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“Then & Now: Comparing the State of US Defense Research and Development from the 1950s to the Present Day”

**Herbert F. York Memorial Lecture
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Thank you, Tai, for that kind introduction. And my thanks to Dr. Susan Shirk and the rest of the IGCC staff for your work organizing this wonderful event.

Before I begin my formal remarks, I'd like to reflect on a moment just about 2 years ago. In May 2009, I was preparing for my Senate Confirmation when my father passed me the news that Herb York had passed on. While I am not quite sure if they ever met, they both had a passion for Physics and worked on similar projects. Dad spent his 43-year career at MIT Lincoln Laboratory in ballistic missile defense, and pointed out that Herb was the first to hold the position for which I was preparing.

So for me, it is a sincere honor to be here today to remember Herb York, a truly remarkable man whose broad legacy endures, not only in the national security issues he addressed but in the organizations he shaped and the lives he touched. We are indebted to Herb for his leadership and vision in the creation of institutions that have become critical to our national security: the Lawrence Livermore National Laboratory, the Advanced Research Projects Agency, and the Office of the Director of Defense Research and Engineering. Besides being an extraordinary scientist, Herb was a dedicated public servant whose commitment to national security is an example for us all.

There is a very interesting sentence in Herb's book *The Advisors: Oppenheimer, Teller and the Superbomb*. His introduction states, "I knew personally nearly all the participants in these events."¹ This included Oppenheimer, Teller, Von Neumann, Vannevar Bush, Ernest Lawrence, Enrico Fermi, Charles Stark Draper, Presidents Eisenhower and Kennedy, and others. Herb was a witness – and a participant – to a remarkable chapter of history.

I'm particularly humbled to be joined today by Herb's wife, Sybil, and his daughters, Rachel and Cynthia. As I understand it, Herb and Sybil met as Berkeley students during World

¹ Herbert F. York, *The Advisors: Oppenheimer, Teller and the Superbomb* (Stanford University Press, 1989), 7.

War II and had their first date at the home of one J. Robert Oppenheimer. It must have been quite the dinner conversation! In your 61 years together, Sybil, you witnessed all of Herb's milestones, both personal and professional. I hope to pay tribute to some of those, as well as his tremendous, generous spirit, here today.

Herbert York came of age, as a scientist and a scholar, in a time of great challenge and uncertainty. In 1949, the same year that Herb received his PhD from the University of California, the Soviets detonated the first plutonium bomb. Eight years later, the Russians launched Sputnik 1 and, along with it, a truly terrifying era of potential conflict with implications across all domains. The nation was for the first time facing a technological challenge and needed clear technical leadership. Herb, with typical clarity, would later describe the Sputnik launch as "the crucial psychological landmark in the course of postwar arms development, affecting almost every facet of defense operations."²

Around this time, Herb York was beginning to establish himself as one of the world's leading physicists because of his work at Ernest Lawrence's Radiation Lab at Berkeley and the Oak Ridge Y-12 plant. He co-discovered the neutral pi meson, which plays an important role in explaining the low-energy properties of the strong nuclear force. He also supported the development of the hydrogen bomb through his efforts on the electromagnetic separation of uranium 235.

And at that time, Ernest Lawrence and Edward Teller, Herb's colleagues at the Radiation Lab, were planning to open a nuclear weapons laboratory to augment the work being done by Los Alamos Laboratory. Lawrence asked Herb to produce some preliminary ideas for the new lab. After receiving Herb's input, Lawrence asked him to serve as the first Director of Lawrence Livermore National Laboratory. Though Herb was only 31, he deftly managed the lab, as well as the visions of its two founders, Lawrence and Teller, who had very different goals for its future. This was a remarkable time and a pivotal point for our nation's national security foundation.

This success led Herb to an unexpected place: Washington, DC. In 1958, President Eisenhower created the Advanced Research Projects Agency (ARPA) to bridge the gap – brought to light by the launch of Sputnik – between defense and science. ARPA was tasked with working those problems that the Services' research divisions had not yet been able to solve, whether it was due to insufficient budget, limited technical concepts, risk aversion, or lack of resources. Herb became ARPA's first Chief Scientist, where he directed space and antimissile research, two fields of increasing importance. This was an agency that had budget, authority and technical depth. Building upon the foundation laid by Herb and his peers, ARPA has developed some of the most groundbreaking technologies of the last 60 years: the Internet, GPS, and stealth technology.

Herb was not in Washington long before leaders at the highest level recognized his enormous potential. Around the time of ARPA's founding, according to Herb, "there really

² Herbert F. York, *Race to Oblivion: A Participant's View of the Arms Race*, (Simon and Schuster, 1970).

wasn't anybody at the top level of the Pentagon who knew modern technology."³ To address this deficit, the Eisenhower administration created the position of Director of Defense Research & Engineering, which was then the third-highest ranking job in the Pentagon. In spite of the fact that Herb was only 37, his technical expertise and proven track record as an agency leader made him President Eisenhower's first choice for DDR&E.

