PM Interviews Dr. Ron Sega, Pentagon's Top Research & Engineering Advisor

The Recognized Challenge of the 21st Century is the Uncertainties

Dr. Ronald M. Sega is more apt to be recognized in a space suit than a business suit. The switch from astronaut to bureaucrat, however, was a natural career progression for the former physics professor, dean of engineering and applied science, Air Force command pilot, and American astronaut, who in his current position as DoD's top advisor for research and engineering, accelerated deployment of the bunker-busting "thermobaric" bomb used by U.S. forces for the first time in Afghanistan.

A man of many talents and interests, from building his own home to bringing the missile shield to life and dominating outer space through hypersonics, he foresees superfast missiles and spaceships that can zap any target. One of his goals is to increase U.S. flight capabilities by one Mach a year until 2012. Sega has truly lived the American dream after his forebears on his father's side first came from Loski potok in Slovenia.

Many of the initiatives emerging from his Pentagon office took on a different focus and form after Sept. 11, 2001—a day that Sega was in the Pentagon when the hijacked airplane struck. Sega and his staff have refocused the Pentagon's research and engineering efforts on taking an integrated approach to technology and moving those tools quickly to warfighters.

For 2004, Sega is working hard to keep basic research programs funded as more and more dollars are focused on operational capabilities related to the war on terrorism and the current conflict in Iraq.

It's important that we be aware not only of the advances in technology outside the areas we're developing for our own purposes, but also of the potential use by adversaries.

On Aug. 6, DAU Professor of Systems Engineering Dr. Marty Falk interviewed Sega on behalf of *Program Manager*. Sega spoke with Falk from his Pentagon office, sharing his personal perspective on transforming the department's research and engineering capabilities.

Q *I'd just like to start out talking a little bit about 9/11. We all know that it had a significant impact on our defense posture. One of the things that came out of it was creation of the Combating Terrorism Technology Task Force drawing representatives from the Services and various defense agencies. Can you tell us a little about what has come out of that task force so far—perhaps what some of the focus areas are and how they relate to your office?*

A After 9/11, we were focusing on what we could offer in terms of support to upcoming research and development efforts. I thought it was important to bring together the leadership on the technical side of the Department of Defense to determine if there were technologies that could be accelerated to be ready in a month or so, in a year, in five years. So we came together on September 19, 2001, with the task to try to address those challenges, especially the near-term one.

On September 21, we had roughly 150 candidate technologies for near-term availability. Working with the users, primarily CENTCOM [Central Command] and SOCOM [Special Operations Command], we identified three of those for

acceleration that very evening. They included the nuclear quadruple resonance system that's currently used for DoD and, I believe, the FAA [Federal Aviation Administration] as well. We created a penetrating system in the CALCM [Conventional Air Launched Cruise Missile], and the thermobaric bomb that is a conversion of BLU-109, and then designated BLU-118B. All were completed within 90 days.

The thermobaric bomb is an interesting story from a couple of perspectives. We started from basic chemistry. In October 2001, through collaborative efforts of DTRA [Defense Threat Reduction Agency], the Air Force, the Navy, and the Department of Energy, we took the lab work and the computer models, selected a leading candidate at the end of October, integrated it into a bomb body and performed static test in Nevada in November, then flight testing on December 14, 2001. The process, from start to finish, was completed in 90 days. So one: there was an additional capability available to the warfighter. And two: it's an example of how we can bring together the expertise from various Services and agencies and bring a system to a fielded state in a very short period of time.

The Combating Terrorism Technology Task Force continues to look at other efforts inside and across the Services and other agencies that would be very useful to accelerate. In Operation Iraqi Freedom, we looked at potential CENTCOM and SOCOM needs, and in some cases we identified technologies that would receive additional funding to accelerate the development and test. And 100 percent of those were successfully completed and delivered. That was a tribute to the folks in the Services and agencies who were working hard with the users to bring technology forward in a rapid and efficient way.

Q

How were these projects handled from a funding standpoint? Did the individual military activities fund them, or is there some central funding that is used to accelerate these things?

We have had a joint warfighting science and technology plan for a number of years. It continues to improve as we involve our end user, the warfighter, in the process.

