

***New Perspectives in Regimes to Control WMD***

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“Traditional institutions are incapable of addressing the growing list of complex global issues.” This challenging statement by Jean-Francois Rischard, the World Bank’s Vice President for Europe,<sup>1</sup> is the starting point for this paper. In summary, it argues that the international community needs new approaches, new thinking, and new partners if it is to be successful in controlling the challenges posed by weapons of mass destruction (WMD). Business as usual, even if there is tinkering around the edges, will not suffice.

### ***The Case for Innovation***

The case for innovation rests on two arguments. First, the world today is a much different place than it was when the fundamental thinking evolved and the traditional tools were developed for addressing the WMD challenge. In particular, globalization has created a world that is more complex and more uncertain than that of the post-World War II decades. The importance of globalization cannot be underestimated. The study of the world of 2020 by the National Intelligence Council, for example, described globalization as “an overarching megatrend,” a force “so ubiquitous that it will substantially shape all other trends.”<sup>2</sup> As such it has shaken and will continue to shake up the world economically, politically, culturally, and in terms of security.

While “globalization” means different things to different people, an examination of various definitions allows one to devise a set of characteristics and features of globalization important for this inquiry. Globalization can be deemed a ***process*** of ***interaction*** on a ***global*** scale. It is marked by worldwide interconnections, exchanges, and flows of goods and resources, information and ideas, science and technology, money and services, people and culture, and even violence, crime, and weapons.<sup>3</sup> It is further characterized by

- An **accelerating speed, growing magnitude, thickening density, and increasing complexity** in those interconnections and flows;
- The core exploitation of the **information revolution**;

- **Innovations** in technology, their applications, and ways of doing business; and
- An **increasingly prominent role of non-governmental actors**, especially corporations and non-governmental organizations.

This last point is especially important. The NIC study argues that in the future more business firms will become global, and those operating in the global arena will become more diverse in size and origin, and they will be more Asian and less Western in orientation.<sup>4</sup> What globalization has also made possible, however, is the emergence of smaller firms that, just as large multinationals, are marketing their products and services on an international basis.

Globalization has already transformed patterns of industrial production at both the national and international levels, leading to changes in industrial structures and practices designed to foster ever more specialization, efficiency, productivity, and competitiveness. These developments are generating more agile manufacturing, resulting in smaller manpower and infrastructure requirements. Such trends are yielding flatter organizational pyramids with empowered employees, new production processes, and lower costs for easier and better technology. In essence, these trends are restructuring business enterprises in fundamental ways.<sup>5</sup> Moreover, the greater number of business competitors on the global stage, large and small, is likely to drive a demand and competition for natural and other resources, not only oil and minerals, but skilled, computer- and scientific-literate manpower. The result is likely to be growing two-way flows in key resources, especially between developed countries and what have been called "innovating developing countries."

In addition to international business, other non-governmental entities are operating on an international basis and in greater numbers. Robert Keohane and Joseph Nye note that the number of non-governmental international actors rose from 6,000 in the 1990s to about 26,000 today.<sup>6</sup> Not only are such non-governmental entities greater in number, but they are also more diverse in interest and agenda. In some cases, these actors have come together in "communities of choice,"<sup>7</sup> recognizing, or

perhaps discovering, a commonality of interest, often through non-traditional means such as the Internet.<sup>8</sup> In a sense, just as in the business world, among other non-governmental entities, globalization is fostering greater specialization. The impact of this growth and diversity is to increase the number of channels within and among society through which action can be taken and influence exerted. More and more these new and increasingly empowered non-state actors are able to express their singular interests through the tools and channels globalization provides. The point has been made with respect to business, but it is applicable to many other non-state actors as well that globalization is allowing them to operate beyond the control of any single government.<sup>9</sup> The result is that even relatively weak actors can have disproportionate impact. Of course, as with many features of globalization, the growth in the influence of non-state actors has a negative aspect. As French analyst Therese Delpech reminds us, "Criminal clandestine networks operating in the midst of post-modern societies, constitute a dark side of globalization that is difficult to detect and to destroy."<sup>10</sup>

