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Defense Science Board
Task Force

On

Training for Future Conflicts

Final Report

June 2003

Office of the Undersecretary of Defense
for Acquisition, Technology and Logistics
Washington, DC 20301-3140

This report is a product of the Defense Science Board (DSB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions, and recommendations in this report do not necessarily represent the official position of the Department of Defense.

This report is UNCLASSIFIED

OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

DEFENSE SCIENCE
BOARD

JUL 11 2003

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY & LOGISTICS)

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on Training for Future Conflicts

I am pleased to forward the final report of the DSB Task Force on Training for Future Conflicts. The Task Force was asked to identify new training methodologies and techniques that ensure U.S. forces can achieve the capabilities envisioned in Joint Vision 2010/2020. In addition, the Task Force was to identify and characterize the education and training demanded by JV 2010/2020 and address joint and interoperability training as well as development and demonstration phasing over the next two decades for technology modernization, operational concepts, and training.

The Task Force's principal finding is that transformation of the military will increase the cognitive demands on even the most junior levels of the military. Research and development funding to create new kinds of training continues to be scarce and is being cut. Additionally, the personnel system, like the acquisition system, often disrupts training and military proficiency with no accountability.

The many recommendations documented in this report seek to overcome the training pitfalls involved in transforming and revolutionizing our forces.

I am pleased to forward the Task Force Chairman's letter and the final report for your review.

William Schneider, Jr.
DSB Chairman

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OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

July 9, 2003

DEFENSE SCIENCE BOARD

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report Defense Science Board Task Force on Training for Future Conflicts

Attached is the final report of the DSB Task Force on Training for Future Conflicts, the follow-up to the 2001 report, *Training Superiority and Training Surprise*. For the current effort, the Task Force was asked to identify training approaches and technologies that would prepare our forces for the constantly evolving military environment. We were to characterize the nature of future conflicts and training needs that would support success in these conflicts. We were also asked to continue to explore the possibility of training surprise: a situation wherein a potential adversary might surprise us with unexpected competence by using revolutionary training techniques.

The task force's principal finding is that transformation of the military will substantially increase the cognitive demands on even the most junior levels of the military. In short, everybody must think. Our current training and educational processes will not adequately prepare our people to cope with these increasing and constantly changing cognitive requirements. Something new is needed to insure that all our forces are competent to do the many tasks that our transformed military will require of them. In general, however, we find that the research and development funding required to create this new kind of training is not only scarce, it is being cut. Finally, we find that the personnel system, like the acquisition system, is similarly free to disrupt training and military proficiency without being called to account for these results.

We therefore recommend the following:

- The Secretary of Defense (SecDef) should require that the forces, acquisition community and personnel establishment deliver to him, at least annually, a high-level report card. SecDef should also require a report from the Intelligence Community on the potential for an enemy to surprise us with unexpected military proficiency as a result of innovations in training.
- USD(AT&L) should establish and test a training sub-system co-equal to all other sub-systems for each acquisition program that will insure that users are trained throughout the system life cycle.
- USD(P&R) should report within one year on how to make the personnel system accountable to readiness and training.
- USD(P&R) should sponsor an Advanced Concept Technology Demonstration (ACTD) to develop joint virtual training environments to allow all forces and individuals to conduct cognitive and mission-related training anytime, anywhere.
- DARPA should expand its new DARWARS Training Superiority program. USD(P&R) should find ways to encourage the Services and joint commands to merge their training

devices and programs with DARPA's universal persistent, on-demand training wars concept.

- USD(P&R) should establish a 6.3/6.4 training budget of at least $40 million per year to fund low-hanging fruit in training research.
- The Chairman of the Joint Chiefs of Staff and the Combatant Commanders should establish at least two deployed Combat Training Teams to search out the training requirements of potential conflicts around the world. The teams would determine what kinds of unique training our forces will need to prepare these forces for unique cultural, political, and military issues in each potential hotspot. The teams would also determine how we would need to train local allies and how those allies could train our forces.
- Finally, the DSB should continue its focus on training issues with a new task force to explore the rapidly emerging concept of a Joint National Training Capability.

Training is not well measured. It is therefore much easier to ignore than personnel and hardware facets of military readiness. Moreover, the Combat Training Center (CTC) training revolution still only reaches some of our forces, and, even for them, this happens only once every several years. In addition, substantial proficiency decay occurs soon after a CTC deployment is completed. Unless the structural and research changes recommended above are implemented, the superb capabilities provided to individual units by the CTC revolution will remain transient, and our average proficiency will stay far below what it could be. We need to continuously hold the competence of our entire force at the highest levels if we are to succeed in the complex, cognitive, come-as-you-are environment of future conflicts.

Dr. Joe Braddock
Task Force Co-Chairman

Dr. Ralph E. Chatham
Task Force Co-Chairman

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DSB Task Force on Training for Future Conflicts

Defense Science Board Task Force

Training For Future Conflicts

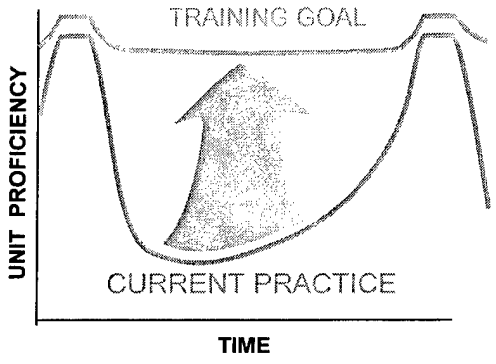
Final Report

2003

Dr. Ralph Chatham

Dr. Joe Braddock

Co-Chairmen



This report can be read on three levels: viewgraph, caption (of which this is one), and amplifying text. The sketch notionally depicts the readiness "bathtub" curve, where peak performance is maintained for only a short time. Future conflicts may not permit us to accept this kind of readiness cycle.

