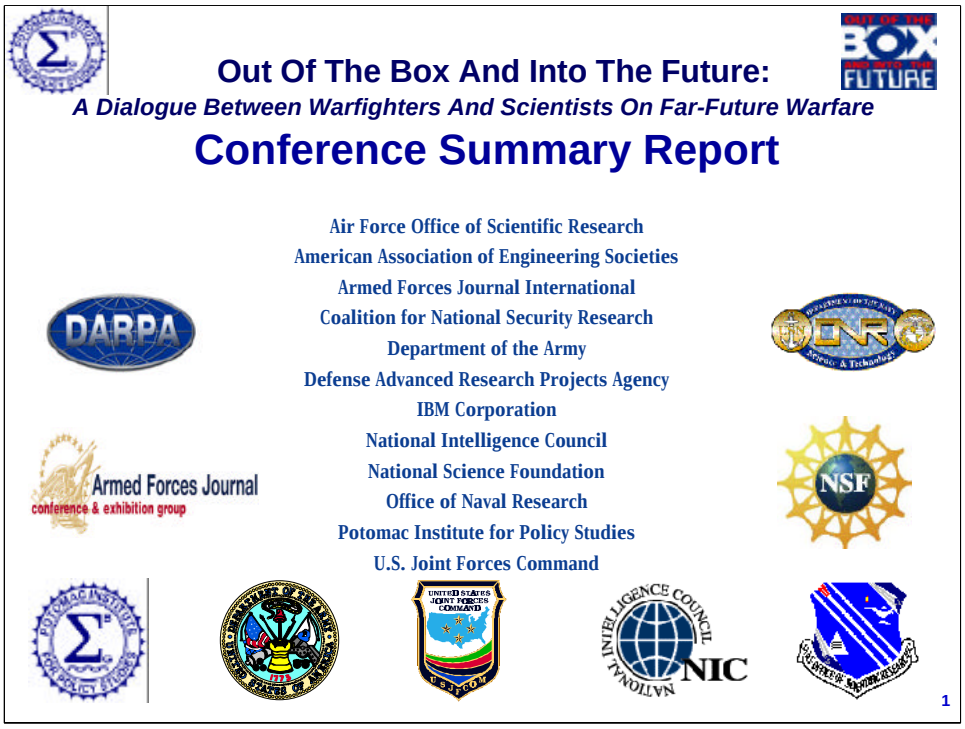


This is a summary report on the Out of the Box Conference held on 26-27 June 2000. Its purpose is to inform conferees, Co-Chairs, and Steering Committee members of some highlights of the conference and to pass it on for comment by the conferees.

This report is a summary of highlights, rather than an analysis. We are continuing to work with the information generated prior to and during the conference to produce a report of analysis, as described on page 5. The analytical report will be completed after receiving inputs on this summary report from conferees, Co-Chairs, and Steering Committee members.

We have divided the conference findings into three categories: Science, Technology and Acquisition; Military Operations; and General Considerations. In many cases, highlights from presentations have been paraphrased. This was done for two reasons. First, the transcripts were sometimes difficult to interpret because of punctuation or word mistakes and, second, speakers often express themselves less economically than they would in writing. We will ask for each speaker to ensure the accuracy of our summaries.

We also offer a discussion of the status of the post conference efforts along with a schedule for accomplishing the tasks we agreed to perform on slide 33. This involves putting the summary report on the Internet for conferee comment, holding the Co-Chair/Steering Committee meeting, setting up the Congressional hearings, and distributing the final report on CD-ROM.

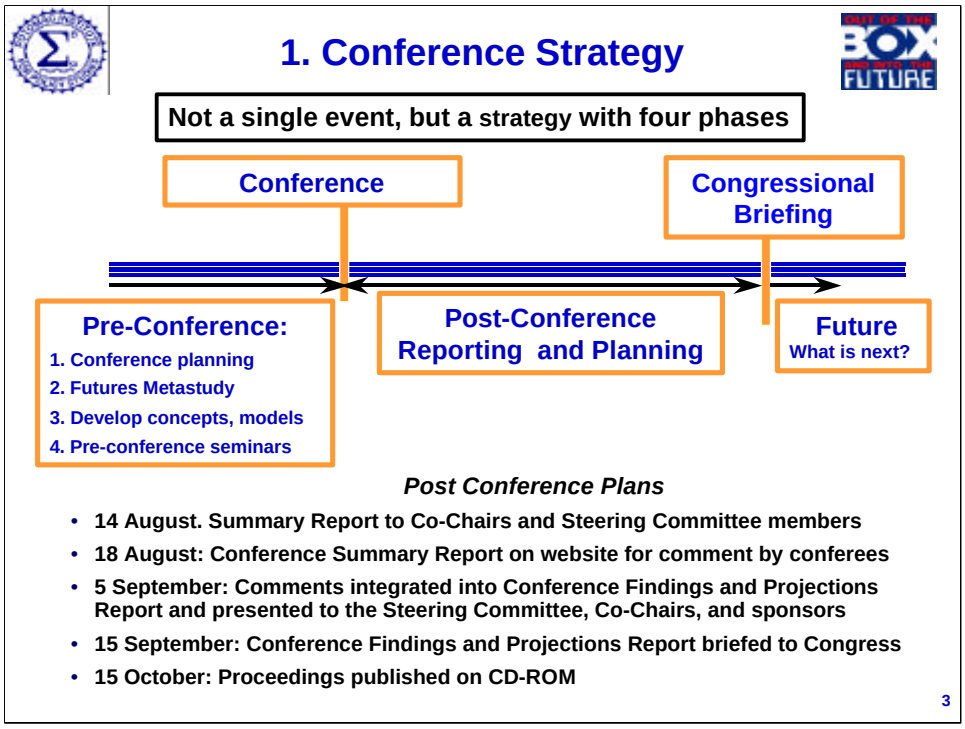
We look forward to meeting with as many of you as possible in the near future. If you cannot make the dates for the meeting, we would be happy to brief you separately. This chart shows a list of sponsors of the conference an associated events. Once again, thank you for your generosity and participation.

This Conference Summary Report is divided into six sections. The first is a review of the conference strategy and plans to accomplish that strategy. This is followed by a discussion of products we are committed to deliver by the end of October to meet the strategy defined in Section 1.

The Third section begins to summarize the conference with comments by conference attendees on both its content and management.

Section 4 consists of selected highlights of the conference. Under the first subject category are comments on science, technology and acquisition. These are divided among seven categories shown above (the seventh comprising of technologies not covered elsewhere). Under Category B are remarks concerning how military operations may change by 2025. Discussion of other considerations in projecting and preparing for the future are summarized under Category C.

A brief description of future plans is offered in section 4, followed by two sections on conference participants and agenda for reference.



The conference was part of a longer-term effort focused on projecting the effects of science and technology on far-future military operations. There are four phases of this effort: Pre-conference, conference, post-conference, and future actions.

It should be emphasized that we could not carry out the plans described in this and following charts without contributions from sponsoring organizations. We appreciate the generosity of our sponsors.

During the next two months a working group, composed of speakers, panel chairs and invited participants, will assimilate the output of the conference. We will document both common and conflicting visions presented in the pre-conference series and the conference on how science and technology will affect far-future military operations in the year 2025. We plan to make this available in summary form to the conferees at the Institute's website by 18 August.

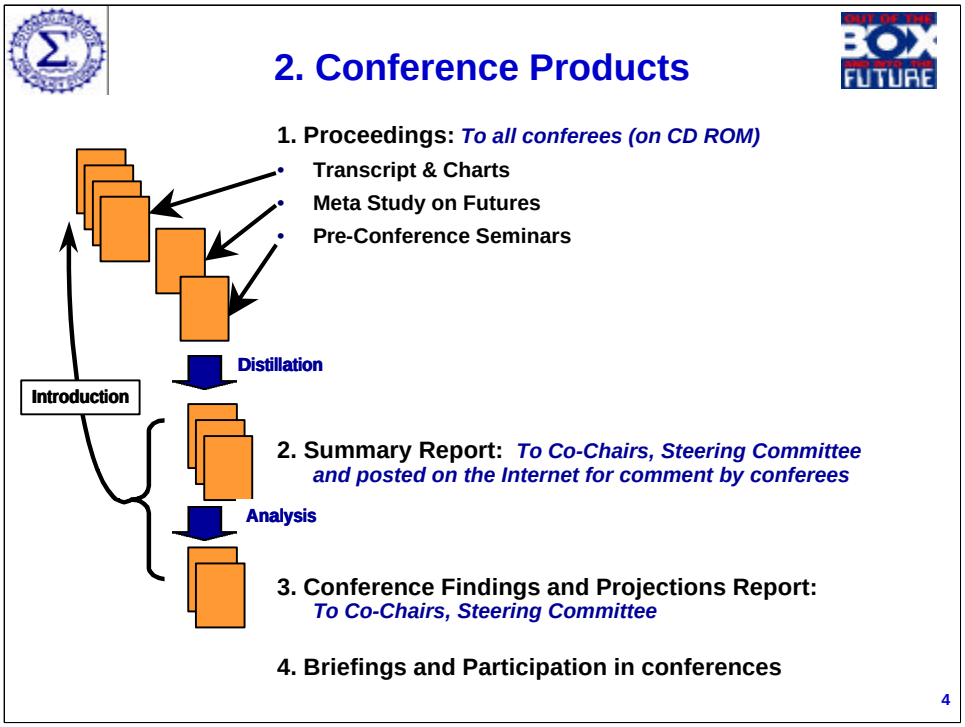
The Working Group will prepare a briefing to be presented by the steering committee, co-chairs, and sponsors to members of Congress after conferee comments are complete. This will be accomplished in a Co-Chair/Steering Committee meeting during the first two weeks of September. Congressional hearings, featuring Co-Chairs and Steering Committee members, will be held at the end of September. After receiving congressional comments, the working group will publish proceedings on CD-ROM.

Congress has asked for our ideas on future events to continue this process (e.g., another conference, a set of wargames, or simply monitoring other planned studies).

Suggestions received thus far are listed on this chart We will present these and other options during the Co-Chair/Steering Committee meeting in September.

Ideas on future events to continue this process:

- Continue the metastudy of Futures studies and publications, reporting the results on a quarterly basis
- Hold bimonthly symposia or colloquia on technology topics pertinent to 2025
- Conference next year on subjects such as:
    - Collaborative warfare technologies
    - Acquisition system for the 21st century
    - Selected technologies
- Conduct wargames to define application for some specific technologies



Four products will be delivered from the "out of the Box Conference. First, the proceedings will be issued on CD-ROM after all transcripts have been edited. Included will be all speaker transcripts and most of the charts used by speakers (some charts were not available). The meta-study conducted on selected futures conferences and studies, and transcripts and charts from the pre-conference seminars will be included as appendices. This will be an extremely large document.

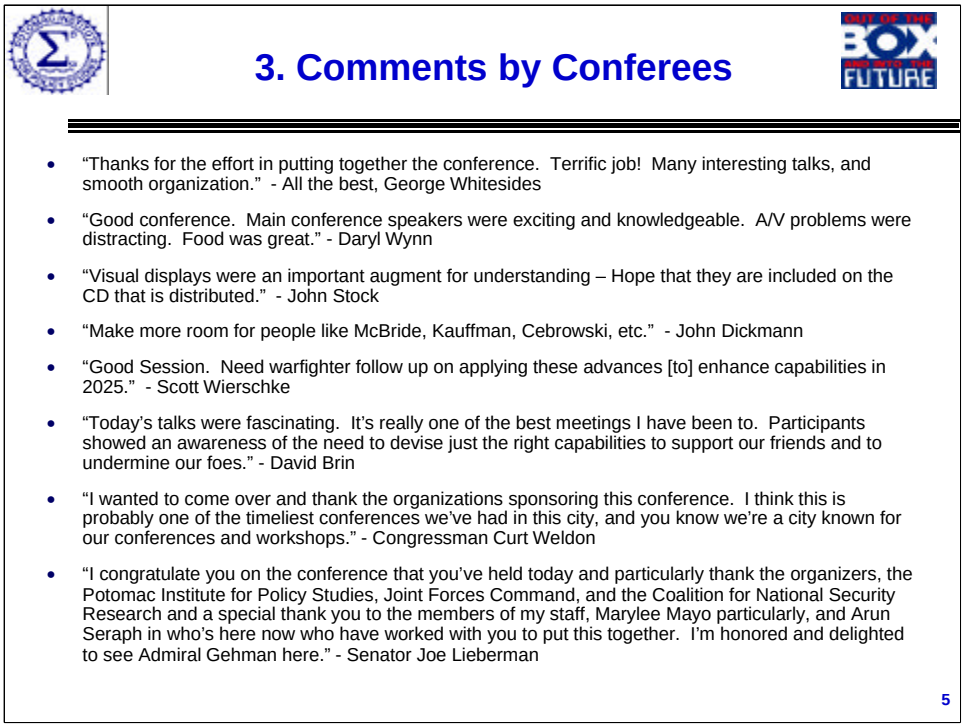
The second product will be this Conference Summary Report, which will be distributed to Co-Chairs and Steering Committee members and placed on the Institute's website for comment by conference attendees. As indicated earlier, the Conference Summary Report contains highlights from the conference, but has not undergone analysis.

The third product will be an analysis of the information in all preceding documents, called the Conference Findings and Projections Report. This will be presented to the Co-Chairs and Steering Committee members and then will be briefed to Congress, along with a portion of the summary report.

The summary and conclusions and recommendations will be included in the proceedings as an introductory section.

Finally, briefings will be developed for use in the meetings with Congress and other conferences and opportunities. The first conference to request this briefing is the Futures conference at Lawrence Livermore Laboratory in December.

Dates for planned events and release of these documents appear in Section 4, Future Plans.



Conference Management: Most comments were very favorable. There were many compliments on the space itself and the accessibility of the International Trade Center (ITC). Attendees enjoyed all sessions, although there was some impatience with the audiovisual equipment and amphitheater room temperature. [Even though the International Trade Center (ITC) had very sophisticated equipment, which showed well when it worked, there were long delays when switching projection machines and there was no means to access information on zip disks, until the Institute brought in a zip drive. Further, lack of audio at the speakers' podium held up the proceedings for over ten minutes at one point.]

There were also many favorable comments on the conference philosophy and design. On the other hand, many complained about the lack of breakfast and break snacks. [We eliminated breakfast and snacks at breaks to keep the registration costs low, especially for academics (at $200) and to cover the cost of pre- and post-conference activities. Although sponsorship helped immensely, some of the post conference activities (e.g., transcripts and proceedings) had to be funded from registration fees. In the face of this, cost for food and drink set-up at the ITC was high. For instance, coffee set-up cost about $4.50 per person per hour.]

Conference Content: Some written comments were:

The JV2010 presentation seemed too constrained – We should have asked GEN Close to discuss JV 2020 (which was not available when we put the agenda together) instead of JV 2010. This is mitigated by the fact that there is much commonality between the findings of the two studies.

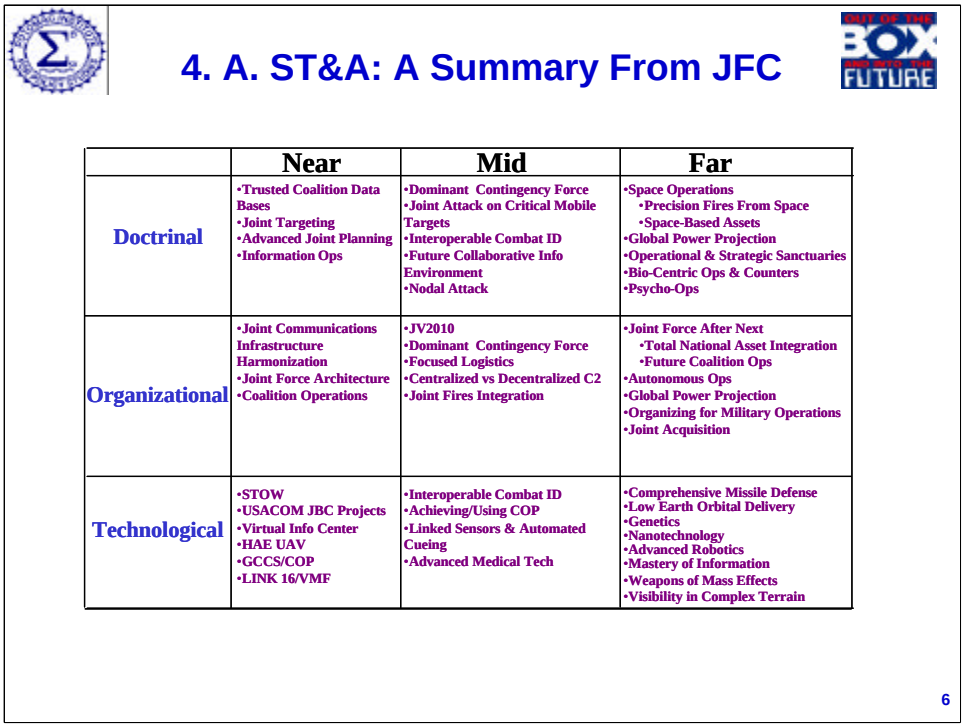
The Fundamental Warfighting Parameters speakers were interesting and shared some basic principles that must be considered, even in the 2025 timeframe, but many conferees felt they were decidedly "in the box." There were several questions for the speakers, which we will pass along.