As soon as he was confirmed as DDR&E, Herb began recruiting top talent from the aerospace and electronics industries. Because of his leadership, reputation, and sheer energy, Herb was able to attract some of the country's brightest minds to join the civil service. Rather than the development of singular technologies, he directed his staff to focus on broader challenge areas. This is a great example of Herb's leadership as well as his innate understanding of how to provide solutions to the nation's most pressing security problems.

As DDR&E, Herb helped establish a centralized research and engineering enterprise that sought to "develop a national R&D strategy and aggressively guide the execution of that strategy by the military departments and ARPA."⁴ In doing so, Herb elevated the role of research and engineering in national policymaking and made the office of the DDR&E into "an effective focal point in the organization of scientific efforts" in the Department.⁵ Herb laid the essential groundwork that has allowed the position of DDR&E, now known as ASD(R&E), to become what it is today: the DoD's Chief Technology Officer, who provides thought leadership for the Department's near-, mid- and far-term research and engineering efforts to develop the technical capabilities in support of Department goals and priorities.

After his term as DDR&E, and during his time as UCSD's first Chancellor, leaders in Washington continued to seek Herb's counsel. He served as a delegate at the strategic arms talks with the Soviet Union in Geneva in the 1960s, and became chief U.S. negotiator in talks with the Soviet Union to impose a comprehensive nuclear test ban. Herb's thinking on procurement was changing; a leading technical expert who had worked on the hydrogen bomb – and who had the ear of the Secretary of Defense and the President of the United States – was now speaking on the record against the proliferation of nuclear materials.

To that end, Herb founded the Institute on Global Conflict and Cooperation (the IGCC) in 1983. His vision for the IGCC was to organize research, host seminars on conflict resolution, and promote international efforts to avoid war. I understand that Herb remained involved in the IGCC until his passing, which is evidence of his enduring commitment to the cause, as well as to the UCSD faculty, staff and students.

³ Herbert F. York, interview given for DARPA's 50th Anniversary Celebration, January 5, 2007.

⁴ Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, *Report of the Defense Science Board Task Force on the Roles and Authorities of the Director of Defense Research and Engineering*, (October 2005), 30.

⁵ Zuoyue Wang, *In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America* (Rutgers University Press, 2008), 104.

Although the list of Herb's accomplishments is long, it is important to remember that, no matter where he happened to be working, Herb was a broad, strategic thinker. His approach shaped several of our Nation's most important institutions – the federal lab system, our advanced research agencies, and the DoD's research and engineering enterprise – in enduring ways. He was able to stand up organizations quickly by inspiring his peers to join him in service, and by bridging the gap between cutting-edge science and the defense establishment. Throughout his career, Herb did not just *implement* solutions and policies... he *created* them.

Today, we, like Herb, operate in an environment of challenge and uncertainty. Our psychological landmark for this era was the terrorist attacks on the World Trade Center and the Pentagon. Almost ten years later, the world remains dangerous due in large measure to the rapid rise and availability of advanced technology. The phenomenon of globalization, and its subsequent dispersion of talent and resources, has profound implications for national security. We're living in a new, 21st-century environment of rapid innovation, and, unfortunately, this is not restricted to a new smart phone or gaming console. The threat of chemical, biological, radiological, and nuclear weapons has not dissipated since Herb York's days as a young scientist. In fact, it has grown; we now face the concern that weapons of mass destruction can be developed not just by nation-states, but also by terrorist groups whose very identity is often unknown. Military operations now take place in complicated cultural and geographical terrain. This often means a terrorist group, with intentions to attack our soldiers or our citizens, can hide their activities among the civilian populace in cities, or in caves and underground facilities hidden from view.

Much like in Herb York's lifetime, these challenges are complex; they require careful thought to define, quantify, and determine the appropriate responses. In some areas, such as Cyber, we need new models of deterrence that will emerge at the intersection of policy and technology. In this context, we have identified a set of science and technology areas where we need new ideas to address our critical national security challenges.

For example, we hear from the front lines that our warfighters are "swimming in sensors but drowning in data."⁶ Proliferation of sensors and large data sets are overwhelming analysts, who lack the tools to efficiently process, retrieve, store, and analyze vast amounts of data. It is imperative that we shorten the cycle time from raw data-gathering to operational decision-making. The Department has begun an initiative to develop an open-architecture approach that will enable rapid integration of existing and future data exploitation tools – more effectively, more efficiently, and more timely.