THIS IS THE SECOND 21st century Defense Science Board report on military training. The report itself has a training goal: instruct and convince the acquisition and personnel communities to recognize instinctively that (1) military proficiency is as dependent on the warriors who operate weapon systems as it is on the weapon system technology, and (2) a superb way to waste personnel or system acquisition money is to ignore training, or to tacitly allow training to pay the bills for acquisition or personnel system flaws in those more measurable arenas.

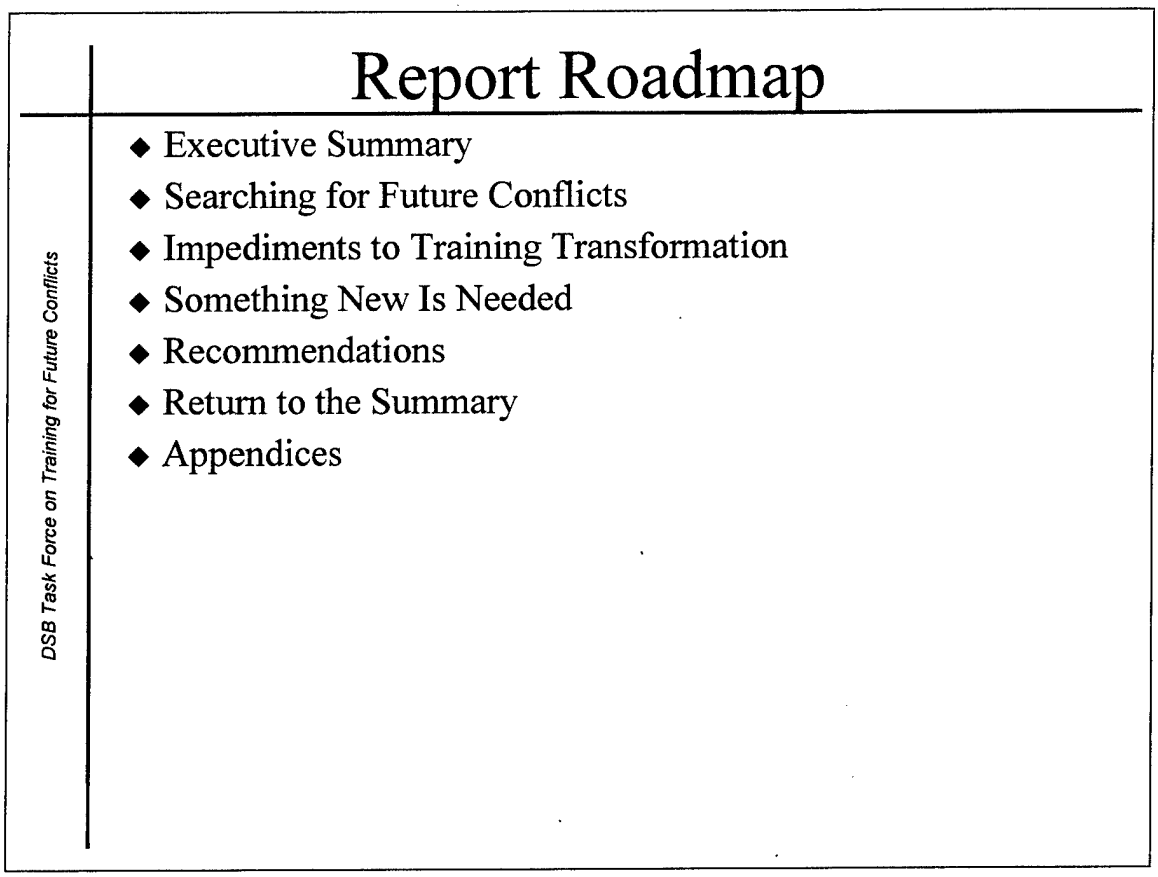
Achieving this goal may take some time. Our first report, *Training Superiority and Training Surprise*, was published in 2001.* Some of our recommendations have been implemented. Most have not. We will present a report card on their implementation in the executive summary. Nevertheless, either because of or in spite of our first report, there seems to be an increase in general awareness of the importance of training to warfare proficiency within the training communities. Less awareness exists outside them.

The task force work described in this report is aimed at determining how our forces must prepare for conflicts in the future, 10 to 20 years from now. We first asked what a future conflict might be