Dr. Fernandez' presentation was well received and elicited many questions (which we have forwarded).

Mr. Peters and Mr. Bushnell were both popular, although there were complaints that they were not given enough time.

Dr. Etter's comments were also well received. Two conferees were concerned that the nuclear and microwave pulse threat to our satellites was not discussed.

During the science panel sessions, Dr. Nowak's presentation of Micropower energy sources was of major interest, as were those of Dr. McBride, Dr. Cross, and the other speakers on the Human Factors and Information Technology Panels. Remarks from the Nanotechnologies Panel (especially those of Prof. Smalley) were immediately picked up by "Chemical and Engineering News." An important comment was that relatively few warfighters attended the science panel sessions. It was an opportunity lost for dialogue.



4. A. ST&A: A Summary From JFC

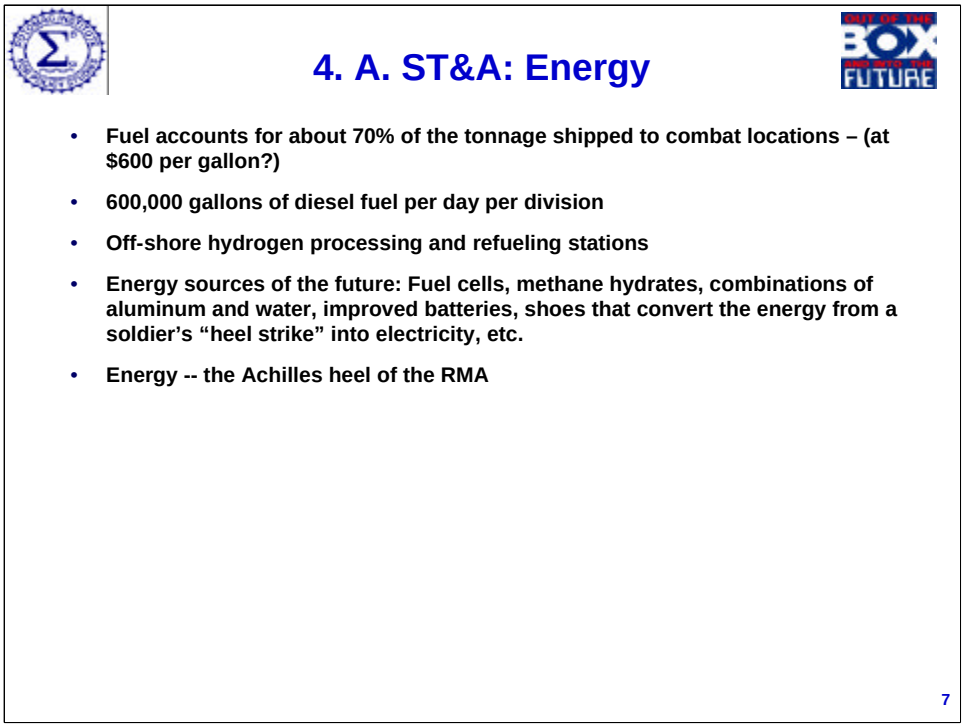
	Near	Mid	Far
Doctrinal	•Trusted Coalition Data Bases •Joint Targeting •Advanced Joint Planning •Information Ops	•Dominant Contingency Force •Joint Attack on Critical Mobile Targets •Interoperable Combat ID •Future Collaborative Info Environment •Nodal Attack	•Space Operations •Precision Fires From Space •Space-Based Assets •Global Power Projection •Operational & Strategic Sanctuaries •Bio-Centric Ops & Counters •Psycho-Ops
Organizational	•Joint Communications Infrastructure Harmonization •Joint Force Architecture •Coalition Operations	•JV2010 •Dominant Contingency Force •Focused Logistics •Centralized vs Decentralized C2 •Joint Fires Integration	•Joint Force After Next •Total National Asset Integration •Future Coalition Ops •Autonomous Ops •Global Power Projection •Organizing for Military Operations •Joint Acquisition
Technological	•STOW •USACOM JBC Projects •Virtual Info Center •HAE UAV •GCCS/COP •LINK 16/VMF	•Interoperable Combat ID •Achieving/Using COP •Linked Sensors & Automated Cueing •Advanced Medical Tech	•Comprehensive Missile Defense •Low Earth Orbital Delivery •Genetics •Nanotechnology •Advanced Robotics •Mastery of Information •Weapons of Mass Effects •Visibility in Complex Terrain

6

We thought this was a good place to begin our reporting on ST&A. This is the Joint Forces Command's list of near, mid, and far-term technologies and needed capabilities. It tracks pretty well with many of the papers given in the conference.

ADM Gehman: Our aim for these two days is to draw the warfighters and the scientists, and all those who support the two groups, into a dialogue that illuminates our challenges and hastens the solutions. This conference should be the beginning of a continuing process of dialogue and problem solving, not just a one-time event. We need to keep motivating and prodding our system in the right direction. And that just doesn't occur, in this town anyway, with one big event. This is a marathon we're on, with a final goal to transform the U.S. military, and a single sprint like this early in the race will not get us to the finish line as a winner.

The matrix is a good list of expectations from the military standpoint. ADM Gehman said that any time he gathered 20 colonels and captains in a room together and asked them what should be worked on, all 20 of them went immediately to the first column, to the near-term technological fixes. He couldn't get anybody to be interested in the other two. But, using a little chart like this, he was able to force the system to work in all nine blocks.



Highlights from the Energy Panel:

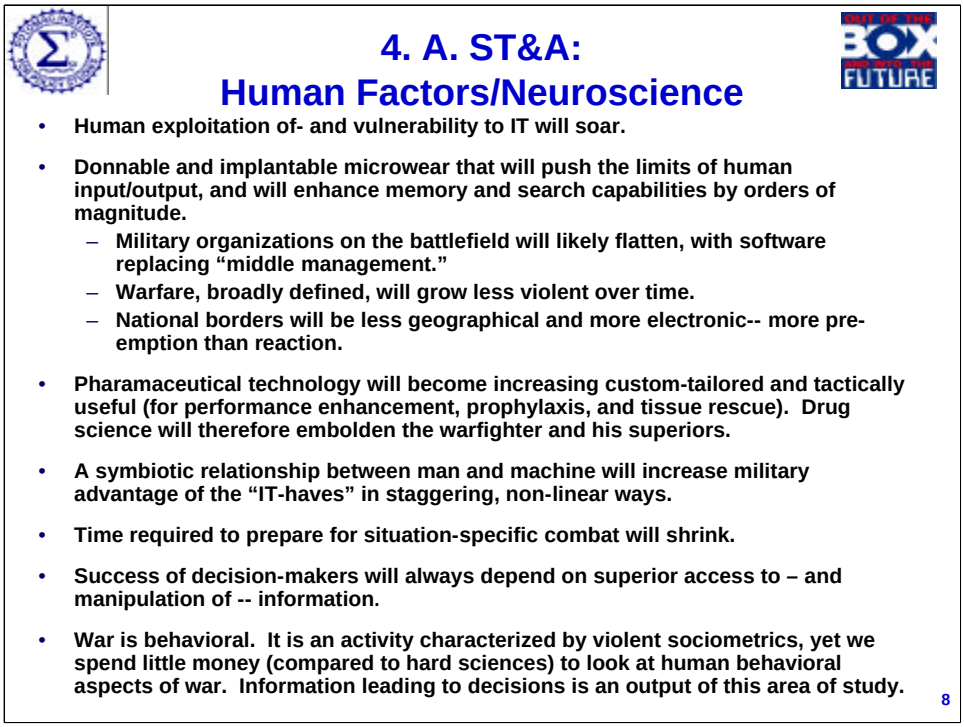
Fuel accounts for about 70% of the tonnage shipped to combat locations. It is both expensive and a very good target. For example, one member of the audience estimated that diesel fuel delivered to the front line costs about $600 per gallon.

Providing 600,000 gallons of diesel fuel per day for a division at the front lines is a major challenge. Introducing new technologies that significantly reduce the weight of weapons systems should provide a substantial reduction in the demand for energy.

Better means must be found to produce energy at the point where it is needed. Navy ships, for example, float on a nearly infinite supply of energy. How can some of that energy be efficiently extracted from seawater? This led to a discussion of possible off-shore hydrogen processing and refueling stations.

Alternative energy sources of the future might include fuel cells, methane hydrates, combinations of aluminum and water, improved batteries, shoes that convert the energy from a soldier's "heel strike" into electricity, etc.

From another panel, Dr. George Whitesides mused that energy is the Achilles heel of the Revolution in Military Affairs.



Highlights from the Human Factors/Neuroscience Panel:

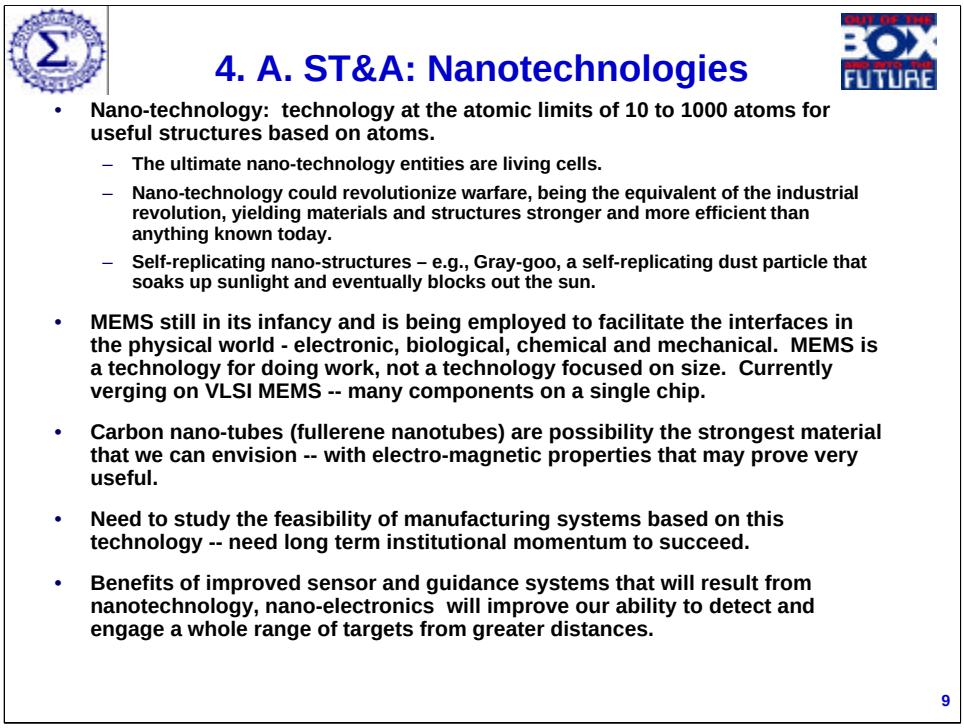
As (1) computational technology continues to follow Moore's law, (2) communication capabilities climb in bandwidth and in qualitative ways, (3) miniaturization proceeds as expected, and (4) reliance on computation spirals, human exploitation of- and vulnerability to IT will soar. By 2025+, humans on the "battlefield," and elsewhere in support, will wear donnable and implantable microwear that will push the limits of human input/output, and will enhance memory and search capabilities by orders of magnitude. Military organizations on the battlefield will likely flatten, with software replacing "middle management." Coupled with the claims that warfare, broadly defined, has grown increasingly less violent over time, and that national borders will be less geographical and more electronic, this establishes the prospect that national security (vs. defense) may comprise large networks of rapidly composeable agents whose jobs will be more pre-emptive than reactive.

Pharamaceutical technology will become increasing custom-tailored and tactically useful (for performance enhancement, prophylaxis, and tissue rescue). Drug science will therefore embolden the warfighter and his superiors.

Lessons learned from the neuroscientific study of learning and memory are being applied to the design of computer software and hardware. A likely outcome is that a symbiotic relationship between man (who will be interfaced with such technology as suggested in the bullet above) and machine (writ large, since the "machine" will physically be, a global network) will increase the military advantage of the "IT-haves" in staggering, non-linear ways. Here again, this may foreshadow a trend toward increasing prevalence of military pre-emptive means, based on perhaps militarily, nontraditional tactics, techniques and procedures.

As education technology (read: military training) becomes more scientifically solid, the time required to prepare for situation-specific combat will shrink. This will provide considerable agility and robustness in preparing warfighters at every level of combat – from the most pressing tactical (minutes prior to weapons engagement) to the most consequential strategic. Computational assets will derive and assemble, on a very rapid basis, object lessons, tutorials on first principles, lessons learned, etc., and provide them to decision-makers, whose success will always depend on superior access to – and manipulation of information.

The last bullet comes from ADM Cebrowski's presentation.



Highlights from the Nanotechnologies Panel:

Nano-technology is defined as technology at the atomic limits of ten to 1000 atoms for useful structures based on atoms. The ultimate nano-technology entities are living cells. Nano-technology could revolutionize warfare, being the equivalent of the industrial revolution at the nano-scale with structural optimization at the atomic level yielding materials and structures stronger and more efficient than anything known today.

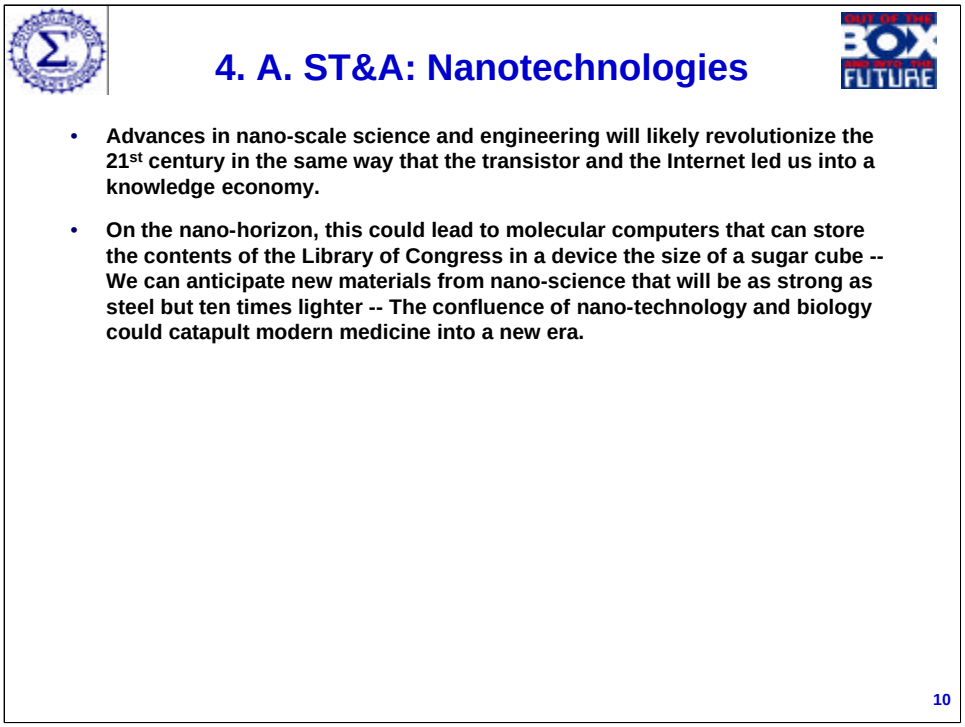
Self-replicating nano-structures can be envisioned. The controversy surrounding self-replicating machines has just begun.

MEMS is still in its infancy, and several problems remain, including industrial problems (standards) and science/technology problems (friction, and adhesion at the molecular level). Dr. Ken Gabriel stated that MEMS is being employed to facilitate the interfaces in the physical world - electronic, biological, chemical, and mechanical. He emphasized that MEMS is a technology for doing work, not a technology focused on size. Currently verging on VLSI MEMS, many components on a single chip. Examples include optical cross-bars that switch fiber-optics; micro-fluidics chips (laboratory on a chip); and control and modulation of fluids such as conformal surface chips.

