONOMIC DEVELOPMENT, SUPPORT INNOVATION, AND PREVENT PROLIFERATION

Given the inability of existing engagement efforts to sustainably redirect the target community, Global Partnership and other contributing countries should leverage resources to develop and demonstrate a new model that proactively creates employment in the states of the former Soviet Union. Ideally, this effort could ultimately become a conduit for redirecting and more productively utilizing G8 nonproliferation funds, while also advancing progress on global nonproliferation, public health, energy, global economic development, and other domestic and international policy goals.

Defining "Employers"

Recognizing the absence of the necessary managerial capability and capacity in existing programs, the first step must be to recruit industry as an employer, rather than a customer. For purposes of program implementation, there are essentially two categories of employers:

1. Companies currently operating in the states of the former Soviet Union; and,
2. Western companies that will have to be brought into the region.

The first group is small due to the nascent state of private sector development throughout the post-Soviet economies. Because they are already operating locally, however, those that do exist and that are capable of effective management should be relatively easily and inexpensively engaged as employers. A survey of companies that could make productive use of former weapons scientists could be accomplished quickly and would provide a clear sense of the potential for, and costs associated with, turning them into employers.

The second group is much larger and, generally speaking, will have greater organizational capacity to make efficient and productive use of the target community. This group will have extensive networks of customers and suppliers in developed markets, which is important to both the viability and sustainability of the effort as a whole. However, it will be more expensive to engage these companies as employers because of the need to help them establish new operations in the region. Nevertheless, there is little or no opportunity cost to utilizing limited resources for this purpose, as compared with continuing to disperse funds through the existing programs, as the latter are only infrequently producing sustainable employment opportunities for the target community.

Western companies that would have an interest in former bioweapons scientists, for instance, are most likely biotech companies, which will be fairly easy to identify and engage. Determining their level of interest and the types of incentives that they will require to establish subsidiaries in the FSU will be more time-consuming. The biggest challenges will be in ensuring that they have a strategic reason—apart from incentives—for doing so and mitigating the risks of failure. Of course, existing US and multilateral programs including the STCs and IPP, other organizational efforts from the US Civilian Research and Development Foundation (CRDF) to the Center for Integration of Medicine and Innovative Technology, as well as private equity and venture capital firms have conducted much of this spade work. Any new program should seek to leverage these efforts, rather than reinvent the wheel.

Mitigating Risks

Ultimately, the risks for the private employer as well as Western governments must be mitigated to the greatest extent possible. To this end, bringing additional stakeholders into nonproliferation programming—such as the Defense Advanced Research Projects Agency (DARPA), the US Agency for International Development (USAID), NIH, CDC, FDA, EPA, and USDA in the case of US programming—will not only provide a wider menu of incentives for private sector participants at the front end, but will also reinforce nonproliferation programming by building in potential clients for goods and services at the back end. For example, DARPA, NIH, and USDA all have an interest in tapping into FSU phage research. DARPA is sponsoring an airborne pathogens sensor that requires strains of anthrax-responsive phage, while NIH and USDA are interested in developing novel alternatives to antibiotics for treating infections in both humans and livestock. All of these agencies have grant-making and contract research programs that involve US biotech companies in an effort to meet these goals.

As noted, the involvement of other government agencies has two values from a program management perspective. First, wider participation increases the financial resources available to the company/employer. Even more importantly, wider participation helps validate industry participation by demonstrating a real market for the scientific expertise that the company is acquiring. It further increases the motivation and commitment of the company to ensure success of its new FSU operation.

Over time, as the field of candidate companies is broadened beyond the Global Partnership countries, the opportunities and overall benefits to the program will increase significantly. Though it would require more time and effort on the part of project managers, the benefits could be significant.

Despite the challenging business environment in the FSU, foreign investment in the region is rising dramatically. In Russia for example, where some of the most public cases of state-industry clashes have occurred lately, the economy received $55.1 billion in foreign investment in 2006, a 2.7 percent increase over 2005 levels. Cyprus, the United Kingdom, the Netherlands, Luxembourg, Germany, France, the Virgin Islands, Switzerland, and the United States were the largest investors in Russia,

accounting for 84.8 percent of the country's total accrued foreign investment and 85.8 percent of total foreign direct investment. Accrued foreign investment in Russia totaled $142.9 billion in 2006.[26]

Accessing these markets and engaging the companies that supply them as employers can dramatically increase the base of prospective employers. After the model has proven to be effective, then its extension beyond G8 redirect programming is possible. The model of private sector engagement could be further translated beyond global nonproliferation objectives toward the direct support of economic development needs in other regions.

Recruiting, Selecting, and Enabling Employers

Prospective employers should be identified through an ongoing process of outreach through existing nonproliferation programs, industry associations in both the FSU and other G8 contributor states, nonprofit science and technology (S&T) development ventures, and potentially in a less targeted way through the issuance of requests for proposals.

Again, much of the groundwork has been laid through existing G8 engagement programs as well as through a variety of private organizations and investment funds. Once identified, companies should be carefully screened for the attributes that have proven to be critical for success in previous and existing programs. At a minimum, these include having a strategic reason for establishing an operation in the target country, sufficient managerial expertise and capacity to manage such an operation, existing products or services to be produced there for existing customers who can reasonably be expected to pay for them, and the financial resources to be in business without participating in this program. It is also important to ensure that the companies have sufficient ownership of the new ventures to exercise effective commercial control.