Finally, a key feature of a globalizing world is the spread and application of new technology and the science that underlies it. Science is moving forward at an incredible pace. The result is that more and more knowledge as well as the tools that exploit such knowledge are falling within the reach of more and more people. The United States today, for example, has become a net importer of high technology. Its share of the global export market for high technology has declined in the last twenty years from 30 percent to 17 percent; its trade balance in high technology manufactures has shifted from +\$33 billion in 1990 to -\$24 billion in 2004.<sup>11</sup> Another figure that shows the importance of the shifts underway with respect to science and technology is that in terms of the numbers of engineering students graduated, in 2004, the number for the United States was 70,000. In India it was 200,000, and in China 500,000.<sup>12</sup>

The life sciences provide a further example of this critical trend. Today the world is witnessing a life sciences revolution. Some people have called the 21<sup>st</sup> century, the "century of biology." Certainly, knowledge of life at the molecular level has exploded.

The speed of advances in certain branches of the life sciences is said to be greater than Moore's Law in information technology. This revolution is further facilitated by the convergence of the life sciences with other critical advanced technologies including information technology, new materials technologies, and nanotechnology. The recent National Intelligence Council study described this development as "a force multiplying convergence" with profound implications for those actors who can adapt to and exploit such trends.<sup>13</sup>

This exploding knowledge in the life sciences is accompanied by a rapid global diffusion of that science and related technologies. In 2002, for example, the pharmaceutical industries of Asia (outside Japan), Africa, and Australia grew at a rate of 11 percent, nearly matching the 12 percent growth rate in North America (albeit from a smaller base).<sup>14</sup> In Asia today, over 1,000 biotech companies conduct business. As a partner in the Human Genome Project, China sequenced over 1% of the human genome with great accuracy, a notable accomplishment for a "developing country."<sup>15</sup> China is also home to the first licensed gene therapy. Singapore has committed to making biotechnology the "fourth pillar of its economy," and it has taken great strides both to lure biotech investment from other parts of the world as well as to develop an indigenous biotechnology capability. Cuba exports biotechnology products to more than 50 countries, and its biotechnology research facilities host visiting scientists from an even greater number of countries.<sup>16</sup> Other important developments in places such as Brazil and South Africa could also be cited.<sup>17</sup>

This changing scientific and technological landscape has critical implications for security. It will create more possibilities for misuse of science and associated technologies not only by nations but by groups and even individuals. The number of regions of the world where people can be found with the requisite ability to exploit knowledge that can do harm has obviously grown significantly. The result is lower entry costs for joining the proliferation process as well as entry at a higher point on the learning curve. The new structures of commercial and scientific enterprises will provide a wider range and more diverse array of legitimate dual use covers for malign

activities. They could also create multiple, parallel, possibly non-traditional pathways to the development of critical biological weapons-related capabilities. The results will make it hard to determine non-compliance leading to uncertain enforcement and response at both the international and national levels.

The impact on treaty regimes will also be felt. John Gee, the former Deputy Director General of the Organization for the Prohibition of Chemical Weapons (OPCW) has noted that key provisions of the Chemical Weapons Convention were premised on the way that the chemical industry was structured and operating at the time the CWC was drafted. It was a time, he points out, when the compounds used as chemical weapons precursors were more or less known, research into new active compounds was expensive and uncertain, limited understanding existed of the human genome or of biomolecules, the chemical industry operationally was highly centralized and vertically integrated, and computer control of chemical processes was in its infancy. He concludes that, "all these realities of days long gone still remain at the foundation of the Conventions verification regime." <sup>18</sup>

A further set of implications was highlighted by the experience of A.Q. Khan. In particular those revelations about his network underlined how global the technology market – whether for good or ill – has become, and it reinforced the reality that in many cases it is no longer access to the technology itself that is the key to success, but the ability to integrate a variety of critical elements that may have been acquired from widely disparate places. It also stressed the disturbing notion that the scope for significant action is now at the level of the individual, giving rise to the prospect of the emergence of "proliferation entrepreneurs," who exploit globalization – especially the networks among self-defined groups with violent agendas operating "below the radars" of national intelligence services.