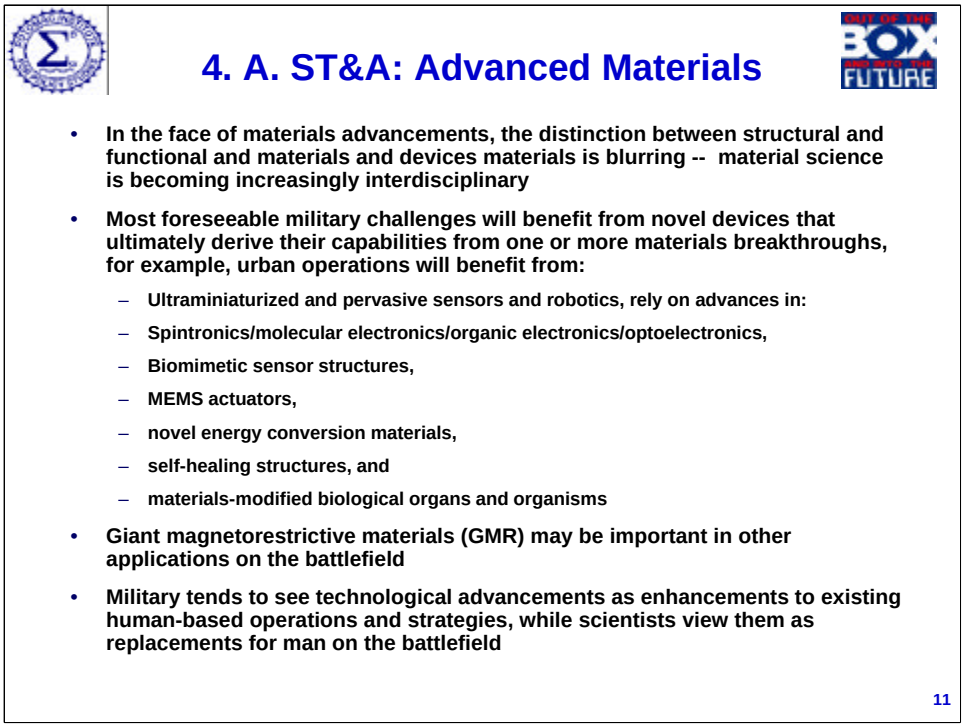
Dr. Paul McWhorter focused on five-level manufacturing technologies. This is today's technology, not 2025. MEMS needs to realize its potential: industry standards; synergy and cooperation across the industry; commercial products; and standard design, packaging, and manufacturing.

Dr. Smalley focused his presentation on an emerging nano-technology called carbon nano-tubes (fullerene nanotubes). Possibility the strongest material that we can envision. They also have electro-magnetic properties that may prove very useful. For example, nano-materials can serve act as wave guides as well as copper. A single molecule transistor has been demonstrated.

Dr. Ralph Merkle asserts that the potential impact of atom-by-atom assembly, that could eventually be self-replicating, will be greater than the development of the atomic bomb. Example: gray-goo, a self-replicating dust particle that soaks up sunlight and eventually blocks out the sun. There are countermeasures that can be conceived for such weapons systems. Optimists believe it take 30 years and the pessimists believe it will take ten years. We need to study the feasibility of manufacturing systems based on this technology, and if it's feasible we will need long-term institutional momentum to succeed.



These are two comments on nanotechnologies from Dr. Joe Bordogna, Deputy Director of NSF.

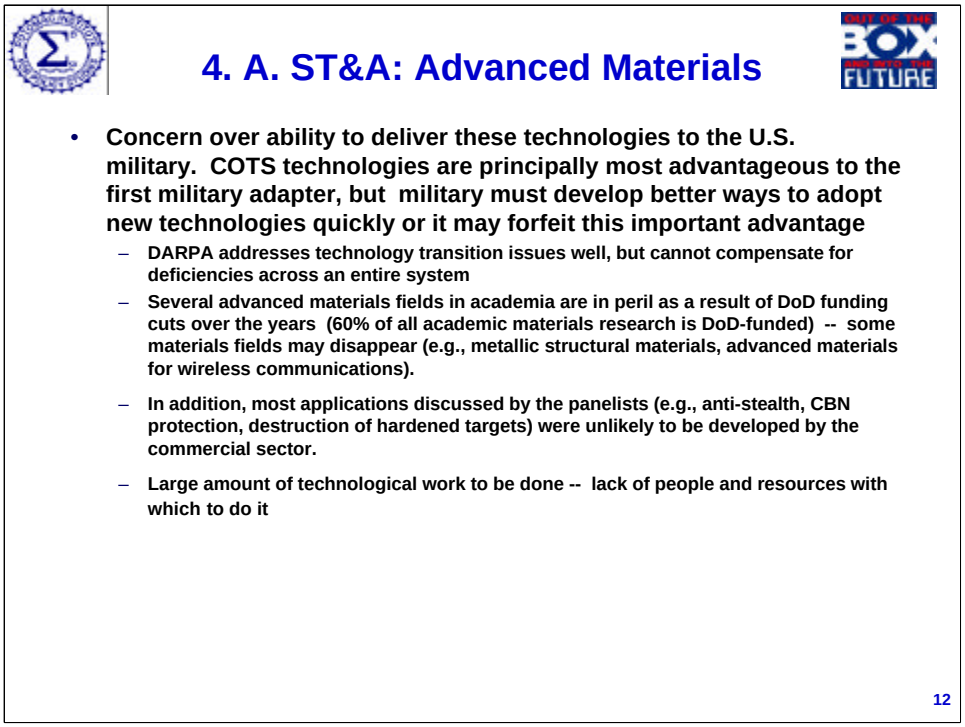


Highlights from the Advanced Materials Panel:

In the face of materials advancements, the distinction between structural and functional materials is blurring, as is the distinction between materials and devices. This means that material science is becoming increasingly interdisciplinary. Below is a summary of presentations by Dr. George Whitesides, Dr. Steven Wax, and Prof. Merrilea Mayo.

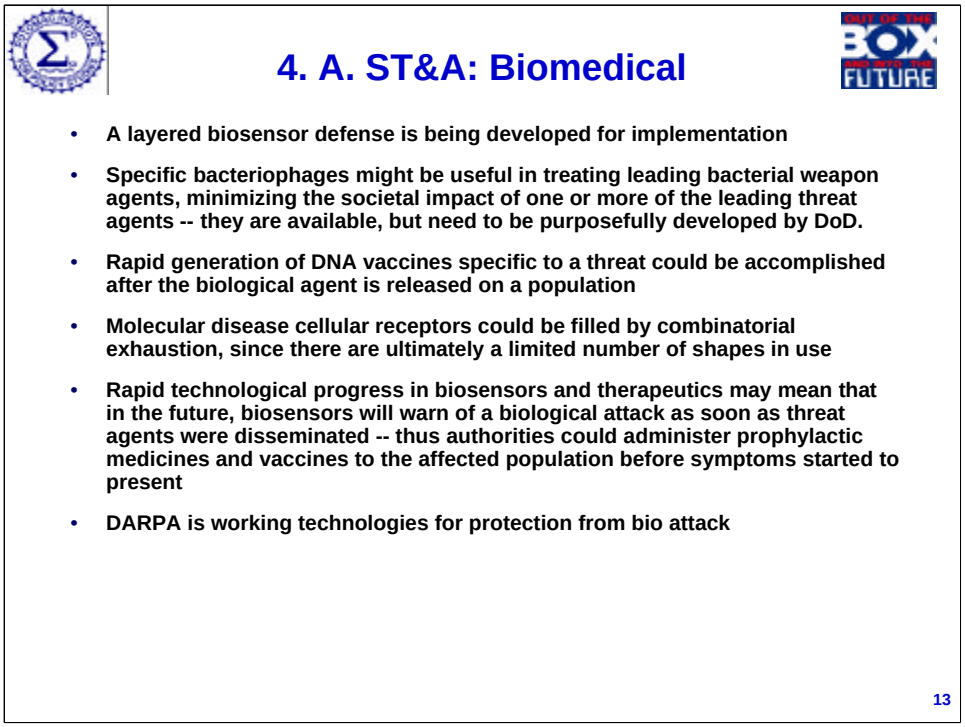
It appears that most foreseeable military challenges will benefit from novel devices that ultimately derive their capabilities from one or more materials breakthroughs. For instance, urban warfare relies heavily on ultraminiaturized and pervasive sensors and robotics, which in turn rely on advances in spintronics/molecular electronics/organic electronics/optoelectronics, biomimetic sensor structures, MEMS actuators, novel energy conversion materials, self-healing structures, and materials-modified biological organs and organisms. Giant magnetorestrictive materials (GMR) may be important in other applications on the battlefield. The result of these advancements will cover a wide spectrum of capabilities enhancements, from lighter and more energy-efficient vehicles and soldiers to "sensors for all senses" to "super stealth."

An interesting dichotomy arose between the views of the military vs. the scientists in these discussions. The military tends to see the technological advancements as enhancements to existing human-based operations and strategies, while scientists view them as replacements for man on the battlefield. As many machine-based capabilities (IR sensing, atmospheric flight, numerically precise calculations) are not intrinsic to man and vice versa, the "machine-as-accessory" view is historically correct. However, the increasing integration and miniaturization of structural, sensing, and processing tasks, down to even the molecular level, made it difficult to articulate the difference between future machine and life-based capabilities. The distinction between man and miniature machine blurred further as materials scientists alluded to the increasing use of organic materials and biological pathways for material synthesis and device assembly.



(cont.) While materials technology itself appeared full of promise, there was great concern over the ability to deliver these technologies to the U.S. military. Commercial Off-the-Shelf (COTS) technologies are principally most advantageous to the first military adapter. The U.S. military must develop better ways to adopt new technologies quickly or it may forfeit this important advantage. In addition, most applications discussed by the panelists [e.g., anti-stealth; chemical, biological and nuclear (CBN) protection; destruction of hardened targets] were unlikely to be developed by the commercial sector. By far the greatest source of concern was the large amount of technological work to be done, and the lack of people and resources with which to do it. In the past, some basic and applied research on materials was done in the great laboratories of the corporate world, but in the 1990's most of these labs were eliminated or restructured to focus almost exclusively (>85%) on advanced development. Defense labs, which sponsored much basic materials research and moved it from technology to military application, have been decimated by funding cuts. In addition, no solution was ever found for the large chasm between research and development (R&D) and acquisition efforts within the military. Start-up corporations have proven to be a useful way to transition materials technologies in the commercial sector, but no military equivalent appears to exist.

DARPA does an exceptional job of addressing technology transition issues within its purview, but a lone agency can not compensate for deficiencies across an entire system. Finally, a number of the academic researchers at the conference expressed their dismay that their academic fields were in peril as a result of DoD funding cuts over the years. Though the complaint was widespread among academics at the conference, it held particular sway in the session on materials research, as 60% of all academic materials research is DoD-funded. Because of declines in DoD funding, some materials fields were believed bound for extinction within a generation or less (e.g., metallic structural materials); others were unfunded despite obvious military application potential and little or no commercial interest (e.g., advanced materials for wireless communications).



Highlights from the BioMedical Panel:

In the biotechnology panel, Dr. Millie Donlon put forward her ideas for a layered biosensor defense. This appeared complex but well-guided, and is already being developed for implementation.

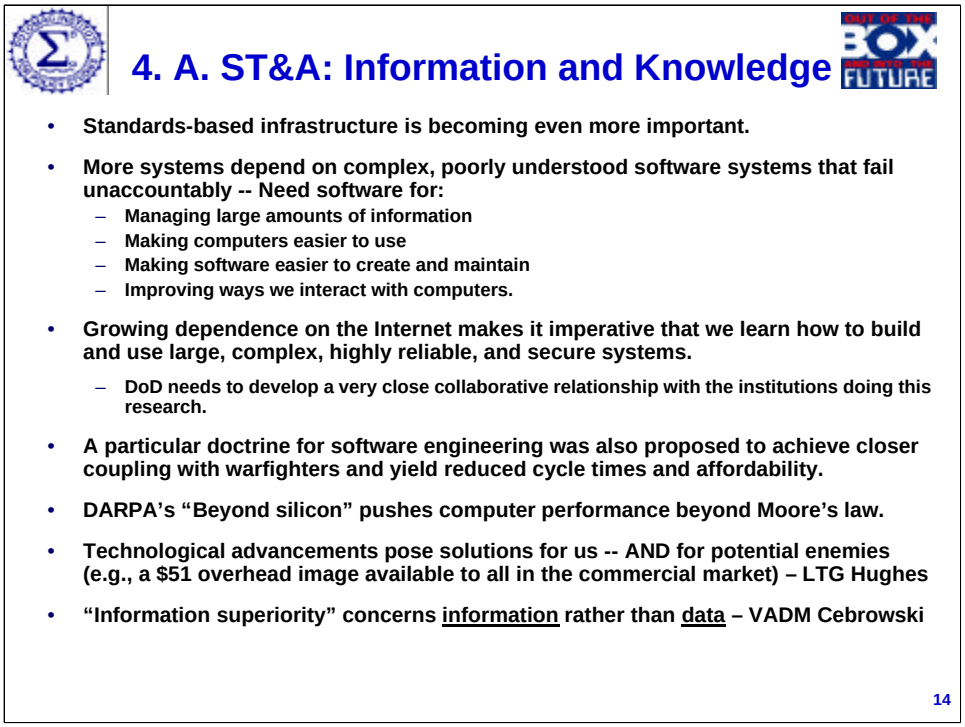
David Siegrist suggested the idea of having specific bacteriophages on hand to treat leading bacterial weapon agents, minimizing the societal impact of one or more of the leading threat agents. Such bacteriophages are available, but need to be purposefully developed by DoD, since there is little civilian perception of need for them.

Dr. Clare Fraser suggested that rapid generation of DNA vaccines specific to a threat could be accomplished after the biological agent is released on a population. DNA vaccines are an intriguing concept -- one that is being pursued by DoD and other organizations. DNA vaccines may have practical and operational limitations as a mainline defense approach, but having a rapid response capability is certainly desirable.

Dr. Stuart Kauffman implied that molecular disease cellular receptors could be filled by combinatorial exhaustion, since there are ultimately a limited number of shapes in use. However, this means filling the receptors, and hence possibly activating the sites, as opposed to blocking the sites with a more complex and unique structure to inhibit the undesirable function.

Secretary Harold Smith emphasized the rapid technological progress in biosensors and therapeutics. He noted that in the future, biosensors would warn of a biological attack as soon as threat agents were disseminated. Thus authorities could administer prophylactic medicines and vaccines to the affected population before symptoms started to present, due to the required incubation period for bacteria and viruses. Secretary Smith believes that because of such technical advances, in the future the defense against biological attack would dominate offensive capabilities.

Dr. Frank Fernandez: In the national level problems, there are two major areas being worked at DARPA: protection from biological attack and protection from information attack.



Highlights from the Information and Knowledge Panel:

This panel brought together experts from software, large-scale advanced technology, and information technology (IT) business applications. Discussion ranged from the characterization of successful organizations in the emerging IT-dominated world to the research priorities needed to succeed as well-informed, intelligent and highly flexible organizations for the future.

All panelists recognized the importance of a standards-based infrastructure to give an organization the flexibility to adapt and thrive, just as the Internet is constantly adapting and thriving today. This becomes more important as increased technology convergence drives integration of tools and applications in various platforms. The connection between all these systems is software and thus, the first research priority.

More societal and DoD systems depend on very large, very complex, and poorly understood software systems that often fail unaccountably. Special emphasis must be placed on developing software for managing large amounts of information for making computers easier to use, for making software easier to create and maintain, and for improving the ways we human beings interact with computers.

Our growing dependence on the Internet makes it imperative that we learn how to build and use large, complex, highly reliable, and secure systems.

The panelists felt it was urgent that the Defense Department develop a very close collaborative relationship with the institutions doing that research. Only then, will they be able to access the kind of profound knowledge that enables the application of the technology rapidly and with assurance. This will leave no doubt in anyone's mind -- possible adversaries -- as to the DoD's ability to deliver.

A particular doctrine for software engineering was also proposed to achieve closer coupling with warfighters and yield reduced cycle times and affordability. This included emphasis on coupling between the designers and the builders of DoD software systems and the users and trainers.

Dr. Frank Fernandez: In the national level problems, there are two major areas being worked at DARPA: protection from biological attack and protection from information attack.