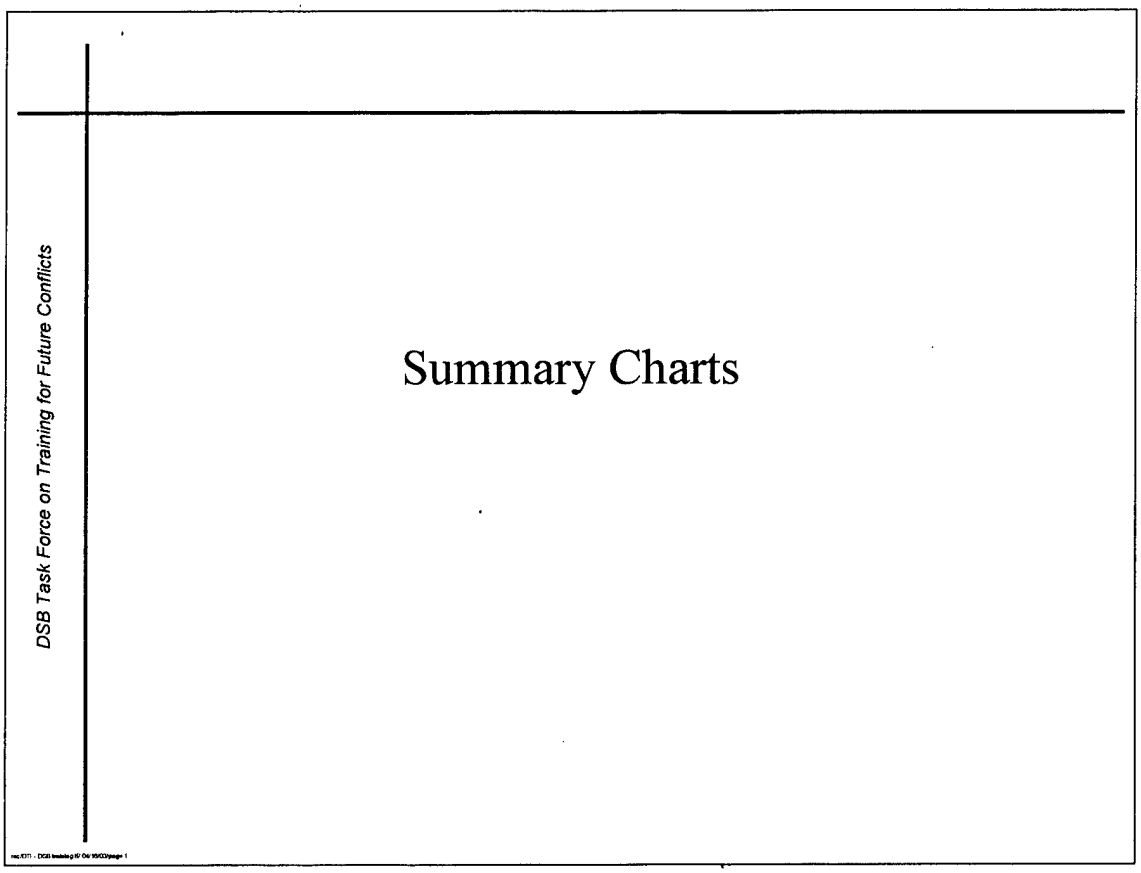
* The report is available, at the time of this writing, at http://www.acq.osd.mil/dsb/reports.htm.

like and how our forces planned to prevail in one.

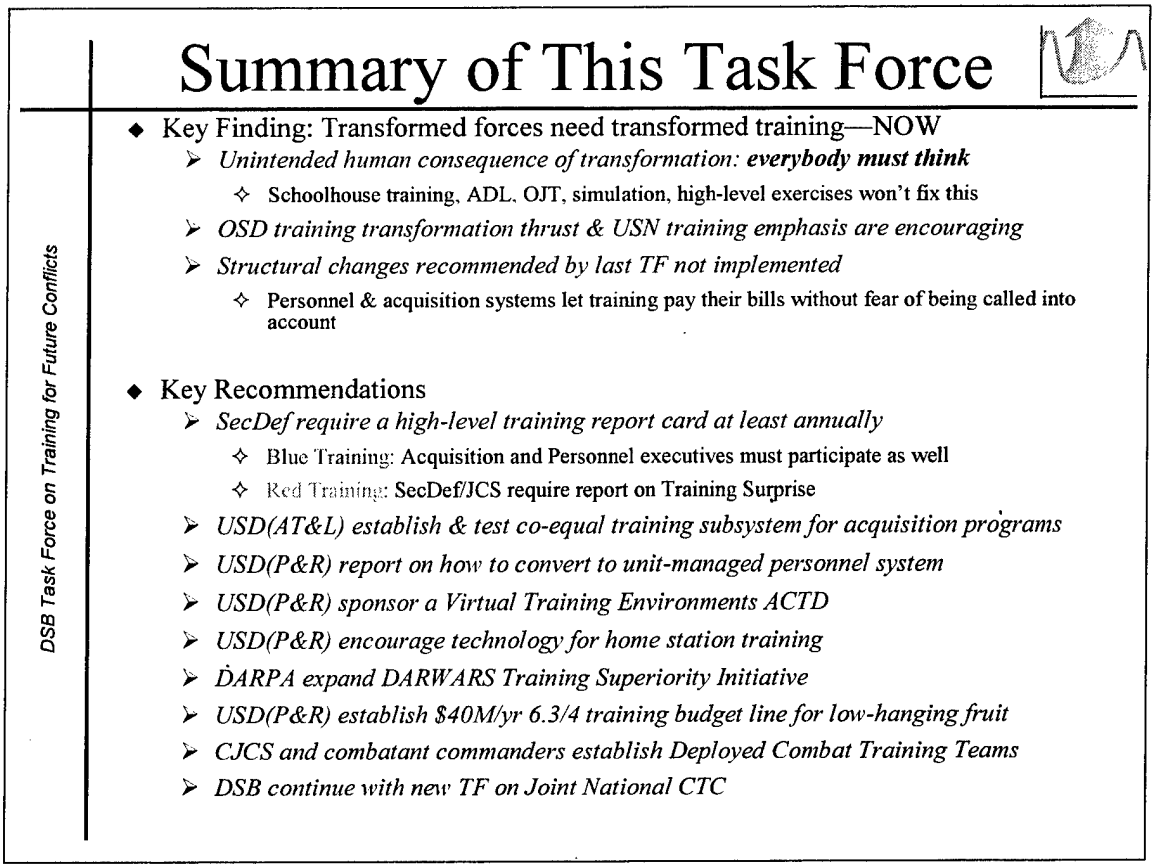
We then considered what future training for future wars might require, but we, like the rest of the nation, were interrupted by the atrocities of 11 September 2001. In the following months we watched the unfolding of a *bona fide* future conflict. The special forces units employed were superbly trained for the Afghan campaign. However, the integration of all of our forces into that war leaves us with training lessons, especially for preparation for "no-plan" contingencies. The rest of our forces need to train in the continuous ways that our special units often can. In this report we suggest some technological and bureaucratic changes that might lead in that direction. Nevertheless, the unimplemented structural changes to the defense and intelligence systems that we recommended in our previous report are still needed if our forces are to be given a chance to learn *before they get to the war* how to fight, jointly, in the new combinations that will be required to succeed in planned or unexpected future conflicts.