Further contributing to the novel security environment is the changing nature of conflict around the globe since the end of the Cold War. Most of today's conflicts are intrastate rather than interstate and often have their epicenter at the community rather than the state level. They involve a wide range of non-governmental

participants including not only the combatants, but private security armies, local warlords, crime bosses, major international corporations, humanitarian organizations, and many others. Whereas power balances, force build-ups, national grievances, and aggressive, universalist ideologies were primary drivers of conflict through much of the twentieth century, today different phenomena --- poverty, disease and declining health, demographic shifts, ecological degradation, competition for control of resources, community polarization, and collapsing government capacity and social infrastructure – are increasing tensions at the community level and have become motivating factors underlying many contemporary conflicts.

The changing nature of conflict has fostered the recognition of the need to broaden conceptual and policy horizons to understand better the critical factors shaping the dynamics of today's conflicts and instability. It is incumbent on policy makers to appreciate these new dynamics, and they must develop innovative strategies, techniques, and tools that are responsive to these complex and novel challenges. However, these developments create serious challenges to governments' abilities to oversee, control, and prevent prohibited behaviors.

- The convergence of changes raises a number of tough questions: In this emerging security environment, what constitutes "proliferation?" What should be a nation's priorities in addressing these new challenges? What are the critical contingencies for which a nation must be prepared? How do these shifts shape the way government agencies do their nonproliferation or counter-proliferation business?
- A RAND study has noted that information and biotechnologies – two key technologies in the globalization process – have in common that their use and control are largely in the hands of individuals and do not require collective action or social infrastructure to be used effectively.<sup>19</sup>
- Government bureaucracies are notoriously slow to adapt. So too are international institutions. How then can governments and international institutions keep pace with the speed at which science and technology is moving, especially in terms of understanding the implications of those changes for security? The problem is not only knowing how new science and technology could make the problem worse. It also involves appreciating what new opportunities scientific and technological advances might create. Too

few mechanisms exist for good science to inform government policy making on a sustained basis.

- In a globalized, complex, and uncertain world, governments cannot do the job alone. They must develop better relationships with and foster inputs from those “working at the coal face” of scientific and technological change every day. This means in the first instance that governments must reach out to the academic research community and business.

The second major argument for innovation in approaching WMD challenges is the simple fact that past approaches have not worked very well.

- What might be called the “Geneva process”— the adoption of formal, multilaterally negotiated, legally binding arms control and nonproliferation agreements—has not yielded major operational results since the conclusion of the CWC in 1992. The inability to achieve a consensus on the Biological Weapons Convention (BWC) protocol after seven years of negotiation highlighted how dysfunctional the process has become, a situation that is unlikely to change any time soon. Another example is the lack of success in using provisions in multilateral treaties such as the BWC, the CWC, and the Nuclear Nonproliferation Treaty (NPT) to involve the United Nations as the last resort to deal with their fundamental problems. It is a history that has hardly been inspiring. The most recent examples are North Korea and Iran in the nuclear realm. These cases have demonstrated how hard it is to get the issue into the United Nations. More disturbing are the doubts expressed by both security and UN experts that any progress will be made in resolving the issues even if they get there. These cases are only the most recent in a sorry legacy of inaction that stretches back decades.
- Contentious political disputes that were obstacles to progress in the past are likely to continue to hinder new attempts based on the usual practices and procedures. In traditional forums, such as treaty review conferences, positive action is often barred by long-standing shibboleths that reflect post-colonial resentments, differing perceptions of what is “fair” in a world shaped by globalization, and competing interests that have little to do with the contemporary security agenda. A case in point: the negative impact of the debates over the “right” of states to exploit the sciences and technology covered by the BWC, the CWC, and the NPT for peaceful purposes and the obligation of developed countries to cooperate and assist in facilitating that right. Too often demands made in the name of these “rights” deflect attention from real security issues to the self-serving agenda of a few radicals and prevent any useful business from being conducted. Another example is the lack of agreement at the 2005 NPT Review Conference. Too many participants seemed to want to focus only on their agendas without paying serious attention to the concerns of others.