A

Well, a little of both. Funding for some of the projects was in the Services. There was some reprogramming, and other projects received additional funding from supplementals or other types of funding vehicles. We actually received quick-reaction mission funds dedicated money in fiscal year 2002, right at the end of the congressional session—about $15 million—and we applied $13 million of that toward the Thermobaric Hellfire effort. Roughly a year later, we had gone through the development of a replacement for the warhead on the Hellfire missile that was much more effective in enclosed structures and still met all the requirements of the model that we had started with—the Mike (MK) model of the thermobaric bomb. In this case, the Marine Corps participated in the development with support from other Services. This is a good example of bringing things forward once a funding source is identified.

Q

The terrorists rely on things like surprise, deception, and asymmetric warfare. As a matter of fact, I recently read in the papers that there have been attempts to conceal weapons in consumer electronic products, like boom boxes. How do we go about determining what capabilities we need to be able to counter this kind of asymmetric threat?

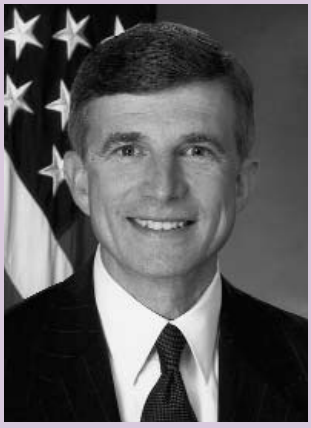
A

The recognized challenge of the 21st century is the uncertainties—recognizing the rate of change in technology that will be increasing as we go forward. The availability of this technology is not only for us but potentially for adversaries. It's important that we be aware not only of the advances in technology outside the areas we're developing for our own purposes, but also of the potential use by adversaries. It is indeed a challenge, and we cannot stop pushing the frontiers of technology, both in application of commercial products and understanding of their possible uses, and in development of technologies that we build on our own or with industry.

Q

Sort of a related question: with the new JCSI3170 [Chairman of the Joint Chiefs of Staff Instruction 3170.01C] and the new JCIDS [Joint Capabilities Integration and Development System] process, we're now focusing on the capabilities-based requirements system as opposed to the old traditional threat-based scenario where we were looking at specific threats. What impact does that have on what we do in the S&T [science and technology] arena? How do we derive what those ca-

Ronald M. Sega, Director, Defense Research and Engineering



Dr. Ronald M. Sega, director of defense research and engineering, is the chief technical advisor to the secretary of defense and the under secretary of defense for acquisition, technology, and logistics on scientific and technical matters, basic and applied research, and advanced technology development. Sega also has management oversight for the Defense Advanced Research Projects Agency.

Sega has had an extensive career in academia, research, and government service. He began his academic career as a faculty member in the Department of Physics at the U.S. Air Force Academy. His research activities in electromagnetic fields led to a doctorate in electrical engineering from the University of Colorado. He was appointed assistant professor in the Department of Electrical and Computer Engineering at the University of Colorado at Colorado Springs in 1982. In addition to teaching and research activities, he also served as the technical director of the Laser and Aerospace Mechanics Directorate at the F.J. Seiler Research Laboratory, and at the University of Houston as the assistant director of flight programs and program manager for the Wake Shield facility. In 1996, Sega became the dean, College of Engineering and Applied Science, University of Colorado at Colorado Springs. He has authored or co-authored over 100 technical publications and was promoted to professor in 1990. He is also a Fellow of the Institute of Electrical and Electronics Engineers and of the Institute for the Advancement of Engineering.

In 1990, Sega joined the National Aeronautics and Space Administration (NASA), becoming an astronaut in July 1991. He served as a mission specialist on two space shuttle flights: STS-60 in 1994, the first joint U.S.-Russian space shuttle mission; and the first flight of the Wake Shield facility; and STS-76 in 1996, the third docking mission to the Russian space station Mir where he was the payload commander. He was also the co-principal investigator for the Wake Shield facility and the director of operations for NASA activities at the Gagarin Cosmonaut Training Center, Russia, in 1994-95.