4. A. ST&A: Information and Knowledge

- **DARPA is developing a small unit operation situational awareness system about the size of the radio -- It is a wave-form hopper and can handle numerous wave-forms. It sets up its own network and provides continuous position navigation – GEN Gorman**
- **Consider an ultra wide band radio that would allow transmission across all of the available radio frequency (RF) links. It would also be able to scavenge wires – General Gorman**
- **When you start looking out at long distances and you want to get great discrimination, suddenly the emergence of voxals, rather than pixels, in a sensor makes a lot of sense – GEN Fogleman**
- **We will see new and improved smart wave-forms – GEN Fogleman**
- **In the past, our system architecture could handle hundreds of processors -- Now we're working with systems of 10,000 processors -- In a very short time, we'll be connecting millions of systems and billions of information appliances through the Internet – Dr. Joe Bordogna**

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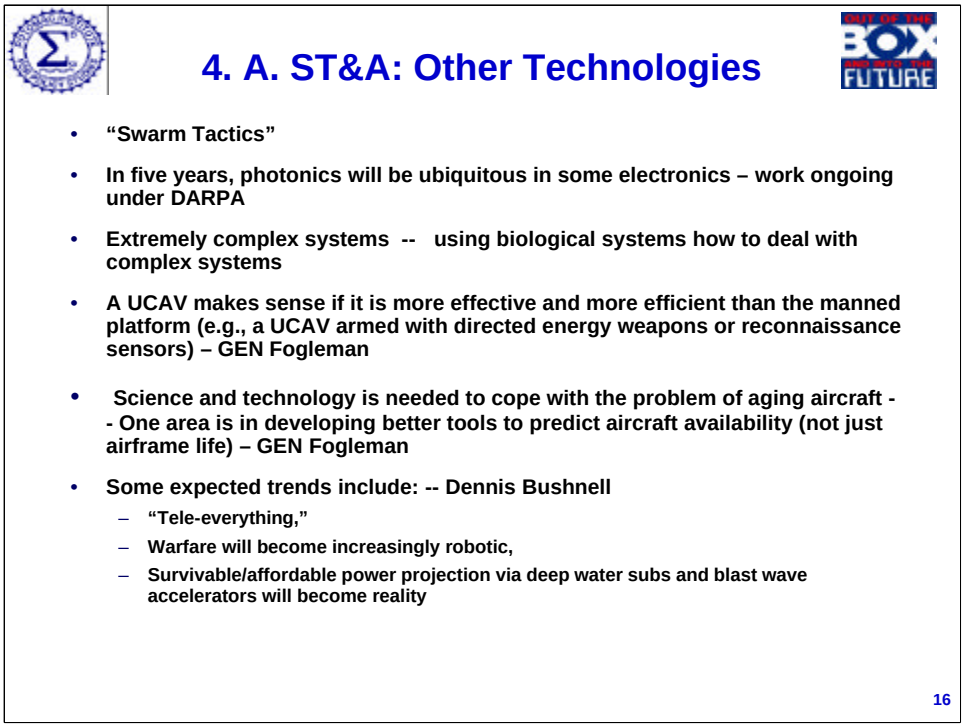
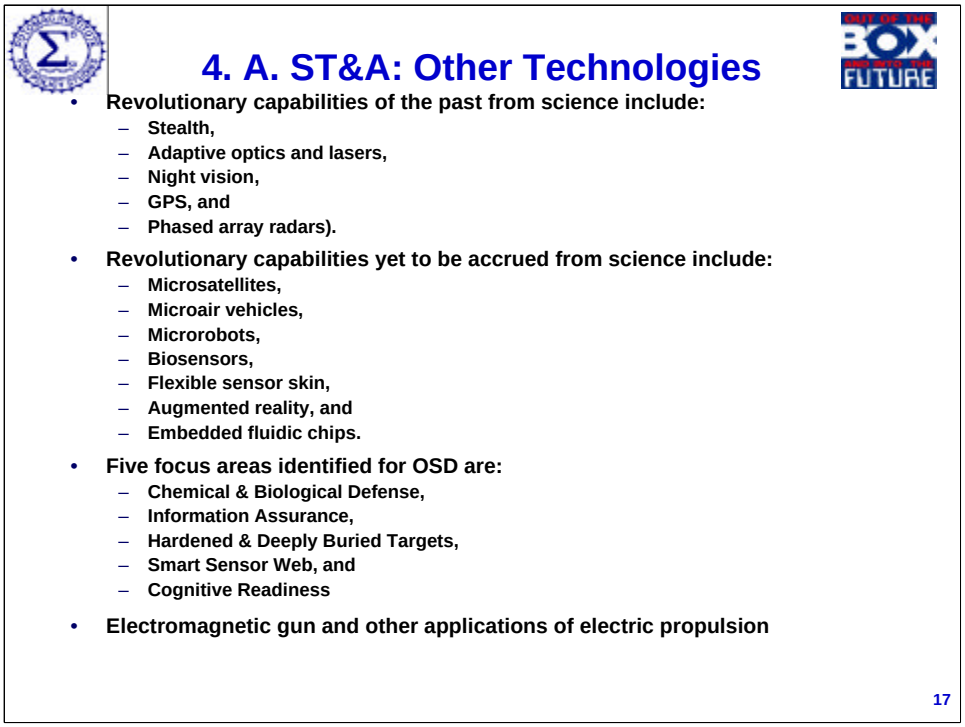


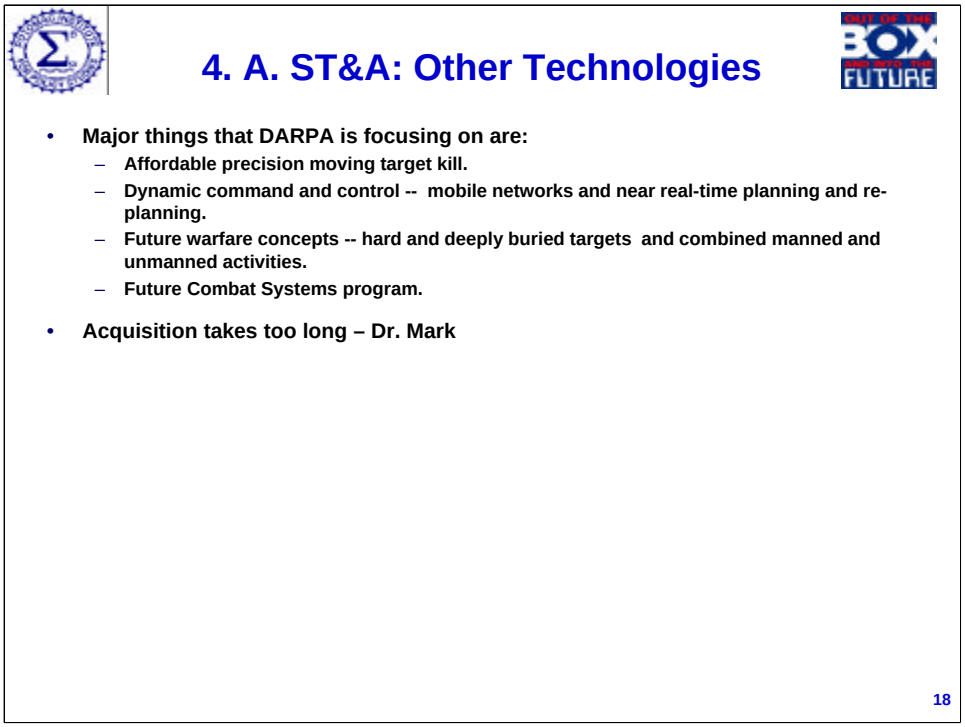
ADM Gehman: An idea that might be worth further advancement is the concept called "Swarm Tactics." The idea is building one million one-dollar weapons, instead of building one million dollar weapon.

Dr. Fernandez: DARPA is conducting a program which is multidisciplinary, involving the intersection of biological, physical, and information systems. We don't know how to model or test the extremely complex systems we are trying to design. Biological systems are complex and have learned how to successfully deal with complex systems. We are at the point where we can measure how these biological systems work in some detail, using micro-systems for instrumentation that we can insert into biological systems as compared to just doing input/output experiments. I think we're getting to the point with our information technology where we can learn to manage the vast amounts of data that we would get from such experiments. The goal is to use biological systems to learn how to deal with complex systems.



Dr. Delores Etter, DUSD (S&T): Dr Etter's presentation was very compact. As shown in this chart, she discussed revolutionary capabilities of the past from science and predicted future revolutionary capabilities to be accrued from science. Five focus areas identified for OSD are: Chemical & Biological Defense, Information Assurance, Hardened & Deeply Buried Targets, Smart Sensor Web, and Cognitive Readiness. She identified several cross cutting initiatives, such as software intensive systems, high performance computing, and modeling and simulation. Finally she cited a number of changing environments that drive DUSD priorities that were listed.

Dr. Hans Mark: Dr. Mark talked about long development times historically needed for important weapons systems technologies. He also discussed the importance of the electromagnetic gun and other applications of electric propulsion.



Dr. Frank Fernandez: In the operations dominance area, there are three major things that we focus on. i) The first is an affordable precision moving target kill. How can we affordably and precisely attack moving targets, both offensively and defensively? The reason for the defensive part is cheap cruise missile defense. ii) in dynamic command and control, we are emphasizing mobile networks and near real-time planning and re-planning. iii) in future warfare concepts, hard and deeply buried targets are major research areas, as are the combined manned and unmanned activities.

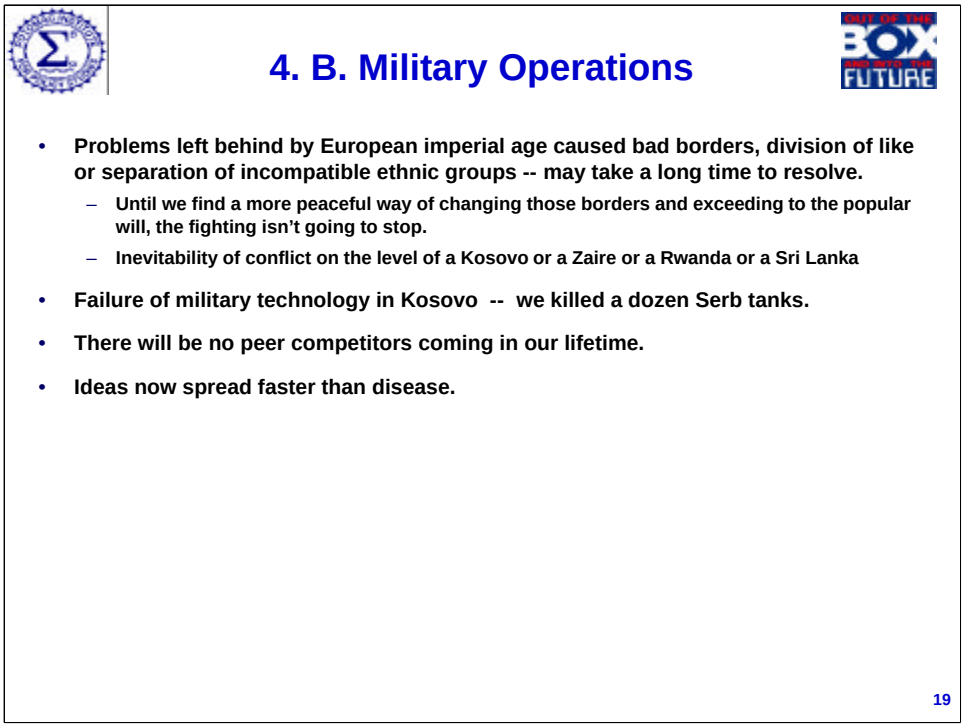
Under high risk/high payoff technologies, we have our core technology, and two new starts:

The first one is a program called ATQ, advanced tactical targeting technology. The question here is, can we use a network of vehicles to develop a very rapid solution that allows us to target enemy assets in an extremely short time and with very, very high accuracy? Can we use the network to remove some of the fundamental ambiguities that exist if you try to do this without a lot of angular resolution from single receivers? What do we do with targets that are not emitting but are moving? Can we use networks of moving target indicator (MTI) radars to essentially go from "blobology" into precision solutions and tracks that are accurate enough so that perhaps we can use them to update a missile in flight? And can we take MTI networks to space?

Next is real-time planning and re-planning. The idea here is taking some of our networking capabilities and doing advanced logistics. The question is, can we use agent technology in a scalable way to let us develop logistics plans and logistics re-planning? The critical thing is to cut the timeline of generating a logistics plan from a few weeks to an hour or less, then we can start to have an adaptive/reactive logistics plans that will allow us to redo the plan, and to do "what ifs" ahead of time.

Another program examines the viability of combined manned and unmanned operations in a network fashion, where the unmanned combat air vehicle (UCAV) does parts of the missions that are just a little too dangerous for human beings -- for example, direct destruction of enemy air defense. We are doing the same thing with the Special Operations Forces on tactical mobile robots.

- DARPA has begun the Future Combat Systems program with the Army (see GEN Gorman's comments).



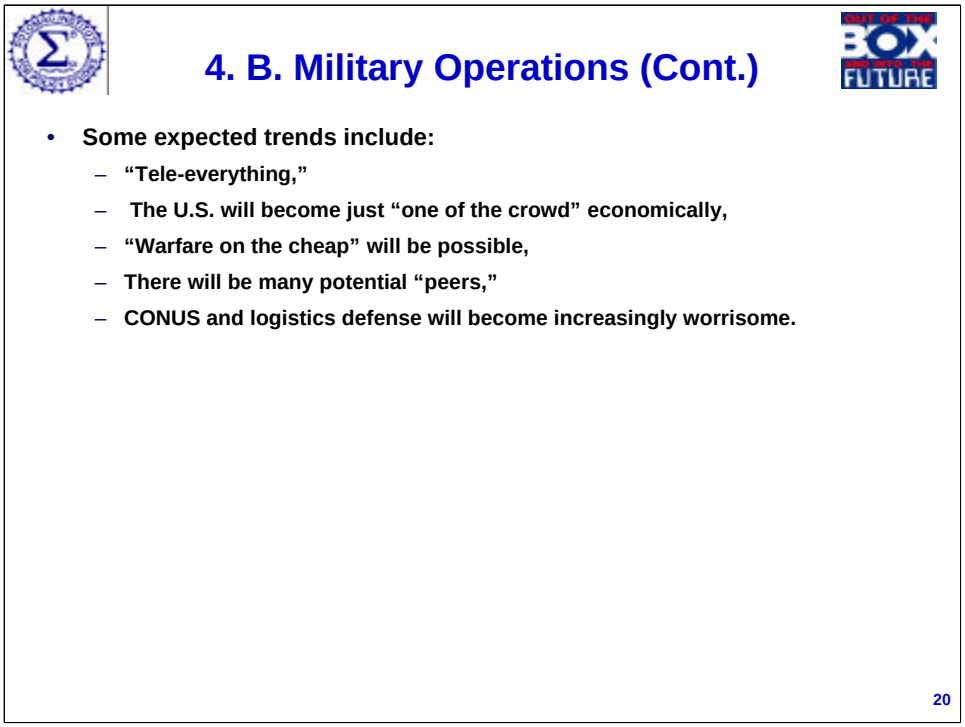
Mr. Ralph Peters: There have been 500 years of European dominance, physical on-the-ground dominance in most cases. The Europeans left the world deformed, by setting borders and dividing or joining populations, often carried out in abject ignorance. Now, can we imagine that 500 years of European dominance and deformation from Mexico, Latin America through southeast Asia, the Arab world, the former Soviet Union, be even partially ameliorated in 30 years? If we are very lucky some of the problems left behind by the European imperial age may be partly resolved within the next hundred years, although it may take much longer. In this post-colonial era, the inevitability of conflict on the level of a Kosovo or a Zaire or a Rwanda or a Sri Lanka is strong and evident. We're going to have to deal with this.

Until we find a more peaceful way of changing those borders and exceeding to the popular will, the fighting isn't going to stop, even if you get all the junk in Joint Vision 2010. For instance, what on earth will the F-22 do for you in Kosovo part 10? Joint Vision 2010 will cost 300 billion a year, we should get more from it.

The real story of Kosovo was the failure of military technology. All this tremendous stuff we bought and we kill a dozen Serb tanks. Pretty pathetic. But, even so, there will be no peer competitors coming in our lifetime.

For the first time in human history, ideas spread faster than disease, or at least notions, claims, chance, and myths do. The internet is incredibly powerful, as are our other technological communications means, such as telephones, SAT phones, satellite, and television. Traditionally, ideas and disease moved at the same speed, human foot, or the speed of a rodent, or perhaps speed of a man on horseback, or a sailing ship. But today the speed of disease vectors is still limited to transportation means. They physically have to go there.