To mitigate the risks of failure, a number of steps should be taken to reduce the challenges the companies will face. Incentives will be the core mechanism for recruiting and enabling the employers. These can take a wide variety of forms, from cash grants and the provision of equipment to subsidized or forgivable loans. They should not, however, be the sole focus of the program. To the degree that bilateral inter-governmental agreements are put in place, they should ensure that the Western companies have the right to sufficient ownership of the new ventures, that they will be protected from governmental manipulation and criminal activities, and to the degree possible, that they will enjoy the most advantageous trade and tax regimes possible.

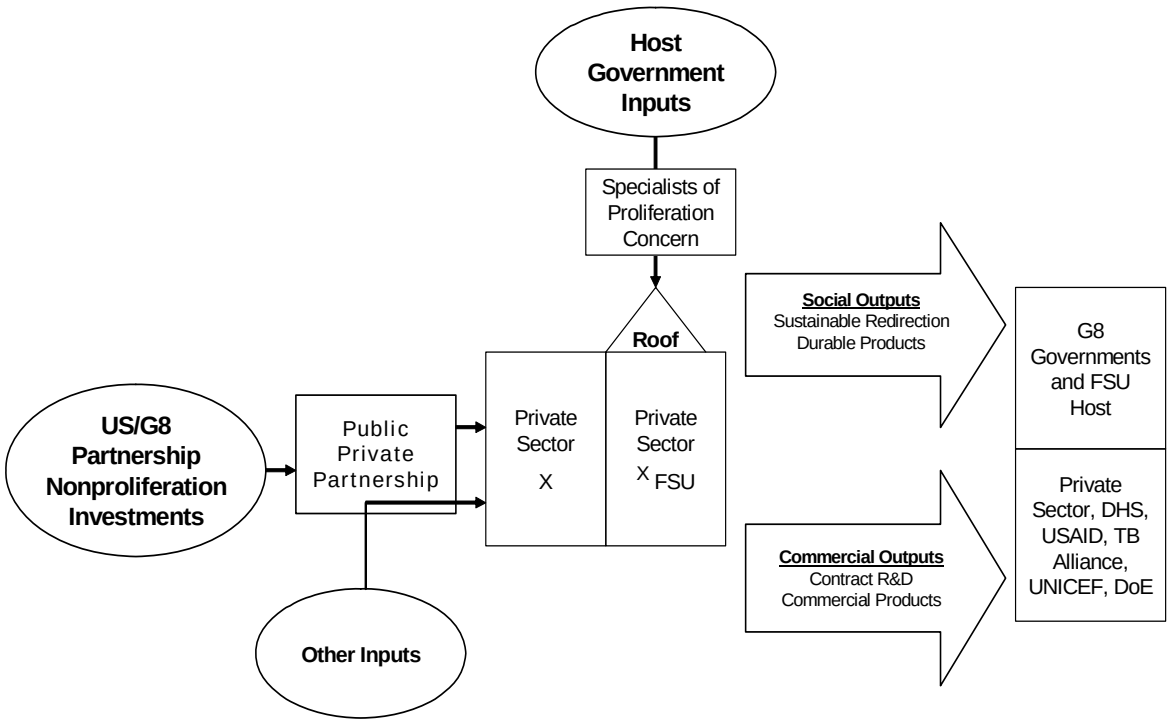
Finally, in the case of smaller and medium-sized companies such as emerging biotech ventures, it would be sensible and likely economically beneficial for both government donors and for industry partners to establish some sort of core R&D facility. Such a facility would allow the companies to share resources, particularly in the early stages as they set up their ventures and learn how to conduct business in the former Soviet Union. Such a facility could provide laboratory and office space, the legal and administrative resources needed to establish a new company in the host country, recruitment of staff other than the redirected scientists, local procurement, customs and logistics support, as well as expert advice on tax, regulation, and other legal issues.

[26] David Johnson, ed., "Foreign Investment in Russia $143 bln in 2006, up 28%, y-o-y," *Johnson's Russia List* #25 - JRL 2007-47 (2007), accessed at: <http://www.cdi.org/russia/johnson/2007-48-25.cfm>.

A core facility would also afford the overall program with greater flexibility in negotiating terms with prospective employers. As an alternative to offering capital grants that would pay for equipment and start-up costs, the program could agree to provide operational funding in decreasing amounts over a period of, for instance, three to four years. Instead of building its own facility, the company would lease space and assume an increasing percentage of the operational costs over time. A variety of approaches will be necessary, and the more flexibility the program has regarding the terms and mechanisms by which it can reduce risks to the companies, the better.

Below is a depiction of the basic model of "sustainable engagement" that we propose:

FIGURE 3



US/G8 Global Partnership Nonproliferation Investments

The model is driven by the nonproliferation goals of the G8 Global Partnership. While under pressure, annual G8 redirect appropriations for scientific engagement are substantial. In the past five years, more than $630 million have been appropriated for these engagement efforts across the Global Partnership. A portion of these resources should be taken, possibly combined with matching funds from host governments where possible, and then funneled through a discrete funding mechanism designed to temporarily subsidize targeted researchers for their work in the private sector.[27]

[27] While host government investment has been the exception rather than the rule, recent investments by the government in Kiev in the Science and Technology Center in Ukraine suggest that a reconfigured engagement effort based upon "collaboration" rather than "threat reduction" could stimulate joint investments in technology commercialization.