Sega has also been active in the Air Force Reserves. A command pilot in the Air Force with over 4,000 hours, he has served in various operational flying assignments, including a tour of duty as an instructor pilot. From 1984 to 2001, as a reservist assigned to Air Force Space Command, he held positions in planning analysis and operational activities, including mission ready crew commander for Satellite Operations-Global Positioning System-Defense Support Program, and Midcourse Space Experiment, among others. Sega was promoted to the rank of major general in the Air Force Reserves in July 2001.

pabilities are and focus our S&T efforts in those areas?

A

The science and technology work becomes increasingly important in a capabilities-based approach to the future. We need not only look at a capability that we want to have in the near term, but also recognize that it is a journey in time and that we want to have the technological edge into the future. The investments that we need to make are not only for the current generation, but for the next generation, next generation, and next generation. So a strong fundamental technology base is also important for maintaining a capabilities-based edge in the future. We need to be looking at and bringing forward the near-, mid-, and long-term capabilities. The breadth of work is quite extensive in terms of the different technologies; and making decisions as to which of them to fund and turn into operational capabilities of the future is quite difficult.

We have increased interaction with the warfighters—the user community—in order to bring our development activity in line with the work done at Joint Staff as well as combatant commands, Services, and agencies. That linkage is important to establish from day one and must continue throughout the life of a capability or system. That involvement also includes acquisition and logistics professionals. Everybody needs to be engaged from day one to the end. As we look at the spiraling of technology into systems, it is implied that we understand the system as well as the technologies that could be available to spiral into the systems. We try to provide mechanisms that allow that transition of those technologies to occur.

Q

It seems to me looking at the new JCIDS process, that there's going to be more up-front activity. It almost seems like the Joint Staff is going to be responsible for some pretty significant decision making. How are we going to get the labs and the technologists involved in that process?

A

We have had a joint warfighting science and technology plan for a number of years. It continues to improve as we involve our end user, the warfighter, in the process. We are now aligning with those functional areas. We need to make sure that the technologies, the direction of the Joint Staff, and our planning process will be aligned. We will also be paying attention to the technology base because that's what we will be drawing from. If we have a strong research and engineering base, then when we do the analysis of alternatives, we will have a robust set of options to select from. We need to look not only at the pull, but also continue some of the push on the technology side.

Q

We've seen some discussion here again in the press recently that possibly the terrorists are not so much going to focus on

the individuals as perhaps try to focus on our economy, try to bring it down. Much of what impacts our economy—the power, communications infrastructure, our financial systems, our transportations systems—is in private hands. What kind of things can the Department of Defense do to help prevent accidents in terms of attacks to that infrastructure?

A

One of the cross-cutting initiatives that we have been engaged in is surveillance technology, and that's a set of technologies being pursued from basic research and so forth, that provides an underpinning for C4ISR—command, control, communications, computers, intelligence, surveillance, and reconnaissance. And in that are the technical pieces that bring information assurance back to the battlespace and allow a network-centric approach to warfare.

We also want to have awareness of the battlespace, so sensor technologies will be needed in the future. Many of the technology efforts will have not only direct application to our warfighting missions, but they also have similar technologies that could be applied to the cases that you mentioned. We collaborate with the DHS—the Department of Homeland Security. One of the principal interfaces to support the DHS is through Northern Command. So we work with them to provide the technologies that they would need to do their job.

Q

I heard somebody in a speech a few weeks ago raise the issue that we had a lot of focus on interoperability from a Joint Coalition perspective, but I'm thinking that interoperability with the civilian world is a real issue.

A

It is, and through a series of exercises, the Northern Command is trying to understand exactly where we are. In the future, we'd like to start with a view toward an integrated approach so that systems are really tied together early from a systems engineering point of view, versus waiting until later and trying to have the ability to connect them.

After 9/11, we were focusing on what we could offer in terms of support to upcoming research and development efforts. I thought it was important to bring together the leadership on the technical side of the Department of Defense to determine if there were technologies that could be accelerated to be ready in a month or so, in a year, in five years.

Q

We've been aware of a few other items that were put on the fast track. For example, there was a hand-held device that converts images from UAVs [unmanned aerial vehicles], a language translator, a pen-size device that disinfects water. How are these kinds of programs being brought forward? How are we able to transition some of them? Another question is what is being done about the supportability issues. A lot of these quick-reaction projects get fielded, they're an immediate success, but then they fall into disrepair or misuse because in the rush to get them out there, we haven't thought about the downstream support issues. How are we dealing with that on some of these projects?

