Chief Scientist Speaks of the Future

Interview with Dr. Thomas Killion

Dr. Thomas H. Killion is the Acting Deputy Assistant Secretary for Research and Technology/Chief Scientist, responsible for the Army Science and Technology program. Prior to this designation, Dr. Killion served as the Director for Technology in the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology under the Deputy ASA for Research and Technology. In this position, he was responsible for oversight and coordination for the majority of the Army's Applied Research program and all of its Advanced Development program. He also co-chaired the Warfighter Technical Council and managed the Science and Technology Objective and Advanced Technology Demonstration approval process for the DAS(R&T). These and other outstanding credentials made him an obvious choice for ASJ to interview about the future of Space technology. He spoke by phone from the Pentagon to ASJ's MAJ Laura Kenney on that topic.

Q: From hot air balloons used during the Civil War for aerial surveillance, to satellites providing similar benefits today — Space has been a combat multiplier since its inception. How important a role do you see it playing in current operations?

A: Immense. Bringing technology to bear that we've invested on in the past, we see the results in widely used space technology today. For example, people invested in basic research in the atomic clock 50 years ago that led to high precision timing. The Global Positioning Satellite system that we use to geo-locate vehicles, people, and targets today is based on that research.

As far as current applications, in addition to using GPS for navigation and precision targeting, there is of course the traditional intelligence function, such as imaging, which maps out terrain, infrastructure and forces, allowing us to plan efficiently and effectively in the application of our force capabilities. As usual, that has been critical.

In communications, Space is absolutely essential, allowing us to remain in constant contact, both in theater and back to the U.S., using both military and commercial assets.

Less obvious, but just as important, is how we utilize Space in the field of meteorology. The Army has invested a lot of resources in learning how best to exploit technology under varying weather conditions and to use that knowledge to guide our use of sensors and weapons.

Q: In future operations?

A: I don't see the importance of any of the above diminishing; in fact I only see it increasing.

In communications, limitations we've had in the past have been infrastructure for Space-based comms, such as fairly large tracking antennas. Electronically scanning antennas will enable us to export low profile satellite communications technology down to the much lower levels.

For intelligence — advances in miniaturization of processing, enabling high capacity laptops and even advanced Personal Digital Assistants (PDAs), can literally put imagery and other intelligence information in the hands of the individual soldier. Very Dick Tracy.

Meteorology has seen tremendous advances in the modeling domain. We're already performing pretty well at large scale … I see us in the future getting better at providing high resolution local data… small scale right down to where the soldier is, enabling him to maximize and take advantage of those weather conditions from an operational sense.

Navigation tools will also advance significantly due to miniaturization; we've already got amazing

handheld systems.

Q: In what particular area do you see it as most valuable — communications, intelligence, weaponry? Why?

A: I don't see any single one as the most valuable; rather I see a convergence of functions over time — a synergy of improvements in each area. Imagine a weapon that, in addition to performing as a weapon hitting a target, simultaneously feeds us intelligence on the target area. Communicating back to us intelligence and navigational information on the terrain, target and weather — all this in a single system. Advancements in terms of communications have sped up such concepts as using an artillery shell as an intelligence-gathering device. It expands the envelope of data sources available to the networked force.

Q: What are drawbacks/showstoppers, if any, to integrating and utilizing Space in such ways?

A: I'd use the term challenges rather than drawback or showstopper. The first such challenge is bandwidth, simply put. Our capabilities are expanding faster than the bandwidth available. We're answering that in various ways: being smarter in terms of data distribution (minimizing the load on the network), real-time bandwidth management, dynamically matching information demands to available bandwidth, and using more efficient antennas (such as directional vs. omni-directional systems). So we're working hard to meet that challenge, to ensure the warfighters have access to the information they need.

Another challenge is making sure that the information we receive from these great assets is accurate, that any adversary is not deceiving the system into believing inaccurate info (similar to how meaconing in navigation systems causes location errors). We need to prevent intrusion, deception or disruption and we're also addressing that through techniques that maximize, maintain and improve the integrity of our access to Space assets.

Q: Science fiction writers and artists — notably Jules Verne and Leonardo da Vinci — conceived of ways to exploit Space decades, even centuries, before such usage became reality. Do you believe such exponential development to be still possible, or are there already visible limits set by the laws of physics, etc. Will there be changes as exponential as we've seen this century, in twenty years? In fifty?

A: The short answer is yes — the changes will be exponential. To expound, a noted futurist, Ray Kurzweil, has postulated that advances in scientific knowledge and technology accelerate in an exponential manner. He believes that the explosion we have seen in technology in the last couple of decades is but a harbinger of what is to come.

Kurzweil believes that we will explore Space further, but probably through robots. He believes that there will come a time when, due to the expansion of computer processing, it will rival human intelligence. Nano probes to network and map the human brain could theoretically allow us to download an individual's intelligence. It would then be reasonable to send that intelligence into Space to explore for us, where perhaps our more fragile biological systems could not endure. We could then explore Space virtually. All of this is theoretical or speculation, but I do believe we will see changes as startling and profound in our future as we have seen in our past.