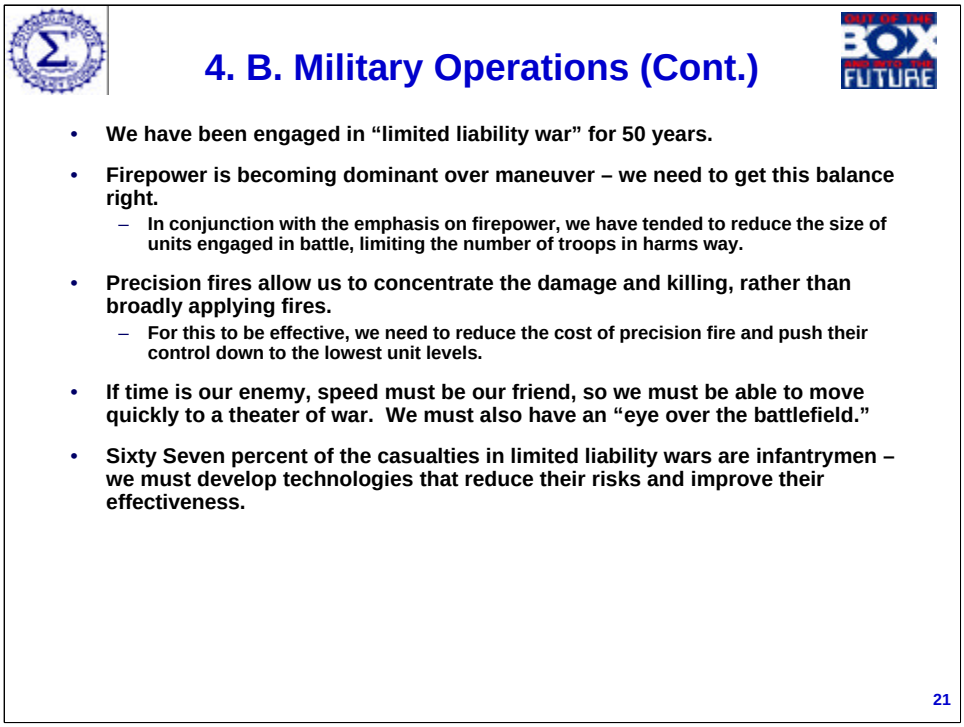
He also presented some interesting ideas on how future conflicts would unfold, stressing the asymmetric aspects of the threat and suggested some radical solutions for some of the threats he posed. The "nuclear weapons" of the 21st century are going to be behavior control weapons. That's really where the DARPA presentation seemed to be leading and why tomorrow's agenda should look at psychobiology and where that sort of thing is going. The ultimate problem of military forces today in most situations is the control of human beings. The Soviet Union had already started to work in this area before its demise and others can be expected to follow as the state of knowledge increases. The Soviet Union had worked on endorphins and the use of chemical biomimetics of endorphins for crowd control in an urban environment to vitiate hostilities, or in a strategic context against the regimes of rogue states.



Mr. Dennis Bushnell: The luncheon presentation by Dennis Bushnell was a rapid-fire tour de force of technologies forecast to affect military operations in the far (and not so far) future.

Politics can and will change "overnight," as shown by recent events in Russia, Iran, Iraq, and Pakistan. Potential capabilities are the future warfare issue. Not who will use them, but what they will be.

Ages of warfare could be characterized by the technologies employed. For instance, hunter/killer groups dominated the period from one million BC to 10,000 BC, agriculture from 10,000 BC to 1800 AD, industrial age equipment from 1800 to 1950, information technology from 1950 to 2020, bio/nanotechnologies from 2020 to the far-future, and virtual technologies in the far future.



Major General Robert H. Scales: For 50 years the U.S. has known of, and episodically employed, the unique style of war, limited liability warfare, we tend to treat as a recent innovation. This style of war, which will take us out to the next 20 years, began during the Korean War, our first limited liability war. We returned our focus on unlimited warfare until after the Cold War ended. We began the Korean War planning and conducting divisional-level operations until the Chinese caught on and changed us. From then on, we have attempted to find the balance between firepower and maneuver – munitions versus manpower.

In time, enemies learn to adjust to our tactics and strategies of massed firepower. They will disperse and will become able to fight under the onslaught of terrible firepower as evidenced by the North Koreans, Vietnamese, Iraqis, and Yugoslavs. In conjunction with the emphasis on firepower, we have tended to reduce the size of units engaged in battle, limiting the number of troops in harms way.

Precision fires allow us to concentrate the damage and killing, rather than broadly applying fires (a tactic that does little good, except for shock, which loses its effectiveness after awhile). It can also reduce logistical loads dramatically. But, for this to be effective, we need to reduce the cost of precision fire and push their control down to the lowest unit levels. As long as precision is expensive, the enemy can break into smaller and smaller units until effective fires are unaffordable.

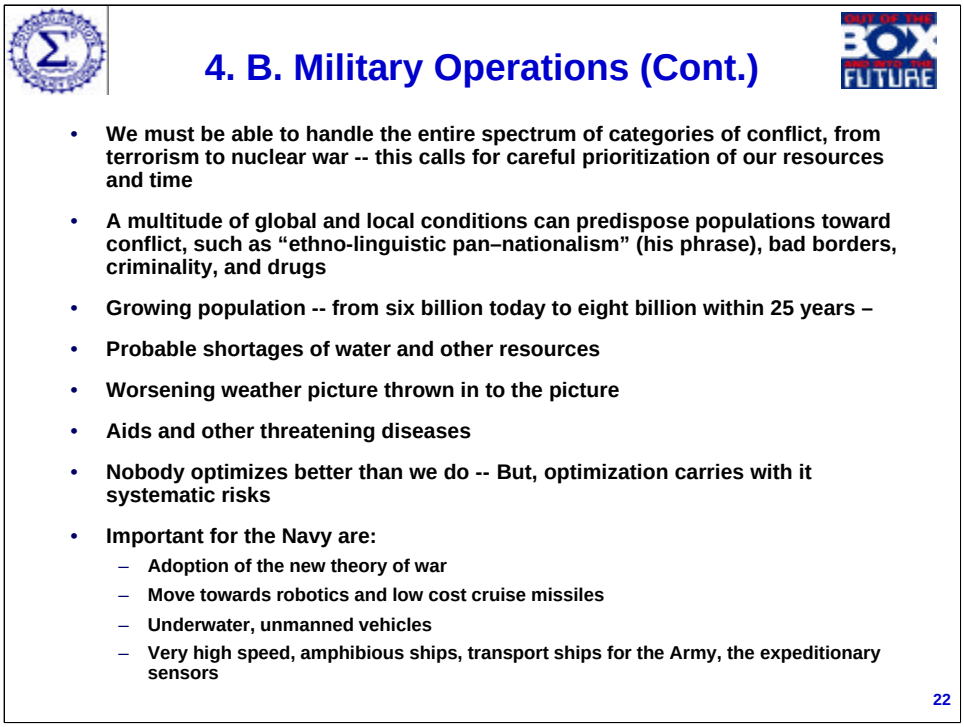
Firepower is becoming dominant over maneuver – we need to get this balance right.

If time is our enemy, speed must be our friend, so we must be able to move quickly to a theater of war. We must also have an "eye over the battlefield" – an effective way to gather the knowledge we need.

Sixty Seven percent of the casualties in limited liability wars are infantrymen – we must develop technologies that reduce their risks and improve their effectiveness.

Lieutenant General Patrick Hughes: LTG Hughes discussed future threats and world situation in a briefing filled with (often shocking) details.

Our national security interests and missions include protecting sovereignty, territory and population of the U.S.; preventing emergence of hostile regional coalitions or hegemony; ensuring uninhibited access to key markets, energy supplies, and strategic resources; deterring and, if necessary, defeating aggression against U.S. allies and friends; and ensuring freedom of the seas, airways, and space and the security of vital lines of communication.



(cont.) The U.S.'s path to the future demands that: we remain engaged as a global leader and harness the unmatched capabilities of our armed forces to shape the international security environment; we respond to the full spectrum of crises when it is in our interest to do so; and we prepare now to meet the challenges of an uncertain future. During the next 25 or so minutes, General Hughes discussed the difficulties of accomplishing this in the face of a world that is rapidly developing a diverse and dangerous set of threats.

We must be able to handle the entire spectrum of categories of conflict, from terrorism to nuclear war. We must resist choosing one or two categories and the threats represented therein to the exclusion of all the other possible categories we may confront. This calls for careful prioritization of our resources and time.

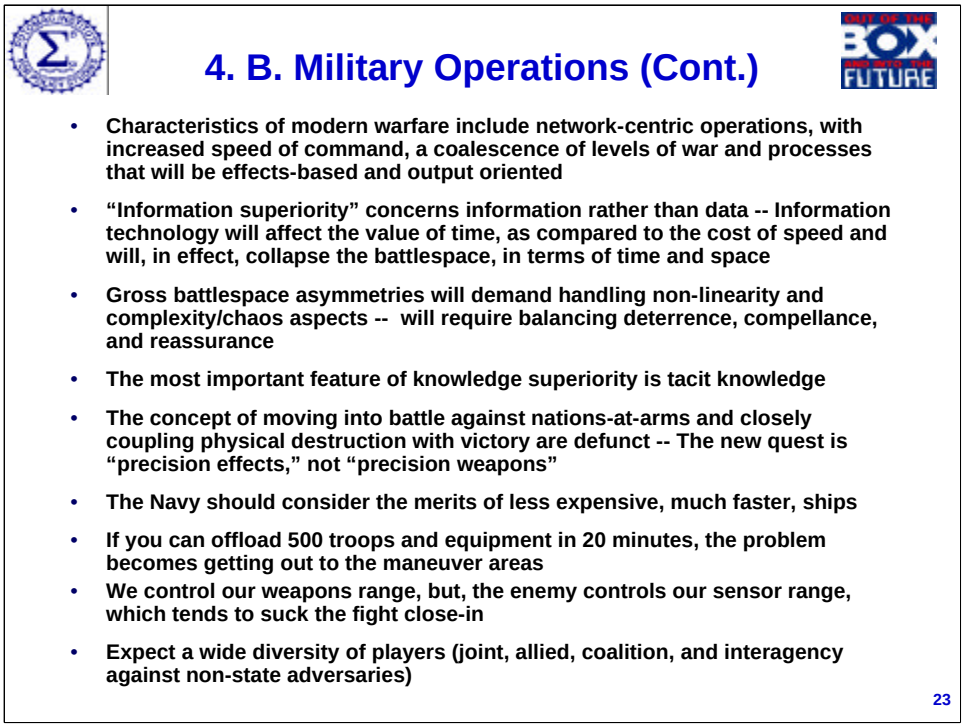
A multitude of global and local conditions can predispose populations toward conflict, such as "ethno-linguistic pan–nationalism" (his phrase), bad borders, criminality, and drugs. There are great pressures accompanying our growing numbers -- from six billion today to eight billion within 25 years – with probable shortages of water and other resources and a worsening weather picture thrown in to the picture. Furthermore, AIDS and other threatening diseases complicate all of this.

Technological advancements pose some military solutions for us, but they are also posing those solutions for potential enemies (well illustrated by a $51 overhead image available to all in the commercial market).

VADM Cebrowski: People often say they are in favor of transforming the military if only you can tell them what it is we're transforming to, but you can't, because the transformation itself is a process. The objective is not to build a rigid bridge to a predictable future, but rather to find our way to an emergent future. Can we find the methods and the processes on which to rely, instead of building a rigid path to the future? So far, the indications are no. That does not mean that we will fail, it merely means that we must work harder.

Nobody optimizes better than we do. But, there are some real downsides to it. Integration is enormously expensive. Optimization is for a point, not for a battlefield continuum in a constant state of flux. It carries with it systematic risks. It costs us an enormous amount of money and results in an industrial age, command structure.

The adoption of the new theory of war and the move towards robotics and low cost cruise missiles has been discussed. Underwater, unmanned vehicles will certainly change the way we do command and control, as will very high speed, amphibious ships, transport ships for the Army, the expeditionary sensors that I talked about and a new kind of lighterage.



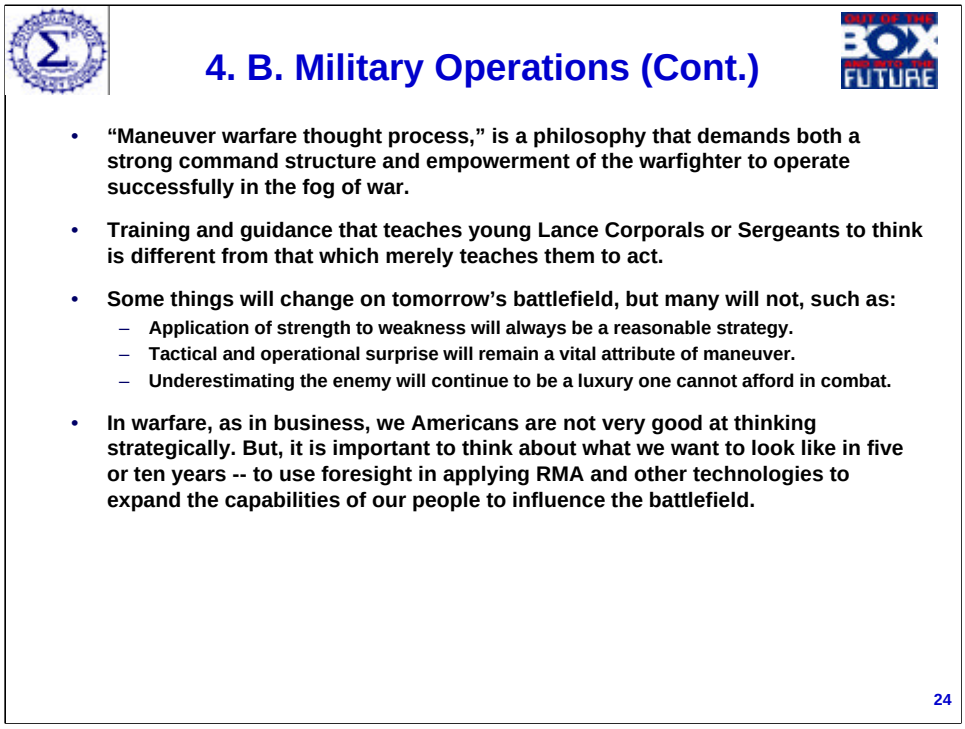
(cont.) Characteristics of modern warfare include network-centric operations, with increased speed of command, a coalescence of levels of war and processes that will be effects-based and output oriented. Information is highly valued, not necessarily for its bulk, but its accuracy, timeliness, and relevance. Information superiority will cover several operating domains, such as sea/space/cyberspace. "Information superiority" concerns information rather than data – we had the latter in Somalia and it did not prevent us from losing skirmishes. Information superiority is the ability to satisfy our information needs versus the enemy's ability to do the same. So, if we can prevent the enemy from getting the information he needs, we have improved our information superiority. Over time, the information age will cause us to value processes more than physical tools. There are profound and important effects of the speed achievable through network-centric warfare. Information technology will affect the value of time, as compared to the cost of speed and will, in effect, collapse the battlespace, in terms of time and space.

Gross battlespace asymmetries will demand the ability to handle non-linearity and complexity/chaos aspects, and that conflict will require balancing deterrence, compellance, and reassurance. Finally, there will be a wide diversity of players, such as joint, allied, coalition, and interagency against non-state adversaries.

Out of all this talk about information and knowledge, knowledge superiority, and the like, the most important feature is tacit knowledge, which comes from being immersed in a problem or in a theatre, gaining experience, making judgments through trial and error, and learning "on the ground." Explicit knowledge is the kind of stuff you can pull off the screen. Being there counts for a lot.

The concept of moving into battle against nations-at-arms and closely coupling physical destruction with victory are defunct. The new quest is "precision effects," not "precision weapons." Ways were discussed to attain these needed characteristics and, for the Navy, how to rebalance the fleet to meet future battle needs.

Estimates by the Office of Naval Intelligence, the Office of Coast Guard Intelligence, and commercial shippers indicate that the speed of commercial ships will be a factor of five or six times faster than now. The fast ship, Atlantic, a billion-dollar experiment, will go faster. but more importantly, its reliability of delivery is very high, even at speeds in the high thirties in nine meters seas. This is very important because, in terms of timeliness, guaranteed delivery becomes very valuable. You can say the same thing for military forces.



(cont.) When commercial shipping does "speed up," it will become embarrassing to try to escort one of these 80-knot ships with your dumpy 20-knot frigate. The Australians supporting East Timor with a ship adopted from the commercial world and capable of doing well over 40 knots. The ship carried about 500 troops and their fighting vehicles and is absolutely seaworthy, good in the open ocean. It was manned with two alternating ten-man crews, but their commercial people would run it with a crew of only three. Its cost is less than that of a fighter.