Welcome to Training for Future Conflicts. *Our report starts with a summary of this work, a summary of our last training report, and a report card on implementation of its recommendations. We then take the standard approach of defining some problems, identifying interesting developments, and then offering recommendations. We end with the same summary chart we started with, but add new supporting words.*



If your time is limited, read only the next 5 charts. If it is really *limited, just read the next one.*



Transformed forces require transformed training. Training technology development is needed, but the training revolution can not proceed within its traditional military stovepipe alone. Training must be excused from paying warfare proficiency bills that are better paid by the acquisition or personnel systems.

OUR MILITARY IS TRANSFORMING itself for the future. The emphasis so far has been upon new weapons systems and new operational doctrine. This emphasis is a natural result of hardware's visibility. Largely unexplored, however, are the human consequences of this emerging transformation.

The process will demand from everyone: initiative, cooperation, decentralized decision-making, and an ability to exploit fleeting opportunities. The future will require that more of our people do new and much more complicated cognitive tasks more rapidly and for longer continuous periods than ever before. Our warriors must also be able to fight in the old ways when the new technology degrades during combat. This amounts to a qualitative change in the demands upon our people that can not be supported by traditional kinds of training. Transforming training to support the warfare transformation will be a difficult undertaking: roadblocks must be removed and research performed, but, as our Training Superiority and Training Surprise task force pointed out, a training transformation could pay for itself. Unfortunately, the current bureaucratic structure won't let this happen.

Within the traditional training domain there *has* been encouraging progress, but the military's goal should not be just training superiority; it should be warfare performance. To create warfare competence, the military services have been charged by law to "man, equip, and train" forces for Combatant Commanders to employ. Large organizations need

to subdivide in order to function and, by and large, the current military bureaucratic divisions match the Title 10 charge: personnel, weapon system acquisition, and training. However, we only measure a subdivision's performance against something like warfare competence in one of these three areas (acquisition). There are few war games, for example, that explore the effect of personnel policies or training practice upon campaign outcome. Hardware gets visibility and money, the personnel system runs open-loop, but the focus of this task force—training—although the chief concern of forces not actually fighting, takes a back seat in the bureaucracy. Training's achievements, its failures, and its costs are not routinely visible to those with authority over discretionary funding in the Department of Defense (DoD). Moreover, the interactions among the three "stovepipes" and a fourth—force employment practices—are seldom explored. This results in training paying bills that would have been better paid by the personnel or acquisition systems.

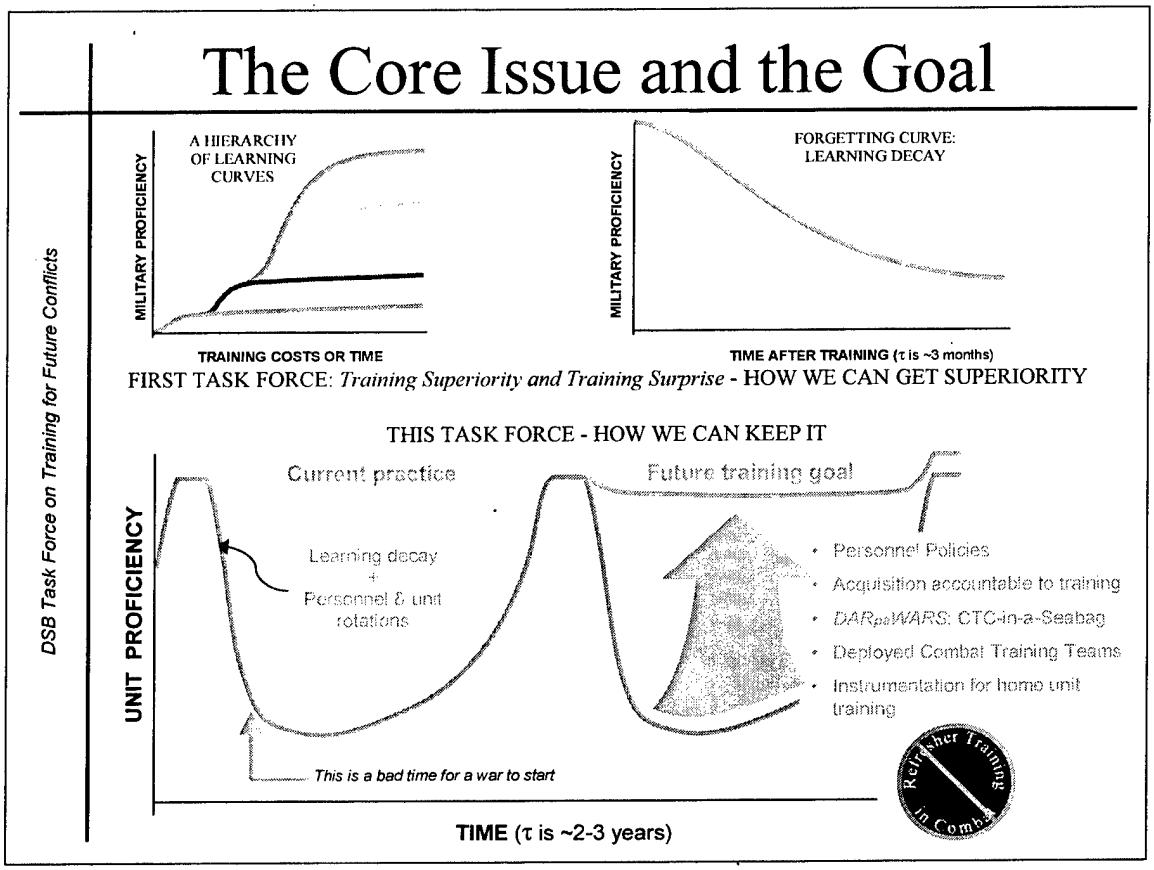
Good management pays attention to the interfaces among its administrative stovepipes. It can do so, however, only if it is thoroughly aware of those interfaces and of the contributions of each division to the entire organization's goals.