Public-Private Partnership

A new Public-Private Partnership capacity should be established to manage government nonproliferation investments. This PPP would provide broad-based portfolio management by "investing" resources in those private companies that are willing to sustainably employ the target population. The PPP would be responsible for conducting due diligence on behalf of all government client(s) (i.e., State Department, Department of Energy, Department of Health and Human Services, Department of Agriculture, US Agency for International Development, etc.) to ensure the long-term integrity and viability of private sector participants and their research objectives for leveraging the scientific capacity in the region. The partnership would also be responsible for interfacing with and coordinating the participation of industry, academic partners, and other contractors.[28]

Other Inputs

While nonproliferation investments through this framework are critical, they are ultimately short-term because the Global Partnership will sunset in 2012. As such, the nonproliferation agencies must develop additional "clients" during the next five years to ensure a level of sustainability after nonproliferation funding evaporates. In the case of bioscientist redirect, for instance, that target community may range from other national governmental agencies (see above) and other international public health and development agencies (the World Bank Group, UNICEF, WHO, PAHO), to existing Public-Private Partnerships dedicated to mitigating the threats of neglected diseases (IAVI, TB Alliance, MVI, PATH). Additional private investment (venture capital) could also be sought to support the growth of a biotech cluster seeded through this program. Recognizing the unique capabilities resident within the scientific communities of these countries, several major American investment houses, including Baring and Draper Fisher Jurvetson, have recently introduced innovation funds for the states of the former Soviet Union. Other functional scientific specialties will appeal to an even wider array of agencies and organizations in the nuclear, chemical and missile fields. These specialties open a wealth of potential collaborative opportunities in the fields of renewable energy, national security and countermeasure product development and services, medical device innovation, environmental remediation, and so on.

[28] The effective implementation of the model will require oversight by a fund manager and coordinator (PPP). An appropriate organization with the requisite regional and functional experience to fill this position for quick implementation is the US Civilian Research and Development Foundation (CRDF). Authorized by Congress in 1995, CRDF is a public-private partnership whose mission is to support international scientific and technical collaboration through grants, technical resources, and training. Today, much of CRDF's mission is devoted to strengthening research in science, health and industry across the states of the FSU, Middle East, North Africa, and South Asia, moving their scientific development toward more sustainable and productive employment. [See United States Civilian Research and Development Foundation, "Overview," About CRDF (2006), accessed at: <http://www.crdf.org/about/>]. CRDF has fewer bureaucratic hindrances and much greater independence in program implementation than existing government programs. Its not-for-profit status and independent bilateral agreements with various governments in the FSU free it from the legal restrictions and suspicions that governments, private businesses, and other NGOs face against foreign investment. Its enviably flexible mandate has made it one of the most efficient and successful operational entities within the suite of US nonproliferation programs. It would serve US interests to capitalize on the experience and knowledge of CRDF as the US institutionalizes private sector engagement in its nonproliferation policy.

Host Government Inputs

Coordination and matchmaking with domestic scientific talent would become the responsibility of the private sector under the supervision of the PPP, which would ultimately answer to the contributing government authorities. Therefore, the responsibility of the Host Government first becomes: a) the release of targeted scientists from state-run institutes; and, b) the provision of a "roof"— a clear sustained signal to both lower levels of government and potentially corrupt local regulatory officials not to manipulate or harm the companies established under this program. In addition and where feasible, Host Government matching funds will be sought to ensure buy-in of the proposed PPP model.[29] As economies have developed during the past decade, many countries are now better suited to become true financial partners in joint development and operation of the program.

Private Sector X

Interested private sector firms would make a single application to the Public-Private Partnership. The PPP would coordinate funding from across the range of participating grantors to develop a targeted incentives package for each successful down-selected applicant. In exchange for defined incentives, the private sector company would be obligated to employ specific individuals who qualify for redirect support because of their WMD expertise. Due to the embryonic state of the private sector within the states of concern, in most cases we anticipate that industry within contributing states will form the lion's share of ventures—at least initially. This does not, however, preclude local firms within the host state from successfully bidding on redirect funding from the PPP. In fact, financial contributions from host governments and potential host country industrial partners are presumed to increase throughout the life of the PPP's focus on any given target population.

Private Sector X_{FSU}

Recognizing the limited pool of private sector talent resident in the host country, and recognizing that various permutations of business models can be applied successfully, we anticipate that the majority of cases will involve establishing FSU subsidiaries of the US companies that hire the redirected specialists. Again, this initial likelihood would eventually give way to a competitive sector within the host country.

Outputs

- *Social*: Social outputs are the "goods" directly and indirectly produced by government incentives. The primary social output of these programs should be the permanent redirection of former WMD specialists into commercially sustainable jobs—nonproliferation. Because this requires the introduction of new companies into the FSU, other "goods" should naturally emerge as a by-product of the effort: broader economic development and expansion, professional training, adoption of international quality control standards and management techniques, advocacy for additional internal economic reform, increased demand for local goods and services, new business creation due to this increase in demand and to spin-off activities, and new technology development.

[29] Per the earlier "lesson" on the necessity of private ownership (see page 32), care must be given to ensure that industry ownership of the facility and control over its human capacity is not diluted as a result.

- *Commercial*: Commercial outputs are the real goods and services that ultimately justify and finance the long-term employment of redirected specialists. These outputs are critical to the success of this model. Without the provision of viable products to a paying client base, sustainable redirect will never be achieved. These products can also be marketed to a broad array of national and international agencies providing not only potentially discounted new sources (over time), but also expanded capacity for commercial research and consumer products.