- Old methods sometimes confuse intermediate goals with ultimate objectives. Many nations seemed to believe, for example, that it is more important to “strengthen the BWC” than deal effectively with biological proliferation or terrorism. In the ill-fated BWC protocol negotiations, most participants appeared to prefer even an outcome of negligible or questionable value to no outcome at all. This is not to argue that the BWC is not important or that it should not be strengthened. It is and it should be. But the BWC is not an end in itself; it is important only insofar as it facilitates action that enhances security. Many countries seem content to focus on the treaty, and they lose sight of the full range of tools needed to address today’s biological challenge.

### ***Shaping a New Approach***

The foundation for effectively promoting new approaches to address today’s WMD challenges is a shared conceptual approach to the problem among all the stakeholders, on both the national and international level. This is not to argue for a unanimously agreed threat or risk assessment. It is unlikely that a consensus could or ever will be achieved. But neither is it necessary. What is important is finding enough common ground to create sufficient shared space for working together. Unfortunately, at the present time, the members of the international community have neither a common view of the problem nor a shared strategy for dealing with it.

Developing common ground might begin with agreement on the following assumptions. First, policy makers and analysts alike must avoid the traditional practice of using the nuclear prism as the dominant lens through which to try to understand the WMD challenges ahead and to develop policy responses. That nuclear weapons are deemed a primary concern because of the scale of destruction they can inflict is obvious and appropriate. But in many ways, nuclear weapons are the “odd man out” in terms of current global trend and the emerging challenges of the evolving global security environment. It is for this reason that so many examples in this paper are non-nuclear. What might be effective in addressing nuclear challenges has little carry over to how success can be achieved with respect to other WMD categories. The hackneyed cliché that “nuclear is not chemical is not biological” is acknowledged virtually universally. But when it comes to exploring issues and

devising policy options, the nuclear perspective often reasserts itself and becomes dominant (and sometimes exclusive). The first innovation therefore should be a fundamental change in mindset that no longer gives the nuclear perspective pride of place.

Second, the WMD challenge is not a problem to be solved, but a risk to be managed. The sources of concern cannot be eliminated. Work in the life sciences, for example, will continue and should do so for important legitimate reasons. This means, however, that the potential for the misuse of that science and associated technologies remains a permanent reality. The challenge in confronting the potential catastrophes inherent in the misuse of the life sciences – whether by states or non-states—is not to prevent international actors from acquiring the capabilities to exploit biology for malign purposes. That is not possible. Rather, the challenge is, as UK Ministry of Defence official Paul Schulte put it, “to keep it out of their behavioral repertoires.” Nuclear weapons are of course an exception in this regard. Access to appropriate nuclear materials and technologies remains perhaps the critical requirement in acquiring a nuclear weapons capability. Yet, the same issues exists in the nuclear realm as it does for other WMD, that is, that relevant work continues and, so long as it does, the international community will have to manage the risks associated with it.

The process of successfully managing the WMD challenge, therefore, must begin with a conceptual shift from threat and vulnerability assessments to risk management approaches. Uncertainty is the hallmark of the WMD challenge in a globalized world. That uncertainty exists because the risk is the product of a complex interaction among several categories of factors—actors, agents, targets, and operational considerations—each of which includes many variables. Taken together, these variables produce a matrix that offers a large set of possible combinations and permutations, each of which produces a pathway to a particular outcome. Some of these pathways yield catastrophic consequences; others result in significant

casualties; still others result in no consequences at all. Risk assessment introduces the necessary concept of probability with respect to these outcomes.

One might argue that current threat assessments also tend to emphasize the weapons user's technological capacity to conduct an attack. The ease or difficulty of terrorists' ability to exploit existing or future science and technology is the subject of intense debate. It is a core concern in the assessment of the risks of "latency." Excessive consideration of a terrorist's technological capabilities, however, diverts attention from his creativity. One should approach planning efforts to meet the challenge with the same caution as the military planner who noted that battle plans become irrelevant with the first shot. Events are almost certain to proceed in ways quite different from those anticipated and planned for. Policy makers and planners should be mindful that their creativity must be equal to that of the terrorist.