We will discuss specific recommendations in a few pages, but our key recommendations deal with ways to:

(1) make visible the influence of training on warfare competence, and
(2) force assessment of where the costs of warfare competence would be best borne.

We recommend continued DSB involvement in the short term and structural changes over the longer term. Both will help insure that the lesson of training value is not lost at the top.

We conclude with a bumper-sticker: if you wish to increase military proficiency *now*, the best place for your marginal dollar is training.



The training curves: hierarchies of learning curves and forgetting curves are discussed in our previous report, Training Superiority and Training Surprise. *The "inter-deployment readiness bathtub curve" (above) represents the real world where proficiency decay is even more rapid because of personnel rotation policies. Filling the bathtub is key to preparing for future no-plan, come-as-you-are wars.*

IN OUR PREVIOUS DSB REPORT we discussed a revolution in training that gives many of our military forces a rapid and measurable order-of-magnitude boost in warfare competence. The key elements in this Combat Training Center (CTC) revolution are:

- Create a realistic war situation,
- Fight units and individuals within in it,
- Measure everything that happens,
- Conduct no-holds-barred collaborative after action reviews to explore critical feedback, and
- Repeat for a few weeks.

This CTC process works for a number of reasons, not the least of which is that it builds upon previously learned competencies to create competence in complex tasks. We created a notional chart of stacked learning curves to describe this. (See the upper left figure in this chart.)

The figure in the upper right, however, illustrates that such a high degree of competence can decay if the task is not practiced frequently. Unfortunately, CTC training is now performed only within a few specialized instrumented ranges, only for some units every few years. Skill decay over time is just one source of warfare proficiency decay; other sources include rapid changes in the technology of warfare, changes in the kind of war to be fought, and personnel turbulence within units (which in the Army unless a war is imminent is

often at its maximum just after a unit completes its training at a CTC).

Although we had hoped to find a way to bottle CTC training and export it electronically, our first task force spent more time considering how to maintain the achievements of the current training revolution. We were less specific about how we might foster a second revolution using new technology.

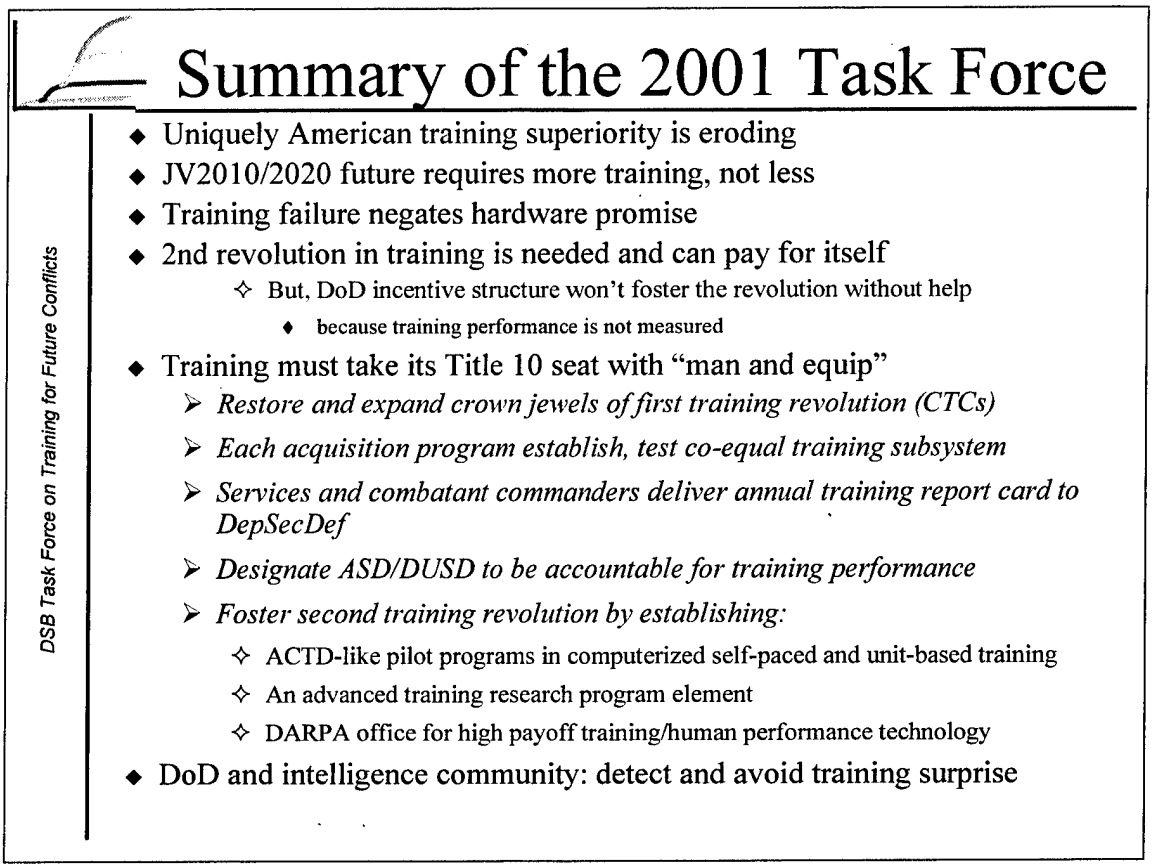
In the current task force, we have reflected on ways to advance from the current state by preventing large readiness drops between applications of the first (CTC) training revolution to individuals and units. We offer several recommendations to keep our personnel and our units out of the inter-deployment readiness bathtub, illustrated by the lower figure in the chart.

First among these are structural changes in the personnel and weapon system acquisition systems. Units, not individuals, are the basis of warfare competence, but evidence suggests that the existing individual-centered personnel system creates performance-degrading turbulence within units. This will not be easy to change.

Second, if we were to insist that costs of future training be considered during the design and procurement of hardware, much of future warriors' added cognitive load and training burden might be eliminated.

