FINAL BRIEFBACK and DISCUSSION SUMMARY

The participants' discussion sessions were divided into three parts. The first focused on an examination of the current state of the S&T-security nexus, in particular, the institutional relationship of the S&T and security communities. The outcome of these discussions identified prerequisite conditions necessary towards developing effective responses to S&T phenomena that have serious security implications. The discussions then flowed to the second part where the participants identified the top three S&T areas of concern derived from the SME presentations on information technology, biotechnology, energy and environment. The third part concluded the discussions: Dr. William Perry and Dr. Siegfried Hecker, co-directors of Stanford University's Center for International Security and Cooperation (CISCA), received the briefs culled from all the previous sessions. They also proposed an outline of ideas that can be used as points of departure for follow-up dialogues between the S&T and security communities.

Understanding the S&T and Security Relationship

There was general agreement among the participants that the international security and S&T environments are very dynamic, interfacing with ever-increasing complexity and urgency. However, a significant gap – a *"valley of disconnection"* (figure 1, p. 170) – exists between the S&T and security policy communities within, and across, countries in the region. The disconnection stems from institutional and policy stovepiping where the "problem/solution set" of the S&T community and the "problem/policy set" of the security community are not coordinated or integrated. Bridging this divide is an integral element of an "interdisciplinary framework" response to S&T developments that have serious security implications.

The group's central discussion focused on identifying the specific variables that articulate this "valley of disconnection" and finding solutions to these challenges. The first concern is the lack of a robust and sustained dialogue between the communities. The group recommended the creation of a *"policy and political space"* where members of the two groups can *dialogue* in an institutional context while also providing the opportunity for both sides to educate each other on their respective areas of expertise and concerns. More importantly, this arrangement provides the opportunity to develop consensus on the understanding of "security," the nature of the threats and challenges, possible responses, and the allocation of resources. The ideal outcome is the formulation of a coordinated set of policy responses.

Closing the gap between the S&T and security communities also require *"translators.*" The group pointed out that there is a dearth of expertise – organizations and individuals - that are able to effectively translate knowledge between the S&T and security worlds. Policy dialogue between S&T professionals and security practitioners will vastly improve with the presence of these translators or "interface institutions," and the group stressed the need to develop and institutionalize these capabilities as soon as possible.