In a globalized world, the challenge of dealing effectively with WMD challenges cannot be met by trying to predict precisely what form an attack will take. Rather, the objective must be preparedness for as wide a range of plausible contingencies as possible. That can only be accomplished if a country has a robust set of critical capabilities that are integrated into a genuinely strategic approach that stresses flexibility and adaptability. But developing those capabilities is not easy. It entails identifying requirements, establishing criteria to determine the appropriate level of capabilities to meet those requirements, balancing a wide set of competing interests, and involving the right set of players. Risk reduction is a multifaceted, complex challenge that includes deterrence, norm-building, prevention, defense, preparedness, and consequence management, mitigation, and amelioration. No single instrument or approach will suffice.

### ***Creating New Partnerships***

The third key assumption is that these requirements will be met successfully only if all of the critical stakeholders are involved and an integrated approach to their cooperation is fostered. This array of critical players includes a diversity of

government agencies, not all of which have traditionally focused on the security agenda. The importance of integrating health-oriented capabilities, for example, has been clearly recognized in many countries.

In addition to getting key government agencies to work together better, strong partnerships are also vital between government and the private sector. In some WMD-related areas, however, badly needed inputs from these important players have been missing. The life sciences communities, in particular, were not well integrated, despite the fact that they stand at the cutting edge of both the remarkable scientific advances and their applications that are shaping the environment within which the biological weapons and bioterrorism challenges must be addressed. This situation must change.

A hands-off attitude from the scientific or business community is a luxury we cannot afford. As the drivers of critical science and technology, industry and the academic scientific community must understand their stakes in the challenge and be fully integrated into the response. The direct contribution that this community can make to dealing with the problem is obvious. It should be the source of the technical tools that must be deployed to help manage risks, including sensors for detection and identification, new medical treatments, and improvements in passive and active protective gear.

The indirect contribution of these communities, however, is also crucial. Even scientists and companies that have no direct relationship to the security sector engage in activities with risks attached. Insufficient safety and security measures at laboratories and other facilities pose clear and obvious risks. But what about risks that are not so obvious? This does not mean that beneficial products should not be made. But they should go forward with the relevant communities being fully aware of the risks that might be involved.

For its part, governments must encourage this development further and engage the science and business communities in ways that take into account legitimate security

concerns without harming the innovation and creativity that is such a key feature of their work. Governments must exercise caution to ensure that they do not, in fact, drive scientists and business people away from such engagement. Onerous requirements that force scientists or companies to conclude that potential benefits from particular research or commercial ventures are not worth the hassle will lead them to forego efforts that could prove to be valuable from both a scientific and security standpoint. Anecdotal evidence suggests that just such things are happening. Therefore governments must focus on developing means for managing security-related risks that achieve an acceptable balance with the requirements of the scientific process and good business practices.

One means to overcome these problems is to create the opportunity and mechanism for bringing the critical stakeholders together to work as partners in managing the risks of the potential misuse of the sciences and technology in which they have so much invested. Such a forum could take the form of a global organization with networked members from business enterprises, venture capitalists, the scientific community, and others working with governments to foster a self-sustaining mechanism to contribute to improved quality of life and to enhanced international standards of public safety and security on a global scale. Such an enterprise would stress in particular responsible, ethical, and sound business and scientific practices. Indeed, in the area of biological safety and security, such an organization, the International Council for the Life Sciences, has been launched.

Such an approach is similar to what Jean-Francois Rischard has called "global issue networks," arrangements that take advantage of the positive aspects of globalization to foster imaginative approaches to dealing with complex challenges. In his view, such networks have significant advantages over existing institutions, whether national or international, in that they minimize bureaucracy and hierarchy and their delivery times can be fast.<sup>20</sup> Such arrangements can lend coherence to ongoing global efforts by connecting all the critical sectors and players, engaging them in creative cooperation, and giving them a vested interest in developing best practices

and codes of behavior that will, in turn, complement and bolster existing legal and regulatory instruments.