Other structural changes include establishing Deployed Combat Training Teams that could—before a war is imminent—search out unique training requirements for future conflicts throughout the world. These would include not only what we might need to train ourselves, but how we might need to train new allies and how they might train us.

Finally, we must enhance the ability to train units and individuals anytime and anywhere through local instrumentation of home stations and training projects like DARPA's persistent, on-demand, universal training wars (DARWARS) program, which aims to create CTC-like cognitive training for everybody using common computer hardware and network facilities.



This is a summary of our last task force's findings and recommendations: The right kind of training can have electrifying effects upon performance. Unfortunately, we do it right only in parts of the Services and even that capability is eroding. We must do more if we want to fight the new Joint Vision kind of warfare. We won't get there on the present course. Worse, there is no single hand at the helm.

The text below is the summary lifted straight out of our previous report. In the last 2 years we have learned nothing to change our minds. The next chart is a report-card on the implementation of our recommendations.

Our [first] task force's principle finding is that the United States military enjoys a huge training superiority over our potential adversaries. This second superiority is at least as important to warfare performance as is America's, better advertised, technological superiority. We should not rely on technological superiority alone. It could not bring victory in Viet Nam, nor is technology alone likely to be sufficient for future victories. During and since Viet Nam, actions by a few foresightful individuals caused our air forces and Army ground forces to adopt a new form of warfare training that has created a training competence complementary to our technological competence and, in part, supported by it. This was a revolution in training.

We can not rest on our laurels. We would need to reduce the cost of training even if nothing in warfare were to change. Warfare will change and training must change with it or we will be unable to fight our Future Combat Systems, our JV-2010/2020 forces, or even maintain logistics systems that sustain our new agile and flexible forces.

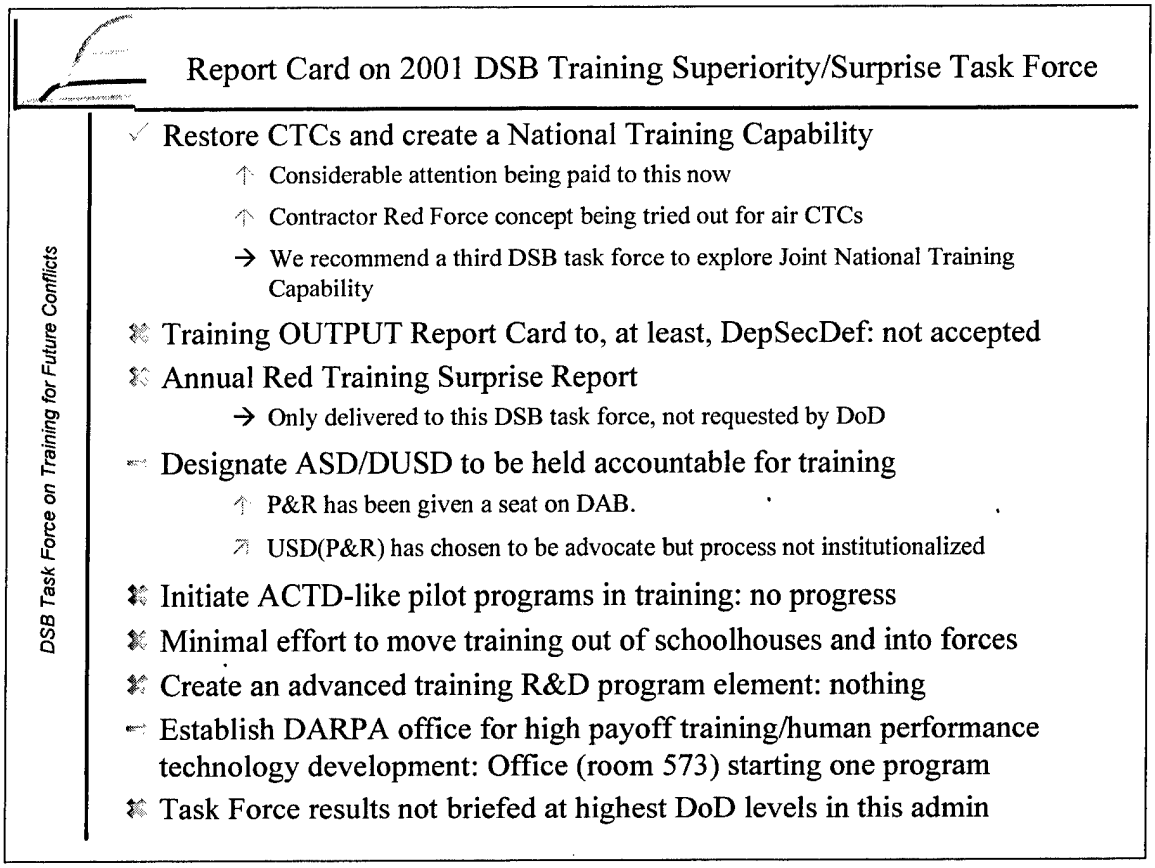
Without a second revolution in training affairs, the revolution in military affairs will not be supportable. That new training revolution is ripe for the pluck-

ing; there is an emerging quantitative understanding of how to develop effective training approaches, and the electronic revolution now makes affordable its wide-spread application. These factors include individualized instruction, direct feedback on performance, beating the forgetting curve by delivering training at the time and point of need, and collaborative & self-paced learning.

However, unless we make structural changes to the DoD, the new training revolution won't occur until long after it is needed. If we fail to make those changes, training will remain an afterthought, something slapped together ad hoc to address failures like those that occurred in the I-HAWK or ARCI programs. Such a failure will be paid for by the Service members we send into harm's way and will waste much of the hard-won resources spent on acquisition of new (and old) weapon systems.

The structural changes we recommend hinge upon making training issues routinely visible to those who write checks in the Pentagon. There is no COTS source for advanced military training nor is there a large industrial lobby to remind decision makers about the importance of training. This lack of external reminders makes structural change all the more important both to preserve our training superiority and to prevent training surprise from our adversaries.