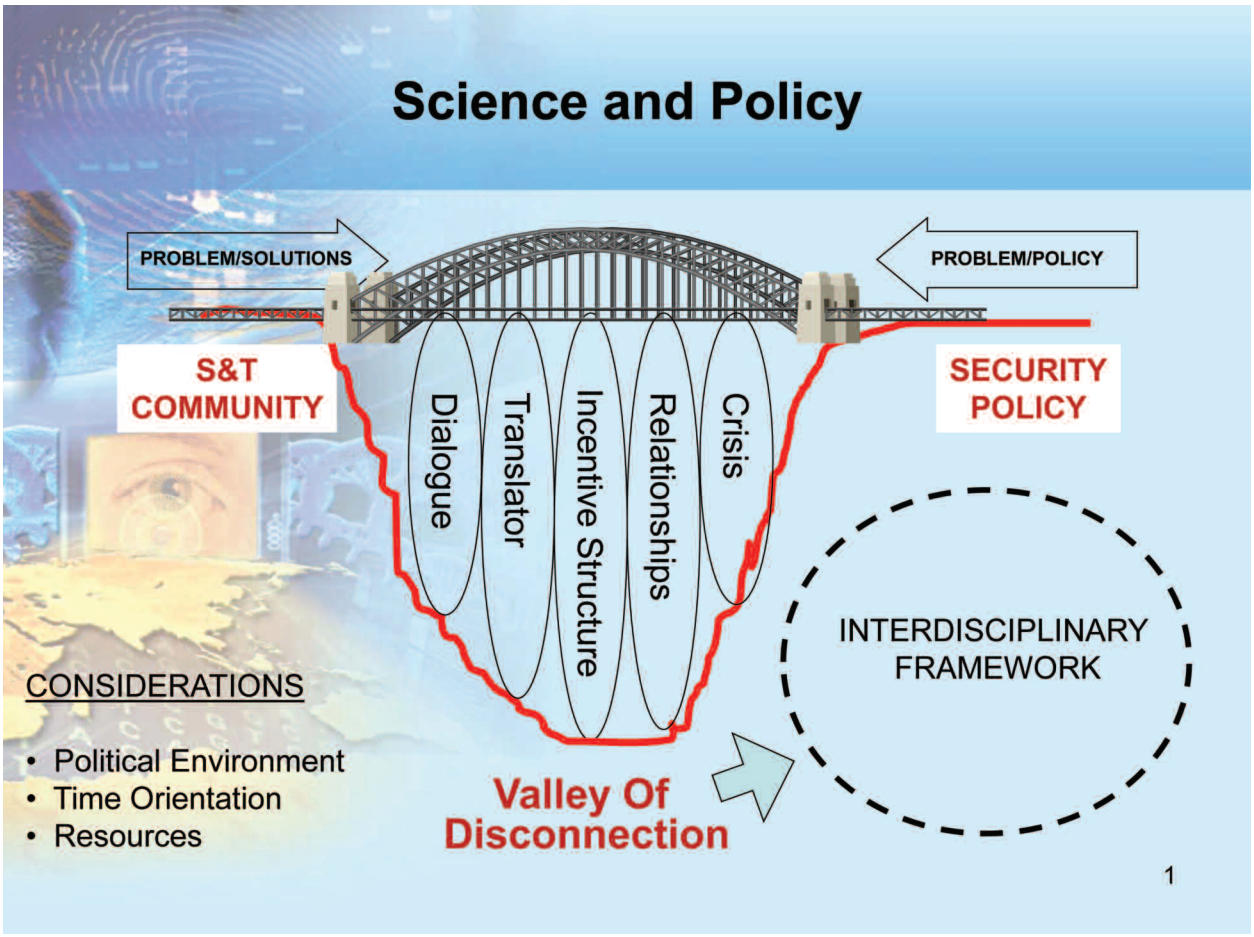

FIGURE 1 Bridging the Divide

The discussions also raised the issue of the differences in the *"incentive structures"* between the two communities: while scientists and engineers try to "find the truth," the broad mandate of security policy makers and practitioners is to ensure the safety and security of their communities. Provision of "mutual incentive structures" for members of the two communities should consider the appropriate scales, levels and contexts for dialogue as well as establishing key connections between different levels of hierarchies. Ultimately, the development of a "culture of shared incentives" reduces misunderstanding, manages expectations and allows for the creation of a common framework for action.

Another way of bridging the divide between the two communities is to develop and nurture *relationships* and to "customize" the dialogues when translators have access to the appropriate organizations and people called upon to address particular policy issues and challenges.

Finally, the group also discussed the emergence or occurrence of a *crisis* situation as an opportunity to bridge the divide between the S&T and security communities. The group conceptualized crisis as a phenomenon generating a plan of action that necessitates dynamic cooperation between the two groups. Some participants observed that the severe conditions of a

crisis also call for "extreme" measures of cooperation, and this may be very useful for bridging the divide.

The group also included a list of considerations crucial to the S&T-security community interface. Insofar as the *political environment* is concerned, strengthening the dialogue between the two groups requires a strong political will, and there was general agreement among the group that the role of having a powerful political backer or "champion" who can "influence the influencers" is a vital one. The group also noted that policy makers will need to consider and reconcile the *"time orientation"* of the S&T community (long) and the security policy makers (short) when formulating responses to threats or challenges. Finally both communities depend on the availability of significant *resources* from the "start-up" period to the "sustain" phase of cross-community cooperation.

The critical value of bridging the S&T-security community divide emphasizes the importance of adopting an *"interdisciplinary framework"* in developing policy responses to the challenges rooted in the interface of S&T and security. Participants pointed out the increasing interrelatedness of various S&T disciplines as well as the growing linkages between various comprehensive security issues that were discussed in the panel presentations: there are technoscientific developments as well as security challenges that link information technology, energy, environment and biotechnology in multiple ways. This growing trend requires a commensurate institutional response to broaden and expand the policy space to recognize and include critical stakeholders.