Q: Can you give us an unclassified view of some Space technology under research and/or development currently?

A: The Army's S&T investment in Space focuses on the tools that we use to exploit the communications, navigation and intelligence information available to us from Space systems, rather than on the satellite systems themselves. Again, the rapid advances in miniaturization of technology play a large role in current development. One example of what we're currently working on is shrinking an Inertial Measurement Unit — used in navigation — to a fraction of its current volume. Using micro-electro-mechanical systems (MEMS) technology, the goal is to provide a low cost device for munitions that provides adequate accuracy and much lower volume so it can be used in even very small munitions, greatly increasing their precision. Where Space technology comes in is that we are also looking at integrating GPS into the system to provide real time location updates in-flight, further increasing the accuracy of the weapon.

A couple of other relevant technology efforts are the work on satellite communications antennas for comms-on-the move, mentioned earlier, and techniques for more rapidly exploiting imagery and other Space-based intelligence to aid in maintaining battlespace awareness.

Q: How adversarial do you see Space technology as becoming? Do you foresee actual Space wars, or Space-based weaponry, despite the current treaties forbidding such, in our lifetime?

A: The answers to those questions really depend on the Space capabilities of our potential adversaries. Many people around the world have access to Space-

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based imagery and communications from commercial or military sources. Denying such access may be necessary in certain situations.

With regard to direct confrontation in space, either anti-satellite weapons or satellite-based warfare, there are probably not too many countries with those capabilities. The recent growth of the Chinese Space program is a concern. In any case, what we need to do is to make our systems as resistant to threat as possible. This means on the ground as well as in Space. And we have to make them resistant to Space weather as well as potential adversaries, the recent solar flares providing a case in point.

I don't see Space wars happening anytime soon, but possibly Space-based weapons.

Q: How can technology be used to protect the sovereignty of Space?

A: I think the best answer to that is ensuring that our systems will survive in the harsh environment of Space, be that Space weather or attack. As we ensure our access, and work to provide better protection to counter any threat of attack, we will be doing our part to ensure that Space remains free.

Q: How deniable to adversaries are the Space benefits we are presently using?

A: That's directly in proportion to how well we design our systems, and how well we protect them. Encryption, jamming, deception, and protection — these are all tools by which we deny any adversaries greater or even equal access.

Q: Realistically, how large a role do you see Space playing in future conflicts?

A: A very large continuing role. Space has become an integral part of how we conduct the warfight. We depend on it for precision navigation, intelligence, meteorology, and communications. Expanding and exploiting the uses of Space to an ever-increasing degree will define how well we support our forces, in logistics as well as operations.

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"valid threat."

Accurately determining valid future threats is the most subjective portion of the formula used to develop a responsive materiel solution's capability. Careful analysis should allow us to make intellectual choices between materiel solution alternatives (but only choices). For instance, what effects do different color shades of the pumpkin have on its stealthiness? What is the optimum shape for the intended sub-ballistic trajectory? And should the pumpkin be developed in total darkness, shade, or full sun to enhance its nucleotide sequencing? Therefore, technological choices may be enhanced with prudent analysis. Ah, but the imagination is required first!

After all, technology is adapted in the "hand" of the user. Give a 1-year-old child a new and totally different toy and what does he do? He feels it, tastes it, tries using it in a variety of ways; hits it on the ground like a hammer, scoops it in his food like a spoon, or hits his brother over the head with it like a weapon. Take this toy away from him before the "newness wears off" and we have a tantrum, red face, and tears. The child is enamored with the new toy. Soldiers also find various uses for their new technology "toys." For example, the first helmets were used to shave in, to bath in, to heat water for cooking in, as pillows for sleep, to keep heads dry in the rain, and, oh yes, to protect heads from shrapnel.

As Americans we have, at all ages of our lives, embraced toys, tools, and ideas as long as the changes have not come too rapidly. My grandfather (in the 1950s) was the first in the neighborhood to own a television. My father (in the 1960s) was always the first to purchase the latest automobile technology. When computers became available and affordable for home use (in the 1980s), I often led the neighborhood in the purchase and use of a computer. My son (in the 2000s) is satisfied with nothing less than the smallest and the fastest self-designed computer technology, palm pilot, cell phone, and DVD.

Each generation of Americans sends a legacy to the next generation to pursue the latest and greatest technology. Do you know anyone without a cell phone, or without access to a fax or a home computer? Did you really need these devices? How did we operate without them? They have no doubt changed the nature of our lives. Everyone knows we will continue this technology spiral. We have to. We are programmed by our ancestors. In the final analysis, it may not really be about a neat three-step development process. It might just be about our love affair with the promises of "Buck Rogers" technology and the eternal chant deep within our American souls: "I love Pumpkin Chunkers. I want a Pumpkin Chunker. I *need* a Pumpkin Chunker."