The key recommendation for fixing the present is to devote more resources to the crown jewels of the U.S.'s first training revolution: the CTCs, to permit JV2020 kinds of training against new threats. The keys to fixing the future are high-level training report cards. It doesn't matter in what format the Services or the intelligence community tells the SecDef about the state of training, what matters is that the reports are delivered. The attention arising from these reports should aid implementation of our other recommendations and sustain recognition of the extraordinary value of training to winning wars.



We advocate regular reports on training to bring the subject to the attention of those who control money in the DoD. In keeping with policy, here is our own report card on implementation of our last task force's recommendations. Green checks and arrows represent encouraging results. A red X represents a recommendation that has been rejected or ignored.

SINCE OUR FIRST task force began, much progress has been made to increase awareness at high levels in the Pentagon of the value of training. Whether or not we influenced it, we note that an initiative to create a Joint National Training Capability is underway. There has also been progress in using commercial sources to provide CTC's opposing air forces.

Our recommendation that DepSecDef require a yearly training report card was not accepted; the Under Secretary of Defense for Personal and Readiness [USD(P&R)], who has taken substantial responsibility for training upon himself, stated that too many reports burden the system already.

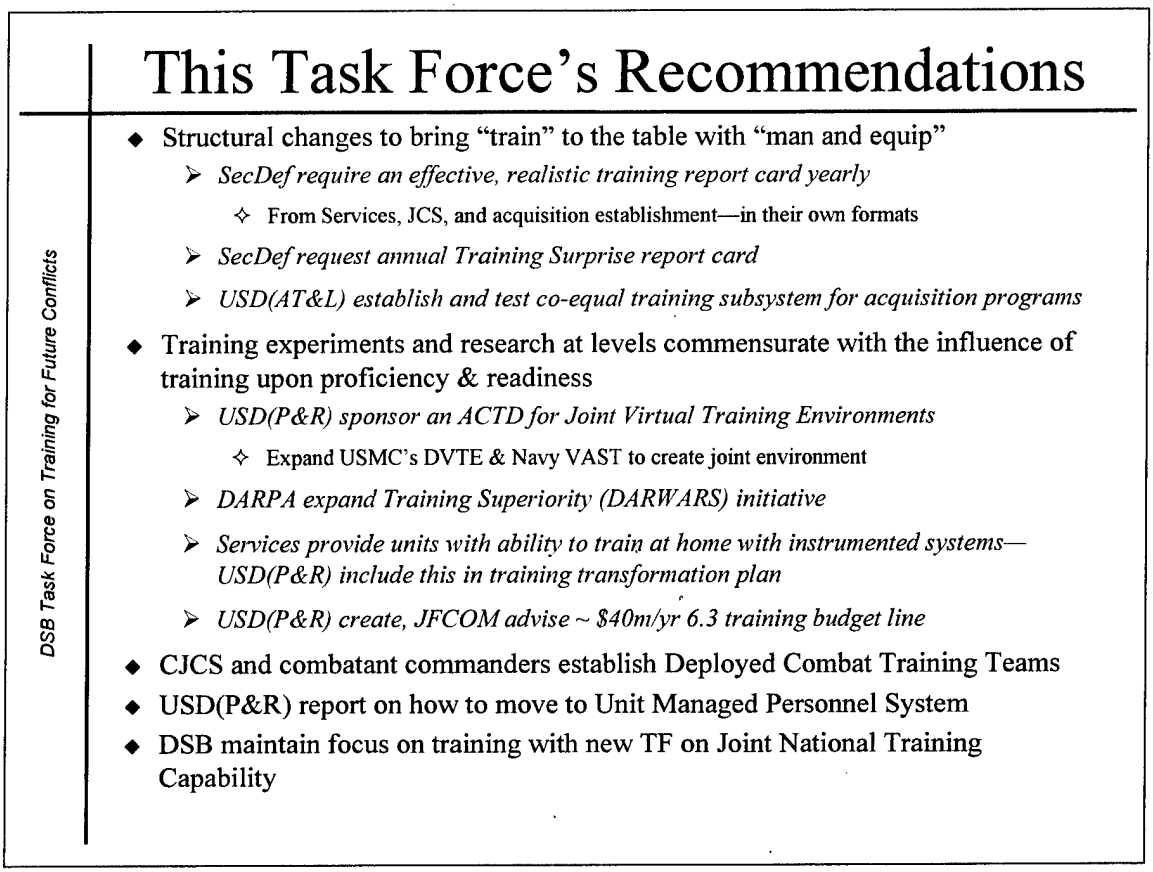
In the area of training surprise, our task force received a report from the intelligence community, but this report was only delivered to us and went no further into the DoD.

In our recommendations we failed to identify any action official to initiate ACTD-like projects in training or to establish an advanced training R&D program element. These recommendations received the customary fate of passive voice advice so crafted: they were ignored. In this report's recommendations (next page) we remedy that omission.

Although DARPA did not, as we recommended, establish an entire office for training and human effectiveness research, we are pleased to report that

one training research program has been created within DARPA. To make this happen, however, one of the co-chairs of this task force (Chatham) left his position in private industry to build and manage the program in DARPA.

Finally, we note that the previous task force co-chairmen (who also co-chaired this task force and are principle authors of this report) have not briefed their message to the highest levels of the Defense Department. This is, in part, due to the interruption caused by the atrocities of 11 September 2001. Our message did, however, reach the Under Secretary of Defence, Personnel and Readiness, USD(P&R), and his staff. They have taken positive action on many of our recommendations. We would like to see steps taken to institutionalize this interest and attention so it does not disappear when the current USD leaves office.



The structural recommendations have not changed since our last report. The training research ones have become more specific. We have added to our list an approach to identify future war's training needs, and a look at how to hold the personnel system accountable to warfare proficiency. We also recommend that the DSB not stop here but address how to create a true national training capability.