A

The transition of technology is an important issue. We've focused on it from day one, and we continue to work on it. Now we have additional mechanisms in place to aid the transition of technology, and we are involving the warfighter much earlier in the process. We have a quick reaction special projects activity that has three parts. One is to look at varied and new ideas, new technologies in the quick-reaction special projects fund. Another is the Technology Transition Initiative [TTI] that provides support for testing a system and making sure it would provide value and that the transition to the Services takes place. And third is the DAC [Defense Acquisition Challenge] program that looks at technologies that may be out there that can enhance a current subsystem and must have buy-in from the program manager and OEM [original equipment manufacturer] of the affected system.

I think that involvement of S&T personnel within the Services, agencies, and combatant commands early on in the process is important in order to understand what is technically possible in the near-term, mid-term, or long-term and to understand the needs that are there. This is probably the most important aspect of bringing technology transition

forward: having communication between all the players.

Q

You mentioned the quick reaction fund. How much money is in that? How do projects get funded. And have you been doing it long enough to have any success stories?

A

This is the first year of the quick reaction special projects fund. The larger part of that was the Defense Acquisition Challenge, and that just closed out. We had a review process that was run, to a great extent, out of AS&C [Advanced Systems and Concepts], which is deputy under secretary of defense AS&C Sue Payton's area, to look at the technologies. The proposals that were the best ones went forward for award this month.

The TTI's purpose is to bridge the "valley of death"—to help technologies coming out defense science and technology labs survive and get to acquisition faster than previously. The program provides current-year funds that otherwise wouldn't be available to facilitate some aspect of this transition.

To give you a few examples, these funds may be used to integrate a technology into existing combat systems, to rapidly assess its viability in a demonstration, or to execute low-rate initial production. To initiate the program this year, the Services and defense agencies were solicited for key projects needing assistance in transition. The projects were then rated and ranked in accordance with mandated criteria. Thirteen were selected for funding. Those projects represent a diverse field of technologies serving the military services and joint combatant commanders.

Q

Are these proposals submitted by the Services, or do contractors come in directly and propose technologies?

A

For the TTI program, the selection process is guided by a technology transition council that meets semi-annually. It is composed of the Services' acquisition executives, their science and technology executives, and the Joint Requirements Oversight Council. It addresses technologies that are ready for transition and the need for transitions, and it provides advice to the technology transition manager, Sue Payton, who then makes final selections.

Probably the most important aspect of bringing technology transition forward [is] having communication between all the players.

Review of initial DAC program project submittals for fiscal year 2003 funding progressed at a rapid pace with initial assessments at the military services and USSOCOM for comment. Nearly 120 military service program offices were contacted for technologies that could potentially benefit their programs of record, and nearly 80 program offices submitted final proposals.

Q

The ACTD [Advanced Concept Technology Demonstration] projects have been ongoing for quite a few years. They have demonstrated a lot of interest in technology, but it seems that often they don't become formal projects. I think a lot of that goes back to the supportability issues too. Are we doing a better job at getting some of those things to transition, or do we have any recent ACTD successes that we can point to?

A

I believe we are doing a better job. We are involving the Services and combatant commanders, who are the requirement sponsors in the ACTD process. We are looking at the funding profiles to make sure the technology transition is possible from the very beginning.

In the early years of the ACTD program, the emphasis was placed on initiating projects that blended emergent technology and innovative operation employment concepts. This commitment to bold transformational efforts continues and is now matched by a commitment of efforts and resources for transition to sustained capabilities for our joint combatant commander customers. The partnership structure of each ACTD now adds a transition manager to the technical manager and operational manager team. Provision for some transition costs inside ACTD management plans also encourages the move from a compelling demonstration to a sustained capability. These elements are added at the same time that the time line for individual ACTDs is being compressed, to speed delivery of capabilities while embedded technologies can provide a decisive operational edge.