Cyber warfare poses another significant challenge to U.S. military capabilities: determined cyber foes can threaten our global logistics network, steal our operational plans, blind our intelligence capabilities, and challenge our operational capabilities. The frequency and sophistication of intrusions into U.S. military computers, information systems, and

⁶ Christopher Drew, "Military Deluged in Drone Intelligence," *New York Times*, January 10, 2010.

communications networks have increased significantly. Dominance across the full spectrum of operations within the cyberspace domain is essential if U.S. forces are to maintain a strategic advantage. The implications today are as significant as Sputnik was in 1958.

In the area of autonomy, we are within reach of an enormous opportunity to build systems that can do more with less human intervention. Next-generation autonomous systems represent an improvement over today's capabilities, but are still too fragile for uncertain and unstructured environments, as well as complex missions. The bottom line: Human involvement is still required with autonomous systems in order to deal with the unexpected. The next level of autonomy will deliver systems that comprehend their environments and relevant aspects of the battlespace in the context of the commander's intent and objectives and, when necessary, in collaboration with human teammates. This idea was first proposed by J.C.R. Licklider, who in 1960 wrote a paper called *Man-Computer Symbiosis*, which outlined two ideas that are as remarkable today as they were when they were first proposed. He wanted to "let computers facilitate formulative thinking as they now facilitate the solution of formulated problems" and "enable men and computers to cooperate in making decisions and controlling complex situations without inflexible dependence on predetermined programs."⁷ The magic here is that Licklider arrived at ARPA in 1962, just a few years after Herb York, and used that agency to launch the initial work in artificial intelligence from the Information Processing Techniques Office.

Data-to-decisions, cyber and autonomy are three of the seven strategic science and technology priorities for the Department. Many of these areas are shaping new technical disciplines for which we need strong collaboration between industry, academia and government. Above all, we need technical leadership in some very new areas.

We need the support of people like you if we are going to open up these new frontiers. There are multiple options for you to participate in the process of creating and preventing technological surprise. Some of them are career-long commitments, others would be full-time for a few years, and still others call upon your commitment for only a season. All offer the opportunity for public service to the nation where you can use your technical insight and depth to open new technical fields that will have an enduring impact.

Consider opportunities at any of the advanced research projects agencies. After Herb helped start ARPA, which was later renamed the Defense Advanced Research Projects Agency, the Intelligence and Energy communities stood up similar institutions. You can serve one of the ARPAs as either as a full-time employee, many of whom agree to serve for a few years with the expectation of returning to industry or academia, or as the recipient of a research grant.

Consider service opportunities with the Defense Science Study Group, a program that introduces outstanding young professors of science and engineering to national security challenges. Over the course of this part-time, two-year program, invitees participate in defense

⁷ J.C.R. Licklider, *Man-Computer Symbiosis*, IRE Transactions on Human Factors in Electronics, v.HFE-1.

policy and related research and development, as well as study the systems, missions, and operations of the Armed Forces.

I would challenge the students here today to engage with the Department's Science, Mathematics and Research for Transformation (SMART) program. This is a scholarship-for-service program which currently funds 670 undergraduate, graduate and doctoral students in 19 DoD-relevant fields of study. And I would challenge faculty to consider the National Security Science and Engineering Faculty Fellowship. This program provides long-term funding awards to 29 university faculty members for basic research in new technical fields for the Department.

While our challenges are indeed daunting, and while the idea of putting your life on hold to move to Washington for a few years to help us solve them might seem like an inconvenience, I ask you to remember the example of Herb York. He was a truly brilliant leader and an exceptionally committed public servant, who never failed to answer the call each and every time it came. Herb himself had some great advice for young people, which I think applies to all of us: "It's a question of odds and the biggest thing is opportunity. Opportunities do come along, the problem, when you see one, ditch everything else and take it if it's a good one.... If you're young and have a family...that can be not only gutsy but can even be harmful...if you've got other responsibilities. But opportunity comes to everybody and what you have to do is be ready to seize it, no matter what else you're doing. ...give up everything else that's career-related.... The real trick is to recognize the opportunity and do something about it."⁸

Do something about it... I like that. The problems we face are too big and too important to ignore. We need people like Herb York – people like YOU – to rise to the occasion as he did.

I walk into the River Entrance of the Pentagon every day, and up that first flight of stairs, I pass the Oath of Office I took on July 2, 2009, the Preamble to the Constitution, and the Declaration of Independence. All are a reminder of the reason I came back to the Department of Defense as DDR&E: to keep our extraordinary men and women in uniform safe, and to ensure that our nation remains strong.

I imagine that Herb had the same motivations during his time in Washington. He was an intellectual giant who distinguished himself as an internationally renowned specialist in fundamental high-energy experimental physics throughout his career. But it is Herb's tireless dedication to public service – along with his dedication to his family, friends, colleagues, and students – that is the primary reason he remains an inspiration to us all.

⁸ Sandra Butcher, "Herb York (1921-2009): On Pugwash History and a NFWF," <http://pugwashhistory.blogspot.com/2009/05/herb-york-1921-2009-on-pugwash-history.html> (May 21, 2009).