If, like the Australian ship, you can offload 500 troops and equipment in 20 minutes (which you cannot do in-stream with maritime prepositioning shipping or with systematical offload via helicopters), you need a shift to a whole new concept, but that's part of what the information age is all about. Now, the problem becomes getting out to the maneuver areas.

We control our weapons range. We could put a weapon on Mars and we can shoot anywhere about as fast as you would care to. But, the enemy controls our sensor range, which tends to suck the fight close in.

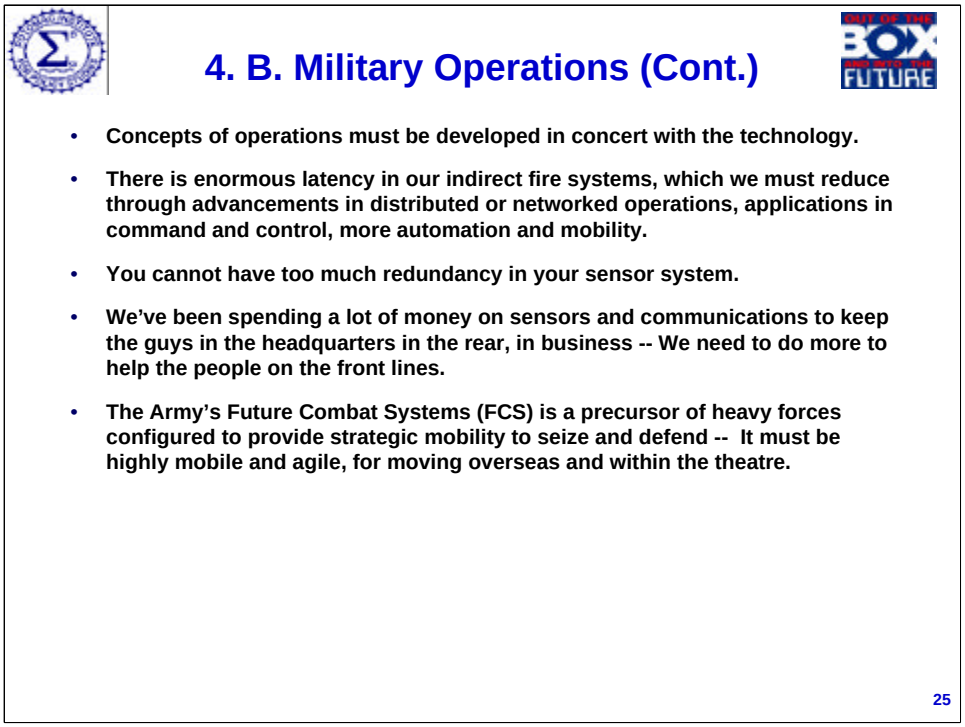
War is behavioral. It is an activity characterized by violent sociometrics, yet we spend little money (compared to hard sciences) to look at human behavioral aspects of war. Information leading to decisions is an output of this area of study.

General Gray: General Gray presented some thoughts on maneuver warfare, sharing both historical perspective and personal experience on what it means to maintain a "maneuver warfare thought process," a philosophy that demands both a strong command structure and empowerment of the warfighter to operate successfully in the fog of war.

Training and guidance that teaches young Lance Corporals or Sergeants to think is different from that which merely teaches them to act.

Some things will change on tomorrow's battlefield, but many will not. For example, the application of strength to weakness will always be a reasonable strategy, tactical and operational surprise will remain a vital attribute of maneuver, and underestimating the enemy will continue to be a luxury one cannot afford in combat.

In warfare, as in business, we Americans are not very good at thinking strategically. "Long range" tends to be about three years. But, it is important to think about what we want to look like in five or ten years -- to use foresight in applying RMA and other technologies to expand the capabilities of our people to influence the battlefield.



General Paul Gorman: General Gorman spoke on precision firepower.

Concepts of operations must be developed in concert with the technology.

Today there is enormous latency in our indirect fire systems, which we want to reduce as much as possible through advancements in distributed or networked operations, applications in command and control, more automation and mobility.

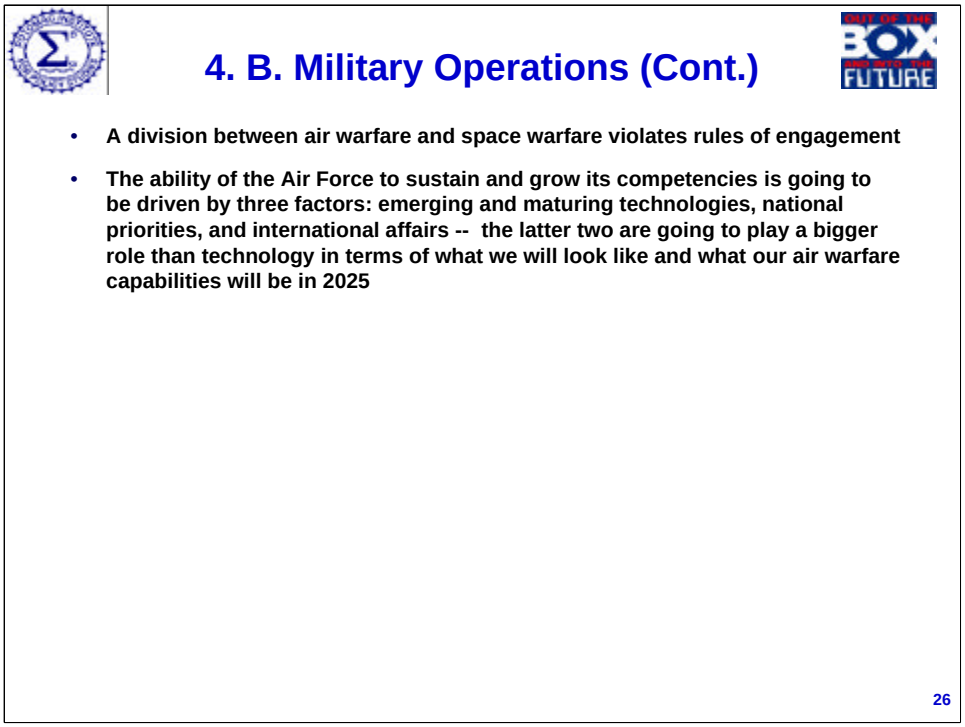
You cannot have too much redundancy in your sensor system.

We've been spending a lot of money on sensors to keep the guys in the headquarters in the rear, in business. But we've done precious little to help the people that are out there where the rubber meets the road – and who are doing the dying. A similar comment can be made concerning communications -- the guys who have the shortest timelines and exchange more information subject to penalty for latency, have had the least amount of communications.

Close battle is the pay off. Doing more with slender forces means you've got to be able to deal with that problem, regardless of whether you're talking about symmetric or asymmetric threats. We've got to get away from the idea of depending upon somebody else to keep us informed and develop a capability to think on our own. We must allow our small units to cope with the situation on their own terms.

The Army's Future Combat Systems (FCS) is a precursor of heavy forces that is being configured to provide strategic mobility to facilitate seizing and defending strategic access facilities, forestalling enemy positional advantage, and setting conditions for operational initiatives. It must be highly mobile and agile, not only for moving overseas, but for moving within the theatre, as well. It must also be able to fight as well or better than today's heavy force. [A Senior Advisory Group was recently formed by the Defense Advanced Research Projects Agency (DARPA) to explore innovative technology solutions that will enable the Army to achieve a lightweight, lethal, survivable, multi-mission ground combat force. Their findings also helped DARPA and the Army determine a course of action leading to development of what has become known as the FCS. Dr. Michael Andrews, Deputy Assistant Secretary of the Army for Science and Technology, presented a summary of the FCS at the Institute as one of the eight pre-conference seminars. We will make his remarks available during the next two months.] General Gorman explained in some detail how these systems work together – we will include this in our conference proceedings. This takes a system of systems, which includes:

- Robotic helicopter equipped with MTI, sidelooking radar, interferometric radar, SIGINT mapper (A-160 system)
- Digital Radio Frequency Tags
- Internetted Unattended Sensors
- Robotic missile batteries (rockets in a box)
- Advanced fire support system (Net Fires)



(cont.) DARPA is developing a small unit operation situational awareness system that is about the size of the radio. It is a wave-form hopper with capability of handling numerous wave-forms. It sets up its own network and provides continuous position navigation.

A better way to design our radio systems would be to use our packet distribution system and piggyback them on existing radio transmissions. A radio of this sort would inserts its packet into a red stream or a neutral stream. At the other end, you pull these packets out, because they are coded, and reintegrate them.

Even further out is an ultra wide band radio that would allow transmission across all of the available RF links. The band would be sufficiently wide to allow it to work pretty well in cities. It would also be able to scavenge wires.

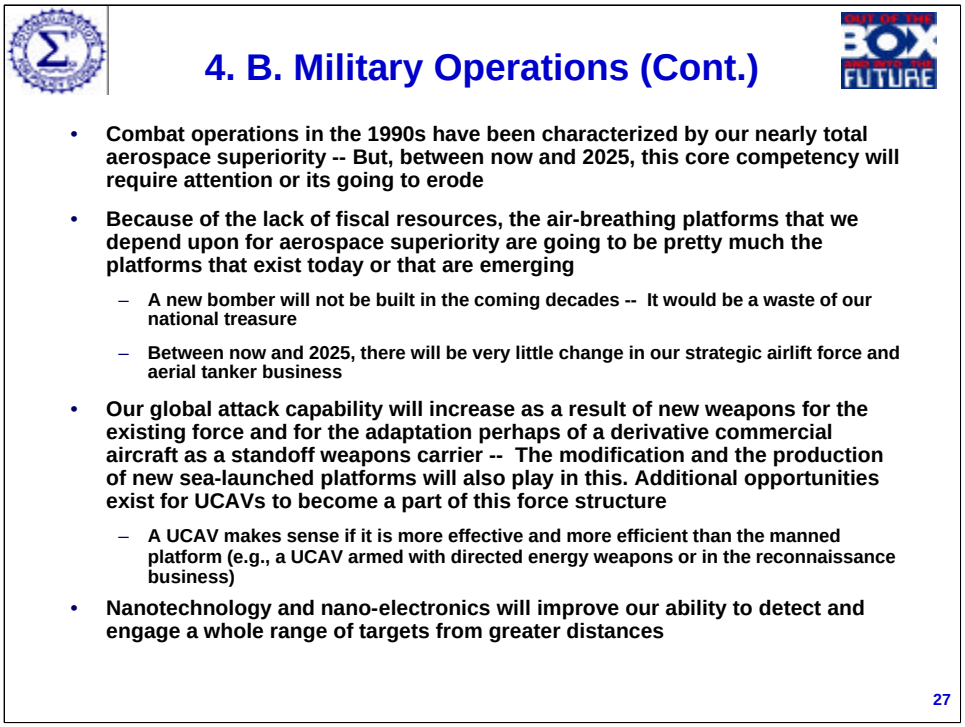
General Fogleman: A division between air warfare and space warfare is a rules of engagement violation in the way that the United States Air Force looks at this thing (although, it's about to be looked at in greater depth by a space commission that'll kick off here within the next couple of weeks). But, the fact of the matter is we generally look at space warfare and air warfare in an integrated fashion.

Most major innovations in weaponry come about as a result of a military adaptation of an existing or an emerging technology. Very few technologies were the result of applied scientific endeavor to solve a particular military problem.

Rather than responding to a few particular scenarios, military technology now must respond to diverse situations. Cost has become a major factor in the development of all systems. We must also recognize that commercial technologies have significant military applications. It is essential that future systems be based on capabilities and cost, perhaps on an equal footing rather than on solutions to specific problems.

The Air Force is responsible for being able to provide aerospace power. Core competencies necessary to do that must include: aerospace superiority, information superiority, global attack, precision engagement, rapid global mobility, agile combat support.

The ability of the Air Force to sustain and grow these competencies is going to be driven by three factors: emerging and maturing technologies, national priorities, and international affairs. I believe the latter two are going to play a bigger role than technology in terms of what we will look like and what our air warfare capabilities will be in 2025. This is not going to be the result of failure by the scientific community, but the fact that domestic politics and international events will play a larger role in shaping fiscal priorities for our national security arena.



(cont.) Aerospace superiority: Combat operations in the 1990s have been characterized by our nearly total aerospace superiority. The combination of dominant space assets, stealth, forced packaging to defeat integrated air defense systems and just some plain dumb luck have given us this capability. But, between now and 2025, this core competency will require attention or its going to erode.

Because of the lack of fiscal resources, the air-breathing platforms that we depend upon for aerospace superiority are going to be pretty much the platform that exist today or that are emerging.

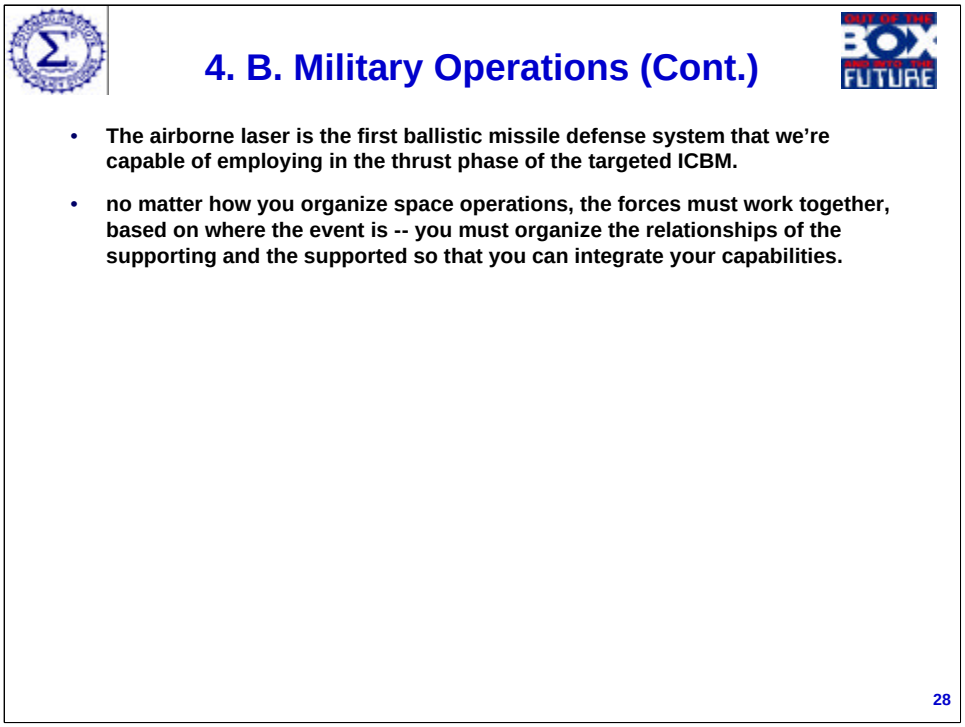
Despite pressure from many circles, to include the Congress of the United States, I do not believe a new bomber will be built in the coming decades. It would be a waste of our national treasure to do that. I think our global attack capability will increase as a result of new weapons for the existing force and for the adaptation perhaps of a derivative commercial aircraft as a standoff weapons carrier. The modification and the production of new sea-launched platforms will also play in this. I think additional opportunities exist for UCAVs to become a part of this force structure.

To me, a UCAV makes sense if it is more effective and more efficient than the manned platform. The UCAV armed with directed energy weapons is a great idea, but it doesn't make a lot of sense to me to drop or fire conventional munitions from it. Clearly, we are also seeing advantages of UCAVs in the reconnaissance business.

The proliferation of commercial space assets (e.g., the 51-dollar photograph that you can get off the internet) that will make it difficult maintain the level of space superiority that we had during the Desert Storm conflict.

Strengths and weaknesses of our information systems and the systems of our adversaries, the ability to distribute, display, and use all information available will continue to be challenged throughout the next two decades. But, assisted by the commercial technologies that will come into play by 2025, most of our distribution challenges will have been solved.

Precision engagement has benefited from stealth and our laser-guided ordinance. In the late 1990s, the GPS increased the number of aircraft and ordinance combinations that were available to provide a combination of precision and flexibility. Air and sea-launched conventional cruise missiles gave the warfighter additional options. These are diminishing night and weather sanctuary for our adversaries. In the future, the benefits of improved sensor systems and guidance systems will come from nanotechnology and nano-electronics. They will improve our ability to detect and engage a whole range of targets from greater distances.