Many ACTD products were employed in Operation Enduring Freedom and Operation Iraqi Freedom. Here are a few examples: Theater Precision Strike Operations, which provides joint commanders with the automation needed to plan and direct counterfire and precision strike operations; LASER [Lan-

guage and Speech Exploitation Resources], which provides improved interoperability, accuracy, and timeliness of translation for speech and document exploitation and translingual retrieval capabilities and products; JMOT [Joint Medical Operations-Telemedicine], which will provide the ability to integrate the Services' deployable theater medical telepresence in remote locations; ACMD [Area Cruise Missile Defense], which integrates various civilian and military sensors into a single, common air-defense operational picture, and is being used by the U.S. Air Force in the JBECC [Joint-Based Expeditionary Connectivity Center]; CASPOD [Contamination Avoidance at Seaports of Debarkation], which provides a fly-away package that fills the gap in chemical and biological defense capability that exists at seaports of debarkation; and finally, HUMINT [human intelligence] and counter intel support tools, which are providing a mature commercial and government off-the-shelf technology to human intelligence and counterintelligence personnel.

Q

Could you tell us a little bit about the National Aerospace Initiative? I know that it is, in your eyes, a very important initiative that's looking at hypersonics, space access, and so forth. I wonder if you can tell us why it is so critical to national security.

A

When I arrived here in August of 2001, I was given a stack of things that were in progress, drafts of studies that were ongoing, and recently completed reports from the Services and agencies on the technologies that were being looked at or suggested in the areas of high-speed flight, including turbine-based ramjet and scramjet types of propulsion options, rocket-based areas, and the space technologies that were in the process of implementing part of the Rumsfeld space commission findings.

We took a look at these areas, and we worked on the integration of the current efforts and did an assessment on the state of technology and the opportunities in these areas. We also looked forward to the future and saw a synergy that would be a very positive force enabling us to have greater capabilities relatively near-term as we increase the speed of systems, give ourselves more options for access to space, and potentially even look in a different way at our space architecture to accomplish the assured, responsive access to space in a more important way. We are focusing on the coordination and integration of the technical efforts not only within the Department of Defense, but also with the key partner in this area—NASA.

The technologies we pursue may be decades away but we must invest in them today to ensure their availability for future warfighters.

Q

I know you've got some challenges. You have a goal I think of a Mach per year to increase in speed.

A

The programs that were in place and those that we have adjusted were on roughly the trajectory to continue the flight programs. We've been working on some of these technologies for decades. Approximately 300 ground tests of various engines have taken place in the last few years, so we're at a point in our development phase of propulsion systems that it's time to fly. We'll gain a great deal of knowledge from doing that, which helps in terms of ground testing programs and modeling and fundamental work as well.

Q

In your career you had two missions on the space shuttle, both of which involved the Russians. You were also the director of operations for NASA activities at the Gagarin Cosmonaut Training Centers, Russia, in 1994-95. Do you have any comments you'd like to share with us on the Russian space program then and now?

A

Yes. The Russians have had some remarkable successes in the space program. My experience was positive with respect to the engineering, the professionalism of the Cosmonaut Corps, the training folks, and the people in the operations centers; the strong capabilities in areas such as propulsion, metallurgy, and in mechanical systems, such as welding. They're very, very good. It was a great and very positive experience.

Q

People—how do you plan to attract (or retain) the innovative thinkers you need? Could you comment on the perceived graying of the workforce and how it will affect your mission?

A

The Defense laboratories are seeking to attract and retain top scientists and engineers [S&Es] to support the DoD laboratory missions. The DoD is developing a new personnel system that will permit us greater flexibility to hire and retain the very best. One good aspect is that the new system will permit direct appointment of new graduates having excellent academic records. This will

allow us to be more competitive with industry in hiring the best and brightest. The process of hiring senior level people will also be streamlined and will allow the payment of significant bonuses to attract the more experienced and qualified S&Es.

Additionally, we have begun to incorporate long-term strategies and guide investments that reshape the S&E supply chain, assuring a quality pipeline of personnel resources.

The DoD laboratory workforce is indeed graying, with many of the S&Es becoming eligible to retire in the next few years. Depending on the particular laboratory, between 25 and 50 percent of the S&Es will be eligible to retire in the next five years. However, this does not mean that they *will* retire. Many are opting to continue to work beyond their retirement eligibility dates. And some are opting to retire from government service, go to work for industrial firms, and return to perform the same or similar duties as contractors.