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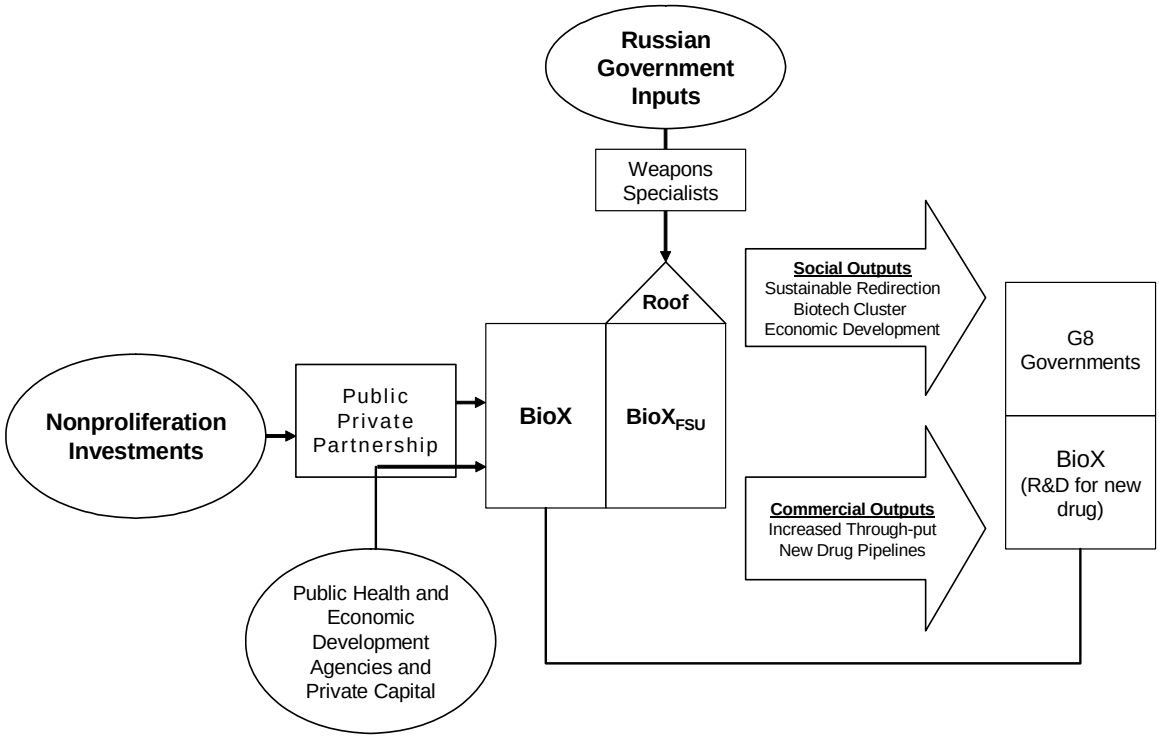
CASE STUDIES: OPERATIONALIZING THE MODEL OF SUSTAINABLE ENGAGEMENT

In an effort to operationalize the proposed model, The Henry L. Stimson Center began exploratory discussions with various Western government agencies and private sector companies to identify illustrative pilot efforts. The following three case studies detail efforts that leverage the private sector as well as cross-sectoral government interests. Due to sensitivities within the private sector and the need for balance from a government perspective, the Center has redacted the names of the private sector companies described below.

Western Subsidiary Development in Russia: Case One—"BioX"

FIGURE 4



The company referred to as BioX is a small Western biotech firm that has a significant pipeline of drug targets identified and at various stages of development. Its most advanced target is nearing Phase 3 clinical trials. The company is well capitalized, having recently completed a third round of venture funding, giving it sufficient capital stock to see multiple drug targets through Phase 3 trials

over the next five years. At present, all operations are in a single state, although the management team is currently considering a modest expansion of capacity into another Western country.

Generally, BioX is not a company that would likely engage in a high-risk venture employing former BW specialists in the FSU. Yet, because BioX is well capitalized and has an extensive pipeline of target drugs to work on, its most sensible path forward at the moment is to concentrate all of its human resources on bringing the most promising targets in this pipeline to market as quickly as possible. Its biggest risk under the current situation is a distracted management team.

Although its tolerance for risk is necessarily very low, BioX is interested in the suite of government-funded efforts designed to engage capacity in the states of the former Soviet Union. Moreover, it is interested for the best possible of reasons: the quality of science available. The lead scientist at BioX is among the foremost Western experts in his field and recognizes comparable talent in a Russian colleague who still works within the walls of one of that country's former weapons institutes. In principle, BioX could hire the Russian scientist away from the institute and resettle him in the West. However, BioX management believes that he can potentially be even more productive by remaining in Russia, where he can maintain his own team at a fraction of the cost necessary to have them emigrate to the West.

BioX perceives three benefits that could be achieved by establishing a subsidiary in Russia:

1. Increasing the through-put of drug target assessment, thus accelerating the potential to bring a drug to market;
2. Potentially adding a new pipeline based on the Russian scientist's knowledge; and,
3. Potentially acquiring a lower cost production facility that could reduce current costs and therefore give them more time to achieve a greater number of hits.

Benefits

The primary nonproliferation benefit of engaging BioX to establish a Russian subsidiary is that the company would be hiring a top Russian scientist and his team of roughly a dozen former BW specialists out of their erstwhile weapons institute. If the Russian team's value is established in the first few years, their continuing value to BioX will be considerable; and, as long as BioX achieves some measure of financial success in the timeframe provided by the existing private capital stock, it will have both the means and motivation to continue to employ the Russian team indefinitely.

If the venture matures as planned, it has the potential to provide additional employment and training in both technical fields as well as in business management, and to create new markets for other local companies by the provision of goods and services needed for the venture's operations. In addition, the venture will inevitably advocate for improvements in governance as it impacts business operations and value.