Identifying the top three S&T areas of concern now and ahead

Informed by the formal presentations and discussions on the four S&T areas (information technology, environment, energy and biotechnology), the participants identified the top three phenomena from these four areas that are likely to have the most significant global impact in the next 20 years and provide focus to future interagency, regional and global interface collaborative efforts.

Initial group deliberations focused on developing the criteria that informed the group's final top three choices. The consensus criteria the group selected were *impact, technology, institutions* and *infrastructure.* Based on these four variables, the participants identified information technology, energy and water as the S&T areas of most concern in the next 20 years. The group clarified the four criteria as summarized below:

Impact of the S&T phenomena

- scale of impact
  - felt on all levels of human organization (global, regional, national, local, individual)
  - includes the rate and scale of impact on the economic, social and cultural dimensions of human society (high likelihood of a crisis situation)

- extent to which the phenomena allows for the highest possible confluence between national priorities and national needs
- very high applicability of 'the law of unintended consequences'

Technologies relevant to the S&T phenomena

- their increasing rate of diffusion and speed of adoption or evolution
- greatly influence trajectories of other technologies and technological systems
- generate widespread and rapid innovations in dual-use applications, further blurring the lines between civilian and military S&T
- possessing high capability to create 'surprises' and 'revolutions'

Institutional issues

- S&T phenomena require dramatic change(s) in national and international frameworks for governance
- S&T phenomena increase the rate of gap between institutional change capacity and S&T phenomena change(s)
- S&T phenomena generate tensions in the areas of intellectual property rights

Infrastructure implications

- S&T phenomena demand increasing/new capabilities and resource requirements, including human capacity
- S&T phenomena raise significant demand for resilience and adaptability due to the emergence of new risks
- S&T phenomena exacerbate tension between embedded infrastructure and new design requirements generated by S&T phenomena

The participants then proceeded to examine each of the top three areas of concern and organized the discussions around the following categories: impact, challenges, opportunities for collaboration and policy implications.

The top three S&T areas of concern now and ahead

Information Technology

Impact

- Security threats
- Malicious attacks
- Cybertheft
- Cyberspying

All these are now occurring now and their impacts are on a global scale. These security breaches can paralyze commerce, be used to 'weaponize' infrastructure (e.g., detonate power plants, crash planes) and create panic, distrust and exploitable instability.

Challenges

- These are technically sophisticated, global problems
- Must develop secure software to reduce vulnerabilities
- Must develop network architectures and components that are intelligent and regenerative (self-aware, self-detecting, self-healing)

Opportunities

- Applicable technologies are emerging from government-funded institutions AND in commercial settings
- IT paired with open source data have profound global power implications

Policy Implications

- Need to establish international forums to coordinate countermeasures
- Need to exploit public-private cooperation to effectively respond

Energy

Impact

- Population growth and industrialization mean global energy needs will increasingly outpace supply
- Dependence on fossil fuels potentially empowers hostile nations
- Security threats

Challenges

- Must develop improved generation, storage and distribution technologies
- Need modeling capabilities that enable optimal matching of national needs and resources with technologies that would streamline implementation
- Compared with other emerging modalities, nuclear energy specifically is at once "ready for prime time," clean and scalable. However, it has a higher potential for accidents and weaponization AND has material disposal challenges.

Opportunities

- Improved materials for storage and diverse new energy generation modalities (solar, biofuel, wind, fusion, nano-scale fuels, etc.) are already being developed in academic and industrial settings. These can be prioritized and exploited depending on national regional needs.
- Leaders can exploit "low-hanging fruits" by encouraging conservation
- Energy independence reduces conflict

Policy Implications

- Need to develop a region-specific plan for prioritizing the development and implementation of generation, storage, and distribution technologies that addresses the natural resources, growth trajectory, etc. of the countries in the region

Water

Impact

- Security threat: Access to clean water is critical to directly sustain human life, to support agriculture and to prevent the spread of disease
- The need for clean water is growing due to population expansion and industrialization
- Unpredictable shocks to water supply may occur due to climate change
- Conflicts over control of clean water may be increasingly likely and could provoke social unrest

Challenges

- Technologies to definitively stop global warming and comprehensively address the unpredictability of water supply do not exist
- Global modeling technologies to predict climate change lack components relevant to understanding future changes in water
- Nations most directly impacted by this threat tend to be less industrialized – so although they are most likely to be hurt, they are "less responsible" for the problem and "less responsible" for paying for the solution.
- Many scientists blame industrialized nations for causing the problem – but most industrialized nations are minimally impacted on a day-to-day basis by the issue and often defensive to the accusations. This can impair the participation of such nations in solution-finding.