International cooperation is especially important in this regard. The world's science and technology base is thoroughly globalized, with capabilities available worldwide that can contribute to domestic security for many nations. Success in exploiting these capabilities will be possible, however, only if national efforts are informed by awareness of developments elsewhere and various national efforts are harmonized. No country has the resources to fund all of its demands for security investments, and maximizing the return on whatever investment is made requires a coordinated approach.

If the need for international cooperation is clear, its promotion nonetheless remains challenging for a number of reasons. First, the absence of common perceptions of threats and risks results in an insufficient basis for developing shared priorities that can guide strategic planning efforts. No agreed criteria provide guidance for answering the crucial question of how much is enough -- nationally or internationally.

Second, international institutional mechanisms remain inadequate to promote cooperation. Although a number of forums exist, they either attend to narrow aspects of the problem or generally lack follow-through to match their rhetoric. Some potentially useful international actors, such as NATO, have played almost no role at all.

Third, security requirements in every country confront competing domestic priorities, especially in the social sector, and different countries reconcile that competition differently. Similarly, both the United States and its friends and allies pursue wide-ranging non-security interests, especially in the economic and commercial sphere, that can bear heavily on decisions concerning their national security investments. Examples include corporate competition in important developing countries, differing approaches to improving global health, or the priorities of national science policy.

Means must be developed that allow nations to advance their singular non-security interests without damaging their common security goals.

### ***A Question of Commitment***

The dialogue between governments and others at the 2005 BWC Experts Group Meeting on codes of conduct threw into sharp relief the roles and responsibilities of those who hold the critical stakes in effectively managing the challenges posed by WMD. How well those issues are ultimately addressed depends on the extent of nations' will and commitment to do so.

The benefit of the BWC Experts Group discussions was to make it crystal clear where the success or failure of efforts to deal with the biological challenge will rest – with individual nations. The whole BWC work program since 2003 has been about what states can do – now – to address the problem. There is no need to wait on the outcome of some negotiating process. There is no international bureaucracy behind which to hide. There is no dearth of ideas for action on the table. There is no excuse.

In focusing responsibility where it belongs, the BWC work plan reinforces thinking that underlies other recent initiatives, most notably the Proliferation Security Initiative (PSI) and UN Security Council Resolution 1540. Both of these efforts also highlight the reality that progress will be made in the fight against WMD only if national governments are willing to take the problem seriously and commit themselves to action. Coordinated national action is obviously the most effective and therefore the preferred mode of action. But to make such practice a reality, the primary emphasis must first be placed on the “national action” component rather than the “coordination.” National action, placed in a coherent strategic framework, informed by a positive attitude toward international cooperation, and implemented with innovative tools, is the most important short-term step that nations must now pursue.

Given the need for international cooperation, some of the more innovative efforts could focus on exploiting what globalization makes possible. As Anne-Marie

Slaughter points out, "Networked threats require a networked response."<sup>21</sup> Global networks that are greater in number, deeper in reach, and more rapid in response can take the raw material of "national action" and process it into a collaborative international effort that will have a better chance of dealing effectively with the increasingly complex challenges posed by WMD. The need is for less "institutionalizing" of international cooperation,<sup>22</sup> and more globalizing it on the basis of what governments and other key actors actually do.

\*This paper is drawn in part from an earlier paper, "Fear in a Handful of Dust: Responding to the Biological Security Challenge," currently being reviewed for publication.

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<sup>1</sup> Jean-Francois Rischard, "Global Issues Networks: Desperate Times Deserve Innovative Measures," *The Washington Quarterly*, Vol. 26, No. 1, Winter 2002-2003, p. 17.

<sup>2</sup> National Intelligence Council, *Mapping the Global Future: Report of the National Intelligence Council's 2020 Project*, December 2004, p. 10. Hereafter referred to as the NIC Report.