Risk and Challenges

The cost of engaging BioX will be relatively high for two reasons. First, the risk to BioX of dispersing management attention by undertaking a Russian venture is very high, so it will have to be

at least cost-neutral to BioX. This means that government subsidies will have to fund essentially the entire venture in the early years. Second, although the labor costs are modest, the capital equipment costs will be significant. For this reason, a core facility capable of providing rented space to BioX could make sound financial sense for both industry and the host and donor governments.

BioX's business model offers both advantages and disadvantages in terms of sustainability. On the one hand, its capital base means that the risk of going out of business over the next five years is extremely low. Provided its Russian subsidiary remains cost-neutral or demonstrates sufficient value to justify raising additional capital, the redirected scientists will enjoy secure employment for this period while learning how to manage and function in an internationally viable, Western-managed biotech company. On the other hand, the long-term viability of this employment depends on BioX's success in bringing a drug to market and securing the revenue commensurate with that process, or at least, in raising additional capital in five years through another round of private equity financing or an initial public offering.

Risk Mitigation

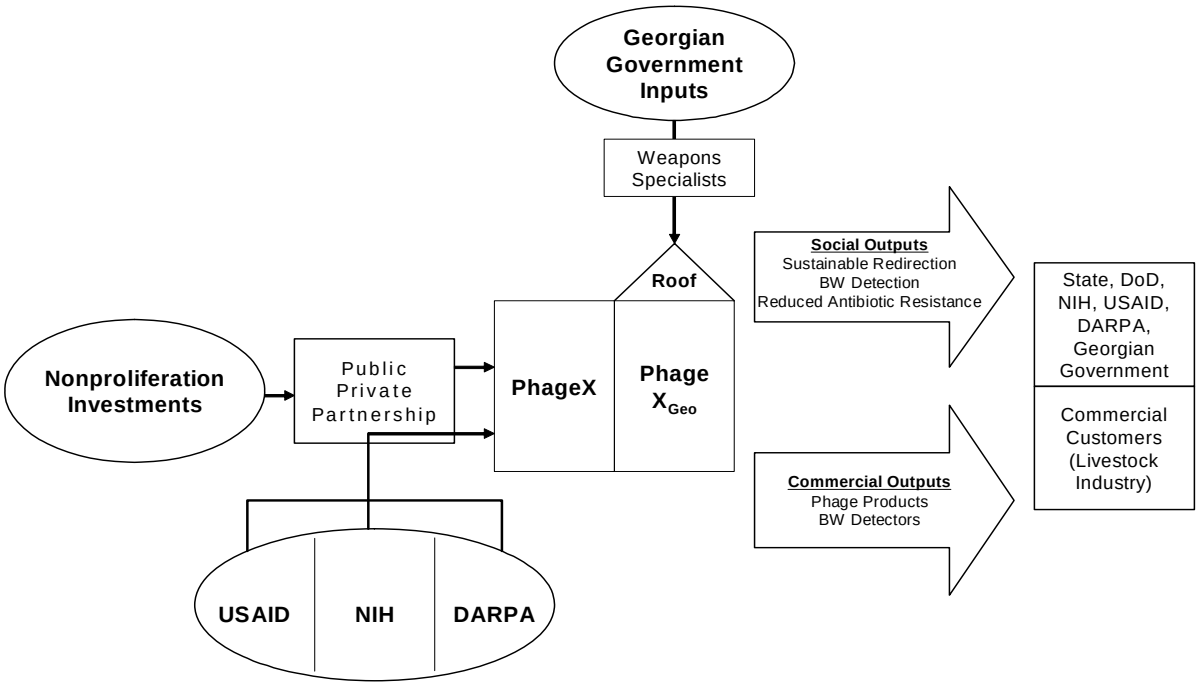
As noted, a core biotech facility established for use by a number of nonproliferation funded enterprises could reduce BioX's capital and operational expenses by sharing both infrastructure and administrative services. By clustering enterprises like BioX, it would also provide redirected scientists with an opportunity to market themselves to other tenants or to "angel" investors in the unlikely event that BioX does not survive.

Project Implementation

Following the proposed model depicted above (see Figure 4), G8 governments would contract the Public-Private Partnership to work with BioX and other government agencies to develop a business plan and funding profile for a BioX subsidiary in Russia. The steps taken during project implementation would depend in large part on the degree of confidence and speed with which BioX wants to proceed. One possible scenario might begin with a fact-finding trip to Russia by company managers. However, in the BioX case, a specific Russian scientist has already been identified and there is a high level of confidence that he or she is capable of directing new BioX research in Russia. Therefore, as a logical first step, the PPP would negotiate a research fellowship from national health research organizations (i.e., NIH) or another interested agency that would allow the Russian scientist(s) to spend a year at BioX headquarters in the West. Having the scientist work at the Western parent facility has the merit of determining his/her value, capabilities, and compatibility of being an employee of BioX and a key manager of a Russian subsidiary. It also allows BioX to provide targeted training in management practices specific to its business, thus laying a stronger foundation for starting a new venture in Russia.

At some time during the course of year one, or immediately afterwards, BioX and the Russian scientist(s) would prepare a business plan and funding proposal for submission to the PPP. If the PPP accepts the proposal, then BioX would be contracted to execute the business plan, bringing in the full Russian team and starting up the new venture.