Opportunities

- Continue to harness desalination technologies
- Technologies that improve modeling may be increasingly available

Collaborative Proposals

- Establish collaboration and actions at appropriate levels of decision-making
- Improve international laws, treaties and technical collaboration
- Identify success in collaboration efforts in other areas for lessons learned that are applicable to creating opportunities
- Align multinational incentives to promote global cooperation
- Design global integrated assessment models that address interconnectedness of energy, water, economies, agriculture, climate and global health
- Develop down-scaled models to address regional and local impacts (context)
- Actively leverage innovations from multinational public and private institutions
- Harness S&T diplomacy as a proactive way to address near-term threats and reduce long-term conflict potential

Final Comments

Dr. Perry and Dr. Hecker put forth an outline of ideas for the group's consideration as possible points of departure for future follow-up dialogues between the S&T and security communities.

First, there is a need to revisit the existing baseline understanding and formulations of "big" concepts such as risk, vulnerability, adaptability, resilience and disruptive innovation. On risk, the question is whether there is a way to develop regional and global initiatives to manage the "spectrum of risks" borne out of the S&T-security interface. Moreover, Drs. Perry and Hecker also raised the notion of "transitional risks" defined as a "special" set of risks of developing nations as they transition from managing "traditional" to "modern" risks. With the increasing linkage between S&T developments and comprehensive security issues growing rapidly, the concept of vulnerability is also undergoing transformation. The question is how to live with it and define it in this fast-changing world. On the issue of adaptability and resilience, Dr. Perry suggests that there is a need to re-examine national and internation institutions, i.e., if these are setting realistic goals and trade-offs in light of the rapidly evolving S&T and security environments. And finally, the increasing occurrence of disruptive innovations bring to the fore the question of whether ad hoc responses are sufficient for ad hoc developments.

The second consideration pertains to the deepening global and regional spill-over effects of S&T developments on the security environment and conversely, the impact of changes in the security arena on S&T trajectories. This highly dynamic situation provides an opportunity to re-think the prevailing world order. Is it time to develop alternative ways of viewing and arranging the internation system? Should India and China be categorized differently?

Dr. Perry also stressed the importance of sustaining, if not increasing, the capacity to develop advanced integrated assessment tools to capture the intersection of S&T and security developments.

These are transformational tools that are particularly crucial now and into the future because certain security issues such as climate change are comprehensive and long-term in its impact.

Finally, Dr. Hecker highlighted the need to enhance and sustain international modes of cooperation and collaboration: to leverage international S&T diplomacy, to develop more robust and sustainable private public partnerships, and to capture, institutionalize and share successful collaboration efforts. Dr. Perry added that there is a need for us to shift our mindset from "independence" to "interdependence" in managing complex and interrelated S&T and security challenges. An example would be adopting a policy of "assurance through diversity" where all countries develop a multi-sourced energy portfolio to stabilize and secure energy resource supplies, consequently creating a thick web of regional and global interdependent networks that favor and affirm collaborative and cooperative behavior. In the same vein, he also noted that S&T priorities will depend on the politics, capacity, legal frameworks, location and resources of the local communities.

The top three S&T phenomena that the participants selected as areas generating the most concern in the next 20 years cannot be resolved by technoscientific solutions alone: Dr. Perry agreed with the findings of the group that the political, socio-cultural and regulatory "sensitivities" are considerations that critically inform national and international responses. Furthermore, the ethical, legal, societal implications (ELSI) of S&T developments must also inform policy responses – scientific and technological developments are necessary, but not sufficient, conditions to solve security concerns and issues. While the S&T phenomena are global in scope, the operationalization of the challenges, opportunities and security implications are local. In broad terms, the deepening interface of S&T and comprehensive security developments in a globalized context calls for a reexamination of established approaches to both S&T and security management.