Many of these individuals are the recognized experts in their scientific and engineering fields, so their loss will impact the laboratories' capabilities. This is why we are asking many of our senior people to mentor the young, new engineers and scientists. One of the DoD laboratory workforce enhancements we are requesting in fiscal 04 is a new DoD laboratory mentoring and new hire development program, which will provide support to senior level researchers to mentor new hires and to collaborate on research projects.

Q

What's being done to revitalize DoD's laboratories and their infrastructure?

A

We have recently revitalized and redirected a major effort to improve laboratory quality. This new effort is the Laboratory Quality Enhancement Program, which involves senior executives from the Services and is chaired by the deputy under secretary of defense for laboratories and basic sciences. This effort involves working groups in four areas: personnel, education, exemplary practices, and enterprise assessment. There will be initiatives in each of these areas that will lead to improvements and innovations in laboratory quality, productivity, relevance, and leadership.

The DoD is developing a new personnel system that will permit us greater flexibility to hire and retain the very best [scientists and engineers]. ... This will allow us to be more competitive with industry in hiring the best and brightest.

Q

Are there differences in how industry conducts its S&T efforts compared with DoD? Can you give us some examples?

A

Yes. The fundamental difference is that industry must focus on minimizing risk and maximizing the bottom line. Industry, therefore, focuses on near-term S&T. DoD, on the other hand, focuses on maintaining technological superiority for future generations. The technologies we pursue may be decades away, but we must invest in them today to ensure their availability for future warfighters. Yet we must also stand ready to provide solutions to near-term problems.

Another difference is the breadth of the DoD's S&T program. The DoD uses commercial technology wherever possible; however, there are many areas in which national security needs are unique. We must stay at the front of fast-moving commercial technologies such as information technology and biotechnology, and we must continue efforts in areas where industry has lost interest or has little interest.

A third difference is the DoD investment in basic research. Historically, the greatest investment in our nation's basic research has come from the federal government, and a large portion of that investment is through the DoD. Because most basic research is conducted in our colleges and universities, the DoD S&T Program has been important in developing the scientists and engineers who are key to the success of industry and the DoD.

Q

Secretary Aldridge's goal was to have 3 percent of the fiscal 2003 budget allotted for science and technology issues—and he almost made it. Will that trend of increased funding continue?

A

The 3 percent goal was actually set by Secretary of Defense Rumsfeld in the September 2001 Quadrennial Defense Review. It remains the Department's goal to

continuously grow the S&T investment toward 3 percent of the total defense budget.

As you noted, we have been making progress towards achieving this goal in our recent budget requests.

Q

Can you tell us what you are doing to focus DoD S&T on Secretary Rumsfeld's transformational goals?

A

In the summer 2002, my staff worked with the military departments and defense agencies to ensure that sufficient funding was being directed toward projects that advance the six Quadrennial Defense Review transformation operational goals. In September 2002, the Linking Science and Technology to Transformation report was completed, and one of the major findings was that the DoD S&T program was mostly aligned with the transformation operational goals, with nearly 80 percent of the program in direct support of these goals. This finding was verified by the recent study that looked at the actual S&T budget contained in the fiscal 2004 presidential budget request.

Q

One last quick question just to wrap up: I wonder if you could share with us the best piece of advice you were ever given and what you think your greatest success has been in your career.

A

The best advice? Probably from my parents: "Do your very best and work hard." I try to do that. And success—my current job. I couldn't ask for anything more important—great people and a very, very important mission for a great country. I'll continue to work hard and do the best I can. Thank you very much.

Editor's Note: To learn more about DDR&E initiatives and programs, visit http://www.dod.mil/ddre/.

Air Force Reserve Major General Ron Sega (center), former American astronaut, is shown aboard the Russian Space Station Mir in 1996. Astronauts Linda Godwin (left) and Rich Clifford (right) are preparing for the first spacewalk ever to take place while the Space Shuttle was docked with Russia's Mir Space Station during the STS-76 mission, the third docking mission to the Russian Space Station. Both are already wearing their space suits, called extravehicular mobility units (EMU), while PayLoad Commander Sega assists them in getting suited-up and during final checks of the equipment. The picture was taken inside the airlock, and the upper parts of the EMUs are still mounted to the walls of the airlock.