Western Subsidiary Development in Russia: Case Two — "PhageX"
FIGURE 5



In this scenario, the role of other government agencies is more pronounced. Western governments and their institutes for health research (such as NIH) have identified phages as a potential alternative to antibiotics and are providing significant funding to encourage more robust research in this area. Simultaneously, defense research institutes (like DARPA) across the G8 have sponsored research into the use of anthrax-sensitive phages in sensors to monitor airborne pathogens. Many of these defense funds leverage significant financial resources each year for private sector research to meet the scientific and technological needs of Western defense departments.

Unlike the research underway at BioX, which is based on the insights and expertise of Western scientists, knowledge of phages is very limited in the West. Due to significant ongoing investments throughout the Cold War, the former Soviet Union holds the lion's share of global expertise in phages. There are, nevertheless, a number of Western companies engaged in developing a fairly wide range of applications of the phage.

This Western company that we will call PhageX is interested in the expertise of the Russian, Georgian, or Ukrainian scientists, but is also looking for additional strains of phage that will be useful in developing a sensor capable of detecting anthrax and other airborne pathogens. Again, because the FSU is the world's best source of expertise and well documented strains of phage, both the public health and national security agencies of governments have a direct and active interest in supporting activities that increase the flow of expertise and materials from the FSU to the West. Western institutes for health research, such as NIH, can fund fellowships for phage specialists to conduct research at PhageX as part of a wider collaboration between the company and a Western university

laboratory. Defense research funds from organizations such as DARPA can provide direct support to PhageX's efforts to develop an airborne pathogen sensor using FSU expertise and phage strains—all at subsidized rates based upon the nonproliferation investments made by Western redirection accounts.

Benefits

Not only do these other government programs increase the resource base available to develop the case for and establish a PhageX subsidiary in the FSU, they also provide ongoing demand for the company to make productive use of competent scientists in the region. Success with NIH-funded research may lead to novel treatments for antibiotic-resistant infections or an ability to reduce the use of antibiotics to postpone the development of resistance. For the defense community, success would provide the donor government, and in principle, the entire world, with a way of more quickly or accurately recognizing and responding to a bioweapons attack. Having a Western company establish a subsidiary in the FSU that can capture some part of this knowledge and materials base would be a very effective way of building a bridge to support this flow.

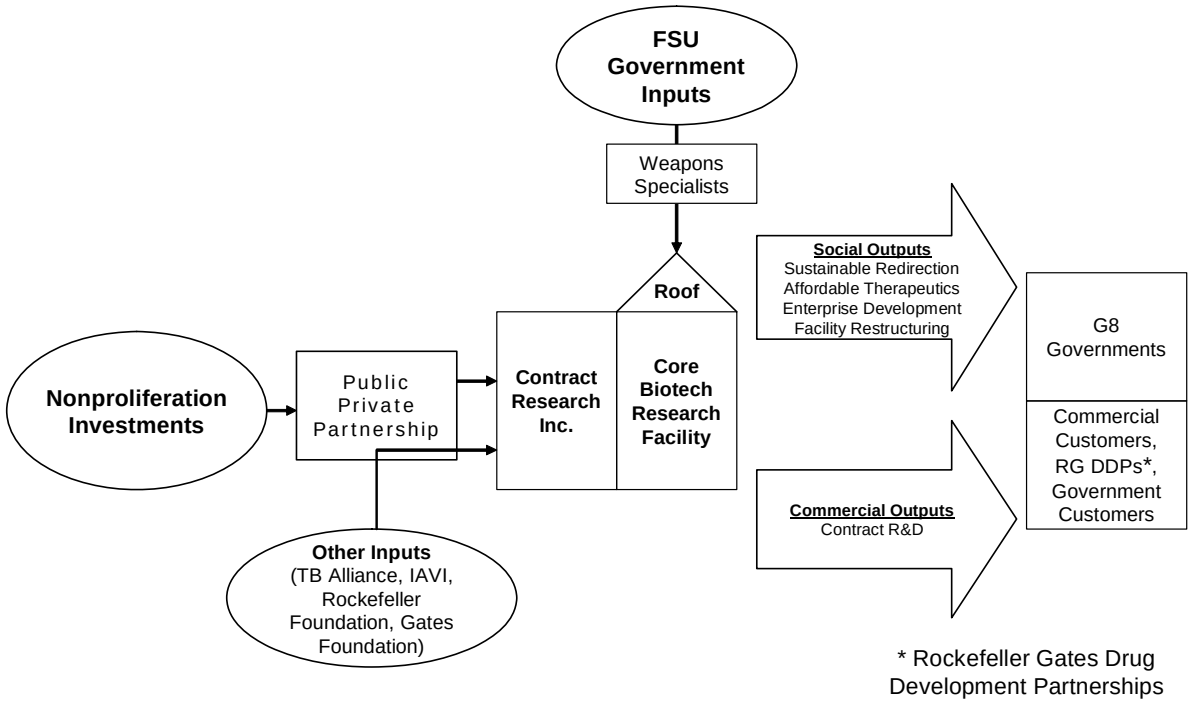
Implementation

In this case, the company will need to first conduct a fact-finding trip to the FSU to determine if the relevant expertise and phage strains that it requires are available in the former BW complex. If that proves to be the case, the next step would be to bring the key scientist(s) to the West on an NIH-funded fellowship. Then, as with BioX, a proper assessment of the scientist's compatibility and competence can be made, and then he/she can be trained to manage a PhageX subsidiary in the former Soviet Union and a proposal can be submitted along these lines.

PhageX differs somewhat from BioX in its business model. Although the company was similarly created to develop a novel drug, it is not as well capitalized and has therefore had to engage in the provision of goods and services, which produces an immediate source of revenue. An FSU facility could potentially augment the company's production and increase the revenue base, increasing the resources available to support its novel drug development. Moreover, the expertise and well-documented strains of phage available in the former Soviet Union may further augment the potential value of both its service and research activities.