(cont.) When you start looking out at long distances and you want to get great discrimination, suddenly the emergence of voxals, rather than pixels, in a sensor makes a lot of sense.

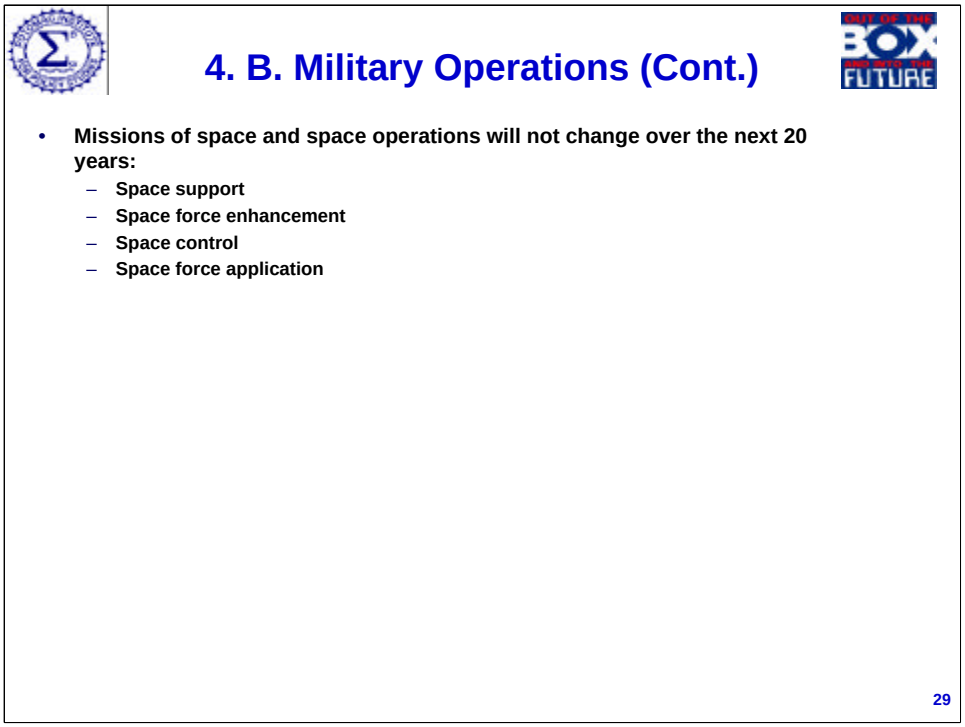
We're also going to see new and improved smart wave-forms. Embedding a signal in another carrier is a form of a smart wave-form. Wave-forms will be capable of carrying inputs from multiple sensor sources back to one processor. Perhaps the greatest breakthrough in the area of precision engagement is going to come from directed energy weapons, and particularly those in the high power microwave family. The ability to destroy circuit boards and communication systems, both military and civilian, without using blast and fragmentation is going to open up a whole new range of publicly acceptable target sets.

The airborne laser is the first ballistic missile defense system that we're capable of employing in the thrust phase of the targeted ICBM. That is before they are capable of deploying decoys or multiple reentry vehicles.

Between now and 2025, there will be very little change in our strategic airlift force and aerial tanker business. The opportunity exists to upgrade the tanker force through the adaptation of a commercial aircraft, but I think budget pressures are going to work against this concept. Tactical airlift will attempt to respond to new employment doctrines and warfighting concepts, but I think this is going to be very difficult because much of the existing capability that we have today is still going to be in service as a result of the planned avionics upgrades, such as the C-134s. But any procurement of new C-130 aircraft should be done in view of the needs of the services and what we have coming forward (e.g., quad-tilt rotor). This scrutiny needs to be done in concert of all the services.

Science and technology is needed to cope with the problem of aging aircraft. One area is in developing better tools to predict aircraft availability (not just airframe life).

General Ashy: Space is the fourth operational medium, one that touches air and views into land and sea. But the way to think about this operationally, no matter how you organize it, is that you need to have forces that can work together, based on where the event is. You cannot do this without conductivity and you cannot do it without functional and effective command and control. You must organize the relationships of the supporting and the supported so that you can integrate your capabilities.



Missions of space and space operations will not change over the next 20 years. These missions are:

Space Support pertains to the functions of putting objects in space and operating them. In other words, space launch and space operations.

Space Force Enhancement is the term that we use to describe "space support to the warfighter." Here, the supported roles of the space forces today will increase relative to the supporting roles. Examples are: weather support for space, communications, ballistic missile warning and intelligence, and navigation (not only for military, but for the international civil and commercial sectors, as well). You can survey the air from air, land, and sea today, and soon we will have the technology to survey it from space, but we must determine a cost-effective way.

Space Control, the issue of space superiority is really one of sovereignty in the domain of space. Nations of the world do not want one nation state to control and deny them access to space and the use of space. It's like thinking about sailing due regard on the high seas. We have international laws that permit us to do that, but when national interests have been threatened, we have had conflict on the high seas -- the same applies to space. When it becomes an issue of national defense or of national interest to operate in space, we must protect our capabilities there and our access to it and deny others.

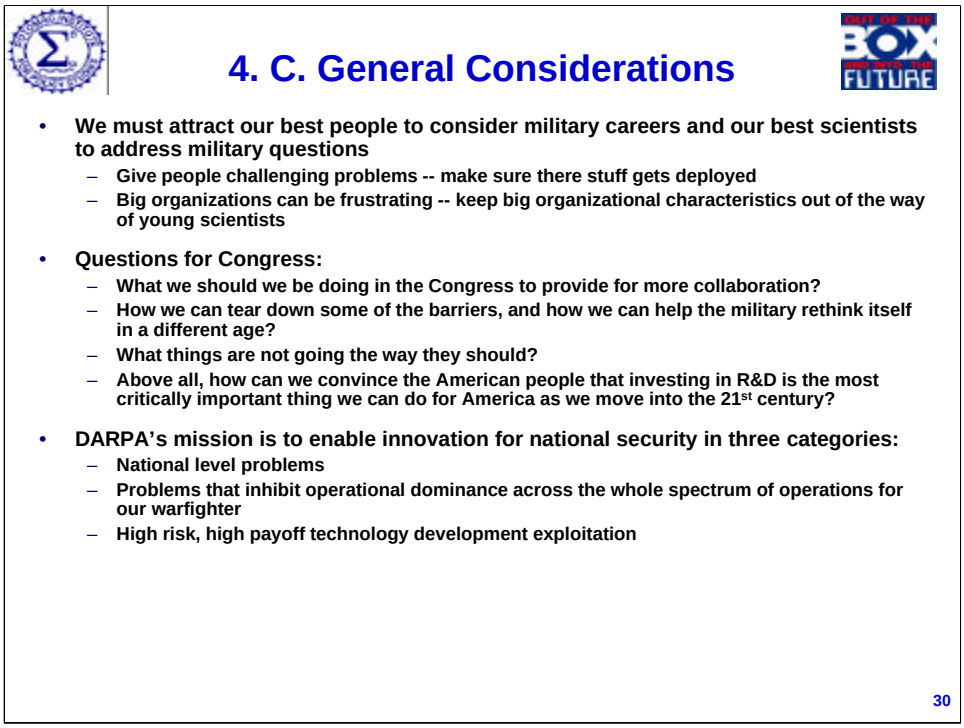
Space Force Application, is the application of space capabilities, from space-to-space, space-to-interspace and space-to-terrestrial media. As we move toward 2025, the fraction of supporting to supported capabilities for space forces will grow, as space control and space force application capabilities become better. The airplane is a good example of this.

The four elements of space operations also apply to air, land, and sea operations.

Shooters can be kinetic, non-kinetic, destructive, non-destructive, and so on. We should identify what physics allows us to do.

Sensor Elements need to be better defined, considering the obstacles to sensing, such as concealment, weather, protection, defense, night, and any others that arise. We need to be able to understand those and develop technologies to collect information on targets to fill our warfighting needs.

Conductivity, relates to how we organize our entities and how they interact, in their supporting and supported relationships, with components of other unified entities that we are operating with. An issue is sensors-to-shooter data, which I believe is often misunderstood. We don't need to be connecting a sensor to a shooter. We ought to create a technological infrastructure that works operationally.

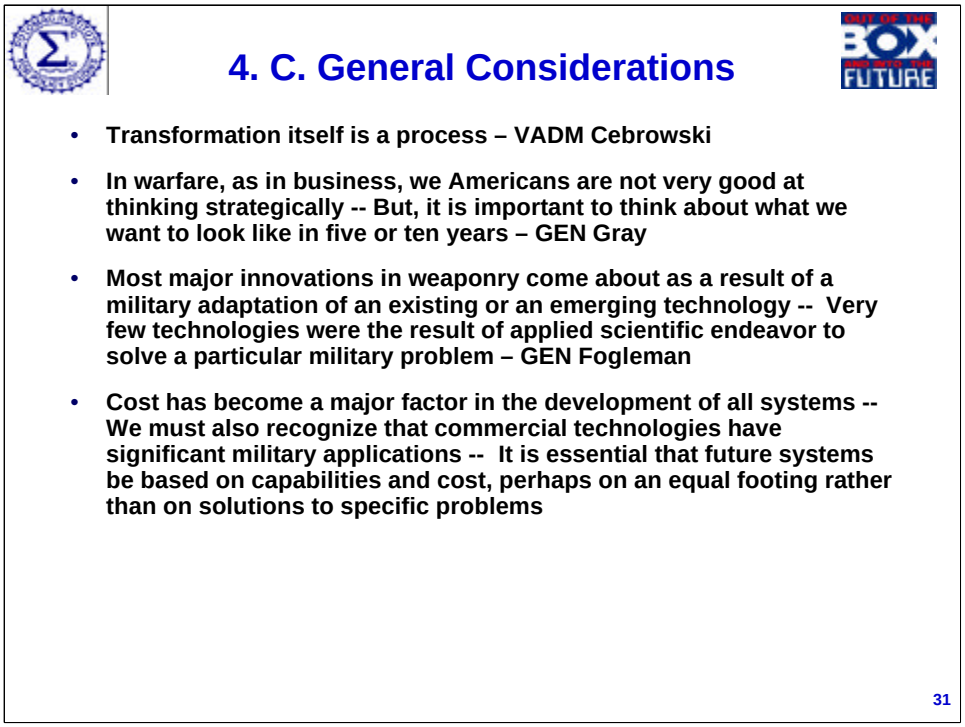


Dr. Patrick Winston: We must attract our best people to consider military careers and our best scientists to address military questions. That means giving people challenging problems -- making sure that the stuff they accomplish gets deployed -- and ensuring that there are not too many big-system problems to deal with. As a colleague of mine once suggested, "all big organizations are stupid." This is especially characteristic of organizations with smart people, because there's no idea so idiotic that a smart person can't defend. The big organizations can be frustrating and we must be sure that big organizational characteristics don't get in the way of young scientists who, these days, have little appetite for that sort of thing. They're too attracted to the 'dot coms.' I've lost about ten percent of my undergraduate students in the last semester to startups. I can't recall ever losing one of them to a defense contractor.

Congressman Weldon: The Congress is very much aware of the challenges that lie ahead in this century and that's why for the past six years we've increased R&D spending by about six billion dollars above the President's request. We see threats emerging, not just in missile proliferation and new technologies being developed by rogue states that can and will threaten America's military around the world, but also we see threats arising from increased possibilities of weapons of mass destruction and all of the ramifications of the use of those weapons.

Tell us what we should be doing in the Congress to provide for more collaboration, how we can tear down some of the barriers, and how we can help the military rethink itself in a different age. And give us your concerns about how things are not going the way they should. But above all, help us turn the corner to convince the American people that investing in R&D is the most critically important thing we can do for America as we move into the 21st century because that's going to take all of you coming together.

Dr. Frank Fernandez: DARPA's mission is to enable innovation for national security in three categories: i) national level problems that are critical to our national survival, ii) problems that inhibit operational dominance across the whole spectrum of operations for our warfighter, and iii) high risk, high payoff technology development exploitation for things that are not on roadmaps, that we really can't justify based on requirements, but which we truly feel could make a significant difference in what's going on.



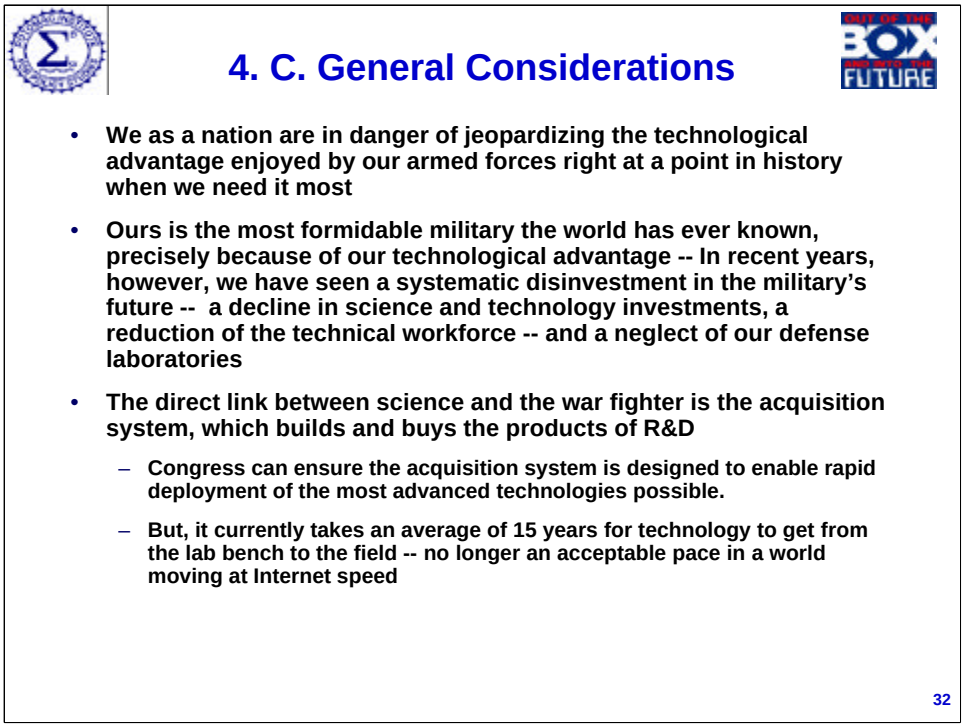
Dr Joe Bordogna: Advances in nano-scale science and engineering will likely revolutionize the 21st century in the same way that the transistor and the Internet led us into a knowledge economy. A nanometer, a billionth of a meter, will allow us to custom construct materials, machines and systems using particles less than half the size of a DNA molecule as the building blocks. This means that we're now at the point of connecting machines to individual cells. On the nano-horizon, this could lead to molecular computers that can store the contents of the Library of Congress in a device the size of a sugar cube. We can anticipate new materials from nano-science that will be as strong as steel but ten times lighter. The confluence of nano-technology and biology could catapult modern medicine into a new era.

In advanced computing, NSF is investing in new terra scale computing systems for use by academic researchers. This will take us through orders of magnitude beyond present general-purpose capabilities. In the past, our system architecture could handle hundreds of processors. Now we're working with systems of 10,000 processors. In a very short time, we'll be connecting millions of systems and billions of information appliances through the internet. Although NSF's terra scale computing system investment is envisioned for academe, we should know better. In the same way that one super computer was the exclusive domain of the Department of Defense -- but not for long. In just the same way, the NSF-funded terra scale machines will not remain only in the domain of the universities. University and military processes will be impacted robustly.

Senator Lieberman: The fundamental point that I want to make is that we as a nation are in danger of jeopardizing the technological advantage enjoyed by our armed forces right at a point in history when we need it most.

Ours is obviously the most formidable military the world has ever known, precisely because of our technological advantage. In recent years, however, we have seen a systematic disinvestment in the military's future. By which I mean a decline in science and technology investments, a reduction of the technical workforce. And I think a neglect of our defense laboratories.

Unfortunately, if history is any guide, people will look back at this period and say it was a period between wars. Although, I can't foresee what the next will be and I hope and pray that it does not come soon, the question remains, how will we use this interim period to continue to invest and innovate in a way that keeps us strong. At the heart of that is this connection between scientists and war fighters.