<sup>3</sup> For examples of definitions of globalization, see Stephen Flanagan, et. al., *Challenges of the Global Century: Report of the Project on Globalization and National Security*, National Defense University, June 2001, p. 8 or Robert O. Keohane and Joseph S. Nye, Jr., "Globalization: What's New? What's not? (And So What?)" *Foreign Policy*, Spring 2000, pp. 105-108.

<sup>4</sup> NIC Report, p. 12.

<sup>5</sup> Ronald F. Lehman, *Technical and Political Latency in the Acquisition of CBRN Weapons by States and Other Actors – An Overview of the Global Security Environment and Its Implications for Policy and Commerce*, presentation to the Meeting on The Future of the Life Sciences: Reaping the Rewards and Managing the Benefits, Sponsored by the International Institute for Strategic Studies-US and the Chemical and Biological Arms Control Institute, December 8, 2004.

<sup>6</sup> Keohane and Nye, p. 116

<sup>7</sup> The term is drawn from Jean-Marie Guhenno, "The Impact of Globalization on Strategy," *Survival*, Winter 1998-99.

<sup>8</sup> See for example, Paul de Armond, "Right Wing Terrorism and Weapons of Mass Destruction: Notives, Strategies and Movements," in *Hype or Reality: The New Terrorism and Mass Casualty Attacks*, edited by Brad Roberts, Chemical and Biological Arms Control Institute, 2000, pp. 58-63.

<sup>9</sup> Ibid.

<sup>10</sup> Therese Delpuch, "The Imbalance of Terror," *The Washington Quarterly*, Winter 2002, p. 34

<sup>11</sup> *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academies of Science, National Academies of Engineering and Institute of Medicine, prepublication copy, 2005, p. 11.

<sup>12</sup> Ibid.

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<sup>13</sup> *Mapping the Global Future*, Report of the National Intelligence Council's 2020 Project (Washington, DC: U.S. Government Printing Office, December 2004), p. 34.

<sup>14</sup> Bryan Bergeron and Paul Chan, *Biotechnology Industry: A Global,, Economic and Financing Overview* (Hoboken, NJ: John Wiley and Sons, 2004), p. 55.

<sup>15</sup> Li Zhenzhen, Zhang Jiuchun, Wen Ke, Halla Thorsteinsdottir, Uyen Quach, Peter A. Singer, and Abdallah S. Daar, "Health Biotechnology in China – Reawakening of a Giant," in *Health Biotechnology Innovation in Developing Countries*, Supplement to Nature Publishing Group, December 2004, p. DC 13.

<sup>16</sup> Halla Thorsteinsdottir, Tirso W. Saenz, Uyen Quach, Abdallah S. Daar, and Peter A. Singer, "Cuba – Innovation through Synergy," in *Health Biotechnology Innovation in Developing Countries*, p. DC 19.

<sup>17</sup> See for example Marcela Ferrer, Halla Thorsteinsdottir, Uyen Quach, Peter A. Singer and Abdallah S. Daar, "The Scientific Muscle of Brazil's Health Biotechnology," in *Ibid.*, p.pp DC 8 – DC 12, and Marion Motari, Uyen Quach, Halla Thorsteinsdottir, Douglas K. Martin, Abdallah S. Daar, and Peter A. Singer, "South Africa – Blazing a Trail for African Biotechnology," in *Ibid.*, pp. DC 37 – DC 41.

<sup>18</sup> John Gee, "Advances in Science and Technology: Maintaining the Effectiveness of the Chemical Weapons Convention," *Pure and Applied Chemistry*, Vol. 74, No. 12, p. 2231.

<sup>19</sup> Philip Anton, Richard Silbergliitt, and James Schneider, *The Global Technology Revolution: Bio/Nano/Materials Trends and Their Synergies with Information Technology by 20`5*, The RAND Corporation, 2001.

<sup>20</sup> Rischard, pp. 24-32.

<sup>21</sup> Anne-Marie Slaughter, "Government Networks, World Order, and the G20," prepared for the meeting on *The G20 at Leader's Level*, Ottawa, February 29, 2004, p. 2.

<sup>22</sup> Robert Keohane has argued, for example, that "institutions themselves are potentially oppressive." Quoted in *Ibid.*, p. 18.