Western Contract Research Organization (CRO) Development in the FSU: Case Three — "Contract Research Inc."

FIGURE 6



Contract Research, Inc. is a fictional Western firm. Although this company is constantly involved in research and development, most of this work is done for clients rather than for the development and pursuit of its own product line. Contract Research, Inc. is therefore a service provider. The company makes money filling in gaps and adding value to other businesses—such as BioX and PhageX. This company ideally already provides services to existing product development partnerships sponsored by the Rockefeller and Gates Foundations, BioX, and PhageX. A key issue, however, is to what degree it can produce its services in Russia for customers in the West.

Benefits

The core facility is something of a cross between an incubator and a contract research facility. It is conceived in response to a number of observations:

First, the challenges and risks faced by a Western company's lack of experience in establishing an FSU-based subsidiary are extensive. With more than one biotech company entering the country under the program, there will be significant benefits to sharing an established facility, rather than setting up a new one for each company. Second, in surveying the biotech sector specifically, the Stimson Center discovered that there are many companies engaged in providing contract research services to the rest of the industry. Such companies appear to be ideally suited to the task of absorbing excess biotechnological expertise in the states of the former Soviet Union. More needs to be done to assess

this potential. Third, an emerging theme among companies already operating in the region suggests that there is insufficient training of prospective employees in specific skills. The reported attrition rates of new hires and costs of on-the-job training are high. A core facility could therefore build in a modest training component funded by other government programs that would both train and help screen potential candidates for jobs in the companies operating at the core facility. Finally, as proposed, this facility, with its training component, has the potential to form the kernel of an FSU biotech cluster. As the number of companies entering the facility increases, so too does the demand for additional goods and services that they consume. With time, this facility could become a self-sustaining magnet for former BW specialists. The concept of establishing a core facility with nonproliferation start-up investments should only be undertaken in support of self-sufficient biotech companies entering an FSU state and agreeing in advance to utilize the facility.

Implementation

Critical to the success of the contract research company is the acceptance and support of the host FSU government. As has been well established, trust is often a commodity in short supply in the states of the former Soviet Union. This is true at both the political and commercial levels. To mitigate these risks, projects should be decidedly modest in their initial ambitions, but should actively build the basis for trust and along with it, an associated growth in both capability and capacity.

The ultimate goal is a biotech cluster built around an international life sciences research institute.

Step 1: Establish a small, easily expandable biotech facility that houses a contract research enterprise and two to three small biotech tenants. Participants in this venture would include: the real estate management company, the contract research company, and the biotech companies leasing space.

Step 2: Expand the core facility to accommodate tenant growth and additional tenants.

Step 3: Establish a small internationally funded research institute that enjoys synergies with tenants and with international public health initiatives. The purpose of such a facility would be to connect the skills of the target community and hard investments in their redirection with global health challenges in the field of neglected diseases.

Step 4: Develop a small-scale, cost-effective, GMP-consistent production facility.

Step 5: Expand the facility.

Initial output of the CRO and its tenants is likely for export only; however, domestic companies could also be solicited from the host state. The intent of the facility would be to move to meet the needs of the local market as quickly as possible. Growth of the cluster must be responsive to the interests of governmental, intergovernmental, and non-governmental entities, but above all, to private sector clients. For instance, Russia or any other FSU host state may seek to increase quality production of a particular vaccine. In service of its mandate, UNICEF wants to support an increase in Russian immunization capacity. TB Alliance, a Rockefeller-created and Gates Foundation-funded Product

Development Partnership, wants to undertake drug trials or research on a promising compound. Draper, Fisher, Jurvetson, a private venture capital fund in Silicon Valley, wants to co-locate and share administrative resources among the new start-ups it is funding or have ready access to contract research or production facilities for its maturing companies.

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CONCLUSION

In surveying potential nonproliferation threats, the existing policy toolkit to address those threats, as well as potential commercial opportunities to augment the toolkit in a sustainable fashion, The Henry L. Stimson Center concludes that:

1. Global Partnership contributors have an opportunity to provide leadership in the development of nonproliferation programs focused on the engagement of WMD specialists in the states of the former Soviet Union;
2. While evidence indicates that the threat of proliferation may be increasing, top-line funding is decreasing due to rising dissatisfaction in the United States (which provides the lion's share of program funds) and other contributors to the International Science and Technology Center in Moscow with the viability and sustainability of current programming;[30]
3. High commodity prices mean that some host governments no longer need emergency funding to support activities in the existing state-run institutes beyond the sharing of best practices in the areas of biosafety and biosecurity; and,
4. Global Partnership programs can therefore shift their "brain drain" focus to enabling employment outside the state sector in areas of strategic interest to other parts of the donor and recipient governments.

The Henry L. Stimson Center's initial findings clearly point to the need for a more proactive and strategic approach to job creation that, if done well, will produce value well beyond meeting the immediate nonproliferation objectives. This would ultimately make it possible to attract other government, non-government, and private sector stakeholders that would significantly increase the sustainability of both employment for redirected scientists, as well as the program itself. The redefined goals of the scientist redirect program across the Global Partnership should:

1. Meet the immediate nonproliferation needs of the Global Partnership;
2. Build sustainability into existing programming to ensure continuation beyond the sunset of G8 funding in 2012; and,
3. Leverage current appropriations in cross-sectoral support of donor and recipient priorities.