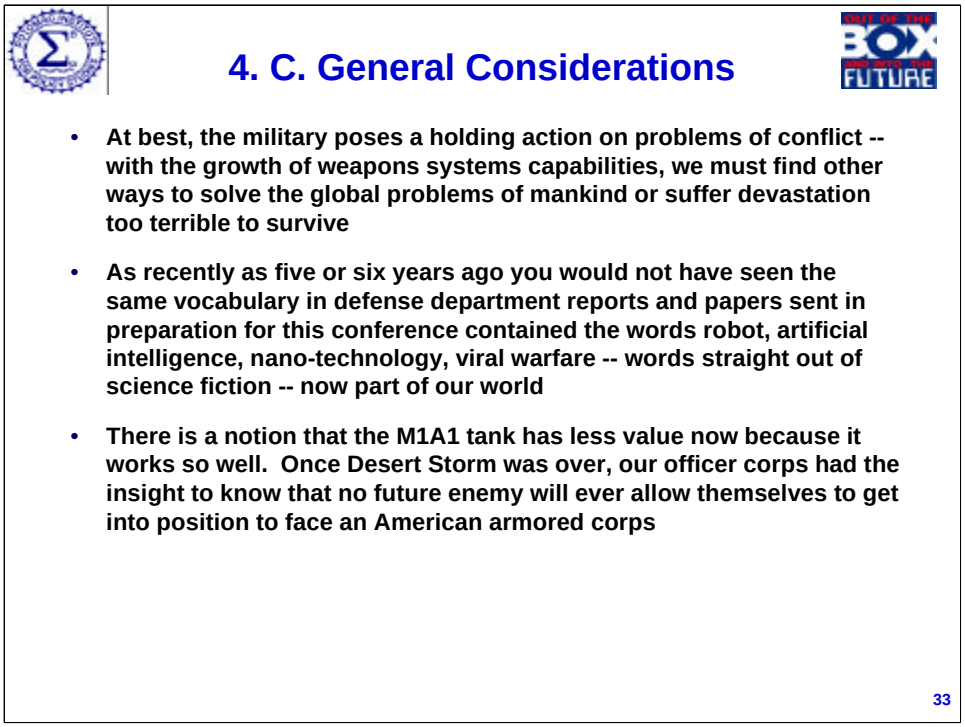
(cont.) There are three areas I want to talk about where I think Congress has a significant role to play in these, questions and where we've got to do a better job. They are funding, organization, and acquisition.

Defense-sponsored science and technology programs have been reduced by nearly a billion and a half dollars since 1993, even after a substantial increase in funding by Congress for fiscal year 2000, the one we're in now. The Fiscal Year 2001 President's request called for another decrease in funding with flat funding projected for the future. You can help show Congress the new and needed capabilities that we can achieve through increased R&D.

Congress needs to encourage the military to innovate in its organizational structure and personnel policies and doctrine. Is the army making sure, for instance, that the millions of dollars being invested in the Future Combat Systems will be matched by a similar investment of resources into training future soldiers who can best understand and utilize this radically different technology? Space will play a huge role in future operations and may turn into a battlefield itself, but are we investing the money and effort to simultaneously develop the technologies and tactics and the space force that will allow us to be strong and dominant in that theatre? And as information and sensor technologies move us toward capabilities and operations that are inherently joint, are we supporting the joint staff and the Joint Forces Command in their efforts to evaluate, experiment with, procure, and deploy joint systems for command and control, air and missile defense and other missions?

The direct link between science and the war fighter is the acquisition system, which builds and buys the products of R&D. Congress can ensure the acquisition system is designed to enable rapid deployment of the most advanced technologies possible. As you know, it currently takes an average of 15 years for technology to get from the lab bench to the field. That pace is no longer acceptable in a world moving at Internet speed.

And we need to continue to reexamine profit policies and cooperative technology programs among government, universities, and industry to make sure that we are exploiting every opportunity to create incentives, including marketplace incentives, to develop innovative systems that leverage our R&D investments.



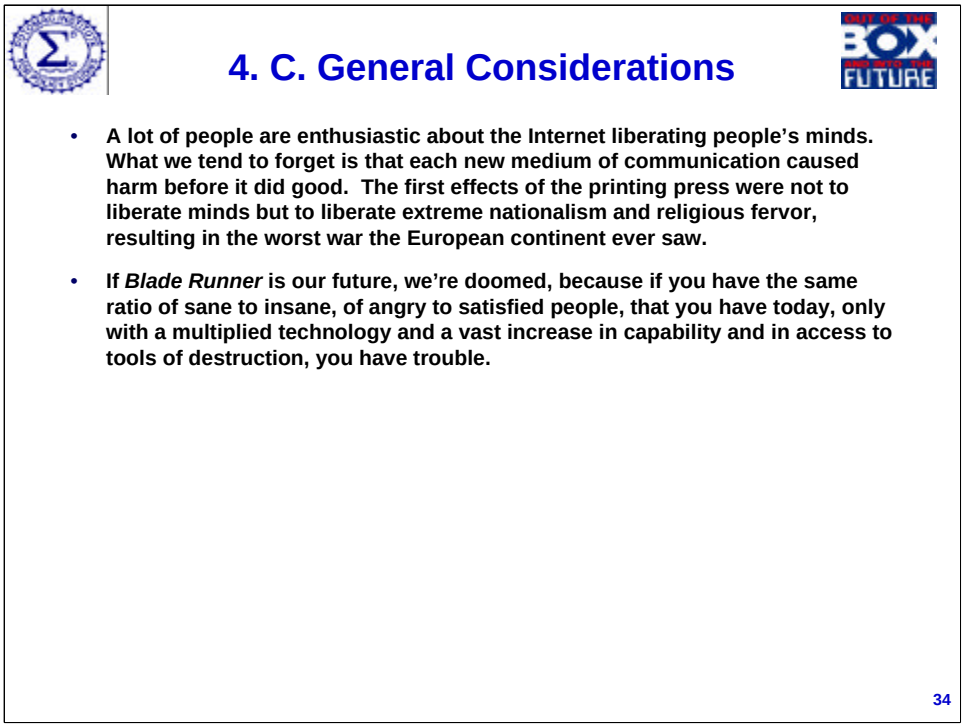
Dr. David Brin: As recently as five or six years ago you would not have seen the same vocabulary in defense department reports that you're seeing now. Papers that we were sent in preparation for this conference contained the words robot, artificial intelligence, nano-technology, viral warfare, -- words straight out of science fiction, which are now part of our world. Admiral Gehman spoke of the need for agility and foresight in a changing world. This may get us through, what we might call the transition age, the second half of the 100 years of transition that began with the Hiroshima bomb in 1945. If we get to 2045 successfully, I think we will see something quite amazing.

What we do when we're trying to predict the future, is to find the quicksand before we step into it. That's what our prefrontal lobes are for, and we do it in two ways. One is anticipation and the other is resiliency. These two approaches are quite compatible with each other.

There is a notion that the M1A1 tank has less value now because it works so well. Once Desert Storm was over, our officer corps had the insight to know that no future enemy will ever allow themselves to get into position to face an American armored corps. And, for that reason, the M1A1 tank is virtually useless. I'm exaggerating of course, but meetings like this are meant to expand the scope of anticipation and to increase the capabilities of our agility and our resiliency.

The military poses at best a holding action on problems of conflict. With the growth of weapons systems capabilities, we must find other ways to solve the global problems of mankind or suffer devastation too terrible to survive. General Gray spoke of stalemates, and that is okay as long as the good civilization that you are protecting is growing bigger and stronger and more agile. Then you will have held the line. As George Marshall's strategy of containing communism could be thought of as medical containment. Because that's in effect what it was, until the paranoiac fever passed (Russian paranoia, not necessarily communism). This is a task that might be achievable by a fearsome, unbeatable, agile, supremely effective protector force until the many fevers spoken of by General Hughes finally pass.

We are the people who don't worry about our next meal or our next harvest. But we have to worry about something, so we worry about our great grandchildren having enough top soil. It is the satiated who worry about the environment, who are capable of saying, "I better share with the rest of the world because my great-great-grandchildren might be living in any part of it. And besides which, I don't want these people to be mad, because they could make life hard for me." In any event, that is a cynic's belief on the source of compassion. Other people would say compassion comes out of love. I would say it comes out of satiation. Either way, let's just hope it comes.



(cont.) A lot of people are enthusiastic about the Internet liberating people's minds. What we tend to forget is that each new medium of communication caused harm before it did good. The first effects of the printing press were not to liberate minds but to liberate extreme nationalism and religious fervor, resulting in the worst war the European continent ever saw. Until finally, there were enough printing presses so some people could read both sides. When Adolph Hitler got his chance at the chancellery in Germany in 1933, the Junker ruling class thought of him as a tool to use against the communists. They thought they could get rid of him anytime they wanted because they controlled the newspapers, underplaying the importance of new media such as loudspeakers and radio, which for a while, until people were inoculated, gave a skilled user the power and force of voice of a god.

If *Blade Runner* is our future, we're doomed. Because if you have the same ratio of sane to insane, of angry to satisfied people that you have today, only with a multiplied technology and a vast increase in capability and in access to tools of destruction, you have trouble.

Our body politic is filled with outraged, outrageous, indignant young people, or at least young at heart, looking around for things to criticize. It is an adversarial process that finds errors quickly. In other words, it's exactly what we need as we charge into the future. No design system, no hierarchical system could ever find the mistakes in time, because none of us is wise enough to be king. It's an amazing system, and you ought to bear that in mind the next time you are outraged by all the outrage out there. I think we could tone it down. I think people could be just as effective T-cells while granting each other's humanity and not demonizing the other political party.

Conference Co-Chairs

The conference chairs include one representative each from the military, congressional, and scientific ranks. The military chair is Admiral Harold Gehman, U.S. Joint Forces Command, the congressional chair is Representative Curt Weldon, chair of the Military R&D Subcommittee of the House Armed Services Committee (pending schedule compatibility), and the scientific chair is Dr. Charles Vest, President of Massachusetts Institute of Technology (MIT). The co-chairs will be asked to suggest improvements and approve the conference concept, garner support for the conference within their spheres of influence, speak at the conference opening, and critique and endorse conference outcomes

Conference Steering Committee

The steering committee is responsible for reviewing the conference structure, participants and goals, and making suggesting improvements prior to final approval by the conference co-chairmen.

Co-Chairs and Members of the Steering Committee will participate in conference follow-on activities and the planned congressional meeting/hearing.

Conference Organizing Committee

The Organizing Committee, managed by the Potomac Institute for Policy Studies, organized and conducteed the conference, with advice and assistance from the co-chairs, steering committee, and sponsors.

6. Conference: 1st Day

0700-0800	Registration (Amphitheater)
	Morning Session: Introduction, Sponsor and Co-Chair Remarks (Amphitheater)
0800-0810	Introduction: Dr. James Richardson, VP for Research, PIPS
0810-0820	Welcome: Mr. Michael Swetnam, President and Chairman, PIPS
0825-0835	Defense Co-Chair: ADM Harold Gehman, CINC USJFC
0840-0850	Science and Engineering Co-Chair: Dr. Patrick Winston, Ford Professor of Artificial Intelligence and Computer Science, MIT for Dr. Charles Vest
0855-0925	Joint Vision 2010 and Beyond: MG George Close, USA (Ret.)
0930-1010	Future Technology Investments: Dr. Frank Fernandez, Director, DARPA
1010-1020	Break
1030-1110	Asymmetrics: Mr. Ralph Peters, Author, *Fighting for the Future? War in 2020*
1120-1240	Luncheon (Atrium Ballroom) -- Future Combat: Mr. Dennis Bushnell, Chief Scientist, NASA Langley
1250-1700	Afternoon Session: Fundamental Warfighting Parameters (Amphitheater)
	– Introduction: MG Robert H. Scales, Jr, USA, Commandant, Army War College
	– Intelligence/Threat: LTG Pat Hughes, USA (Ret.), Former Director, DIA
	– Info./Networking: VADM Arthur Cebrowski, USN, Pres., Naval War College
	– Maneuver/Power Projection/Protection: GEN Al Gray, USMC (Ret.)
	– Firepower/Precision Targeting: GEN Paul Gorman, USA (Ret.)
	– Air Warfare: GEN Ronald Fogleman, USAF (Ret.)
	– Space Warfare: GEN Joseph Ashy, USAF (Ret.)
1700-1755	Book Signing and Cash Bar
1800-1840	1800-1840 Senator Lieberman: Introduced by Dr. Joseph Bordogna, Deputy Director, NSF
1845-2100	Dinner (Atrium Ballroom): Representative Curt Weldon;
	Coming Full Circle — 21st Century Defense Doctrines Will Stress Citizenship: Dr. David Brin, Scientist and Novelist, *Earth*, *Startide Rising*, *The Postman*

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This and the next chart offer the final agenda of the conference for reference.

6. Conference: 2nd Day

0800-0850: Morning Session Keynote: Dr. Delores Etter, Deputy Undersecretary of Defense (Science and Technology)

0900-1200: Panels on Science and Technology Trends

- Energy: Dr. Terry Surles, LLNL (Chair); Dr. Robert Bill, ARL; Dr. Robert Nowak, DARPA
- Human Factors/Neuroscience: Dr. Dennis McBride, UCF (Chair); Dr. Dan Alkon, NIH; Dr. William Calvin, UW
- Nanotechnologies: Prof. Richard Smalley, Rice U (Chair); Prof. Ken Gabriel, CMU; Dr. Ralph Merkle, Xerox Palo Alto Research Center; Dr. Paul J. McWhorter, Dep. Dir, SNL Microsystems Ctr;

1200-1320: Free Time

1320-1400: Afternoon Session Keynote: Dr. Hans Mark, Director, Defense Research, Development, and Engineering

1410-1710: Panels on Science and Technology Trends

- Information and Knowledge: Dr. Steven Cross, Software Engineering Institute, CMU (Chair); Dr. Irving Wladawsky-Berger, PITAC Co-Chair, IBM Corporation; Dr. Paul Messina, ASCI Program, CalTech
- Biomedical: Dr. Stuart Kaufmann, Bios Group LP (Chair); Dr. Millie Donlon, DARPA; Dr. Claire Fraser, TIGR; Mr. David Siegrist, PIPS; Dr. Harold P. Smith, Jr., UC – Berkley
- Advanced Materials: Dr. George Whitesides, Harvard (Chair); Professor Merrilea Mayo, Penn State; Dr. Steve Wax, DARPA

1700 Conference Adjourns

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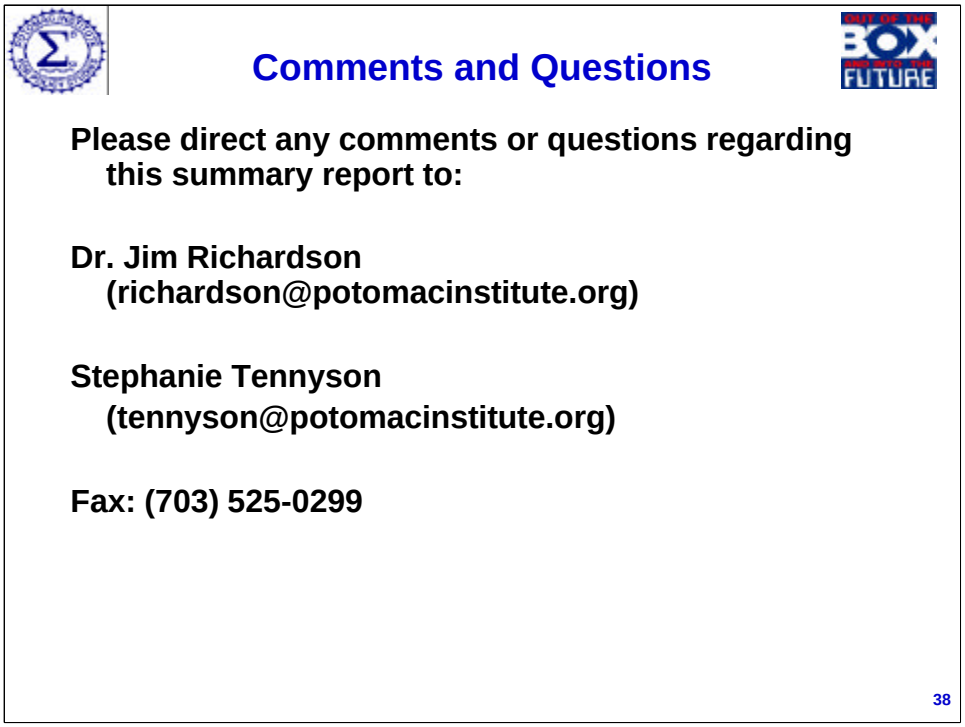

The Institute welcomes comments and questions from the conference Co-Chairs, Steering Committee, and conference attendees. Please direct your comments and questions to either Dr. Jim Richardson (richardson@potomacinstitute.org) or Stephanie Tennyson (tennyson@potomacinsitute.org) by e-mail or fax (703-525-0299). If your comments or questions are pertinent to a particular slide, please reference the slide number in your remarks. We look forward to hearing from you.