To achieve this outcome, the Global Partnership partners should:

1. Develop interdepartmental buy-in within their own governments to leverage mutual resources in support of nonproliferation and economic development, as well as public health, environmental, agricultural, and other objectives.

[30] ISTC contributors include: Canada, European Union, Japan, Norway, Russia, and South Korea.

2. Build capacity to identify and enable the private sector to employ the target population by:
    a. Validating the science available by cataloguing available skills and competencies; and,
    b. Engaging prospective employers through a systematic survey in the FSU and the West with particular focus on viable Western biotech firms;
3. Pilot this initiative and ultimately market its utility to other donor countries, as well as to other "clients" in the global health, economic development, and S&T communities.

This approach is substantively different from those currently being used because it focuses on nonproliferation through employment as the core objective, rather than research (ISTC and STCU) or technology development (IPP). At present, employment is an indirect and relatively infrequent consequence of the core R&D objective—it is a byproduct rather than a direct result of the programs, and therefore does not achieve *sustainable* nonproliferation objectives.

In addition, existing approaches do not effectively leverage cross-sectoral/interdepartmental interests. While the Stimson Center finds that G8 government agencies can make common cause to pursue an agenda, due to a variety of challenges largely related to staffing shortfalls, collaboration to date has occurred on an infrequent and *ad hoc* basis.

APPENDIX A – ABOUT THE AUTHORS

Brian D. Finlay is a Senior Associate at The Henry L. Stimson Center, where he works on issues of weapons proliferation, economic development, scientist redirection, and private sector engagement. Brian currently serves as the co-director of the Cooperative Nonproliferation Program, a multifaceted program designed to accelerate existing efforts and design innovative initiatives aimed at more rapidly and sustainably securing dangerous nuclear and biological weapons, materials, and expertise, while leveraging resources to address other issues of global concern, such as international public health and global economic development. Prior to joining the Stimson Center in January 2005, Brian served as Director of the Nuclear Threat Reduction Initiative and as a Senior Researcher at the Brookings Institution. Before emigrating from Canada, he was a Project Manager for the Laboratory Centre for Disease Control, Health Canada, in Ottawa. He also served as a consultant to the Department of Foreign Affairs, where he worked on the Ottawa Treaty on Landmines and the Comprehensive Nuclear Test Ban Treaty. Brian holds an MA from the Norman Paterson School of International Affairs at Carleton University, a Graduate Diploma from the School of Advanced International Studies, Johns Hopkins University, and an Honors BA from the University of Western Ontario.

Dr. Elizabeth "Libby" Turpen joined the Stimson Center in 2001 to establish the Senate component of the Security for a New Century (SNC) program. SNC is a bipartisan study group series designed to educate congressional staff about the complex security challenges facing US policymakers. In addition to providing direction for SNC, Libby also co-directs the Cooperative Nonproliferation Program. This effort encourages action by the US Congress to secure nuclear materials, dismantle existing weapons, and provide new employment for former weapons scientists. Building on a program of research, analysis, and public education, this project leverages existing networks of private sector actors to raise awareness about the value of threat reduction and nonproliferation initiatives. Prior to joining the Center, Libby served as Legislative Assistant for Senator Pete Domenici and was responsible for defense, nonproliferation, and foreign affairs. Previously, she worked as a consultant for Aquila Technologies Group on nonproliferation policy, US-Russian programs, and the national security implications of technology advances. Libby has extensive teaching and lecturing experience, and she holds a PhD from the Fletcher School of Law and Diplomacy at Tufts University and a BA from the University of New Mexico.

Frederick "Rick" Kellett joined the Center in late 2005 as a Visiting Fellow with the Cooperative Nonproliferation Program. His experience over the past decade includes serving as Regional Director of a management consulting operation focused on local entrepreneurs in Central Asia and, more recently, as Executive Vice President of Byelocorp Scientific, Inc., making him uniquely suited to contribute to this initiative. BSI is one of the few Western companies to have successfully utilized former Soviet weapons research and manufacturing capabilities to create commercially viable civilian enterprises. One effort brought together a team of Belarusian and American scientists and engineers to develop a revolutionary optics finishing technology, which is now being used by every major optics manufacturer in the world. Another restructured a Kazakhstan weapons factory to produce large industrial process equipment for the region's growing oil business. Importantly, the latter also became the key supplier of equipment and packaging for spent nuclear fuel during the shutdown of the BN-350 reactor under a DoE nonproliferation initiative.

Mission of The Henry L. Stimson Center

Located in Washington, DC, The Henry L. Stimson Center is a nonprofit, nonpartisan institution dedicated to offering practical solutions to problems of national and international security. Since it was founded in 1989, the Stimson Center has been committed to meaningful impact, a thorough integration of analysis and outreach, and a creative and innovative approach to solving problems. The Center focuses on three program areas: Reducing WMD and Transnational Threats, Building Regional Security, and Strengthening Institutions for Peace and Security. These program areas encompass work on a wide range of security issues, from creative approaches to nonproliferation and regional security in Asia to peace operations and domestic preparedness.

About the Cooperative Nonproliferation Program

The Cooperative Nonproliferation Program offers innovative, functional approaches to address the most significant threat to international security today: the spread of weapons of mass destruction. It seeks to bridge the gap between traditional "hard" security (proliferation) and "soft" security objectives (capacity-building, global development, and public health). The program partners with the public and private sector—an under-exploited resource—to achieve mutual security and development objectives. Only by exploring and leveraging all available means to address the growing threat of proliferation can its root causes be treated, rather than just its symptoms.