"TRAINING" FIRST APPEARS in an OSD job title four levels down in the hierarchy. In large part this is because training funding is diffuse; there is no equivalent in training to a major system acquisition program office. Given its effect on warfare proficiency, however, training deserves more visibility.

The first and last recommendations on this chart deal with methods to create this visibility. Reports that are critically reviewed force out issues and deficiencies that will otherwise be ignored. Reports from the Services, Joint Forces and acquisition establishment will not only highlight issues within the current training structure, they will force analyses of trades across stovepipes and identify when training is paying bills that would be better paid by the acquisition or personnel communities.

The recommended Training Surprise Report should achieve a similar effect by encouraging the intelligence community to search for indicators of innovative training practices among potential adversaries that could lead to rapid proficiency changes. Finally, in the area of increasing training visibility in the Pentagon, we recommend that the DSB continue to highlight these issues by initiating a third training task force.

Aside from visibility, there is the matter of funding for training research, which has been dropping for a decade even as new training approaches have become more necessary. Virtual training environments based upon common com-

puters have now shown that they can provide ways for our forces to practice cognitive and mission skills outside of large CTCs (for example, on shipboard and at remote sites). Follow-ons to successful initial effectiveness demonstrations, however, are not funded. They should be; the technology level is just right for their expansion into a multi-Service Advanced Concept Technology Demonstration (ACTD).

DARPA has initiated a Training Superiority project, nicknamed DARWARS, to create new kinds of training systems and then to link them and other training systems together to provide a set of universal, on-demand, persistent training wars for anyone, any echelon, at any time. Success will be determined by whether the Services and joint training programs join the process. This requires that a sufficient number of training systems be created and displayed to the Services to draw them into the process. The current program may be too small to achieve this. It should be expanded.

While DARWARS aims to collapse CTC training into a seabag, the next recommendation deals with creating sufficient instrumentation capability to allow units to train in the field at their home stations. This can be done today in part by paying attention to the issue during the design of emerging communications systems. We ask USD(P&R) to include this goal in his training transformation plans. P&R should also create a funding line to support low-hanging fruit that, with an additional infusion of cash, could deliver training value quickly.

We should prepare for future come-as-you-are wars by identifying in advance what kinds of training we and our new pick-up allies may need. The joint warfare organizations should establish a few permanent deployed teams—designated here as Deployed Combat Training Teams—dedicated to this task.

Finally, we recommend investigating how we might reform the personnel system so that it becomes more responsive to the impact it has on training and on warfare proficiency.

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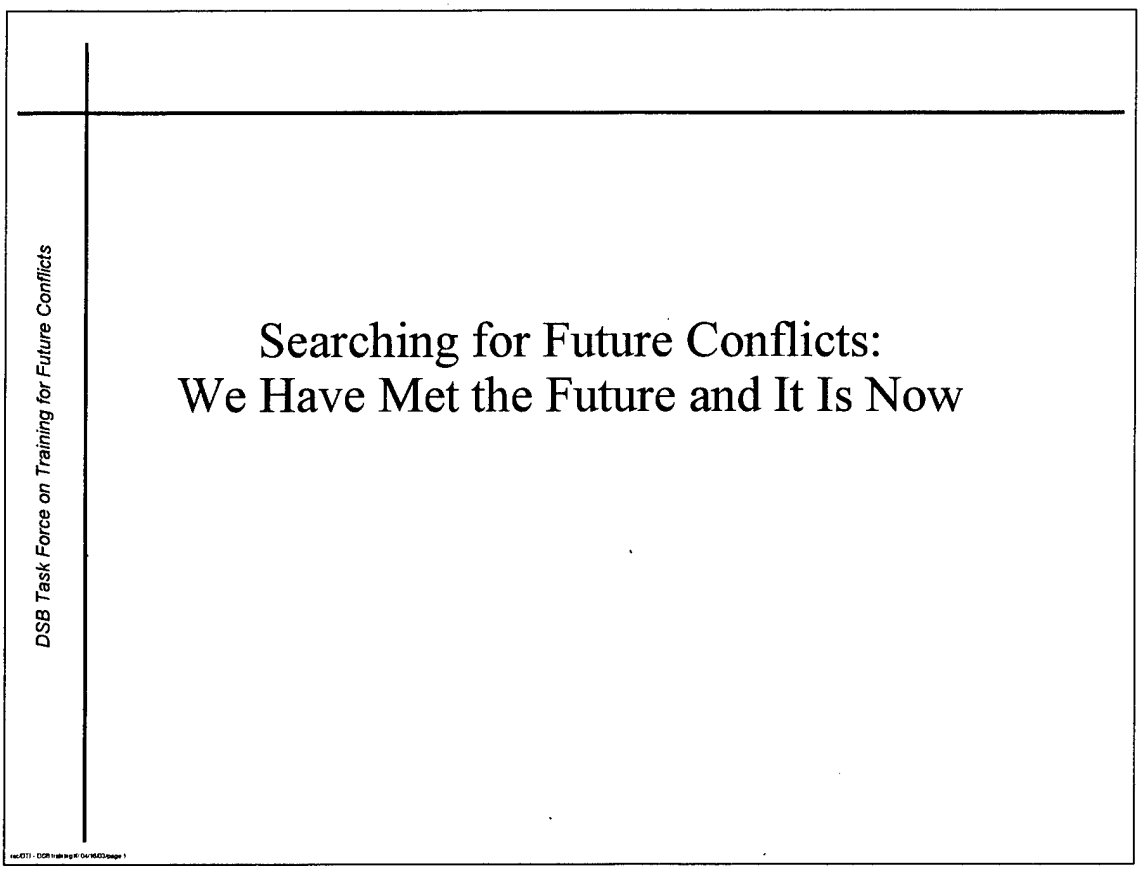
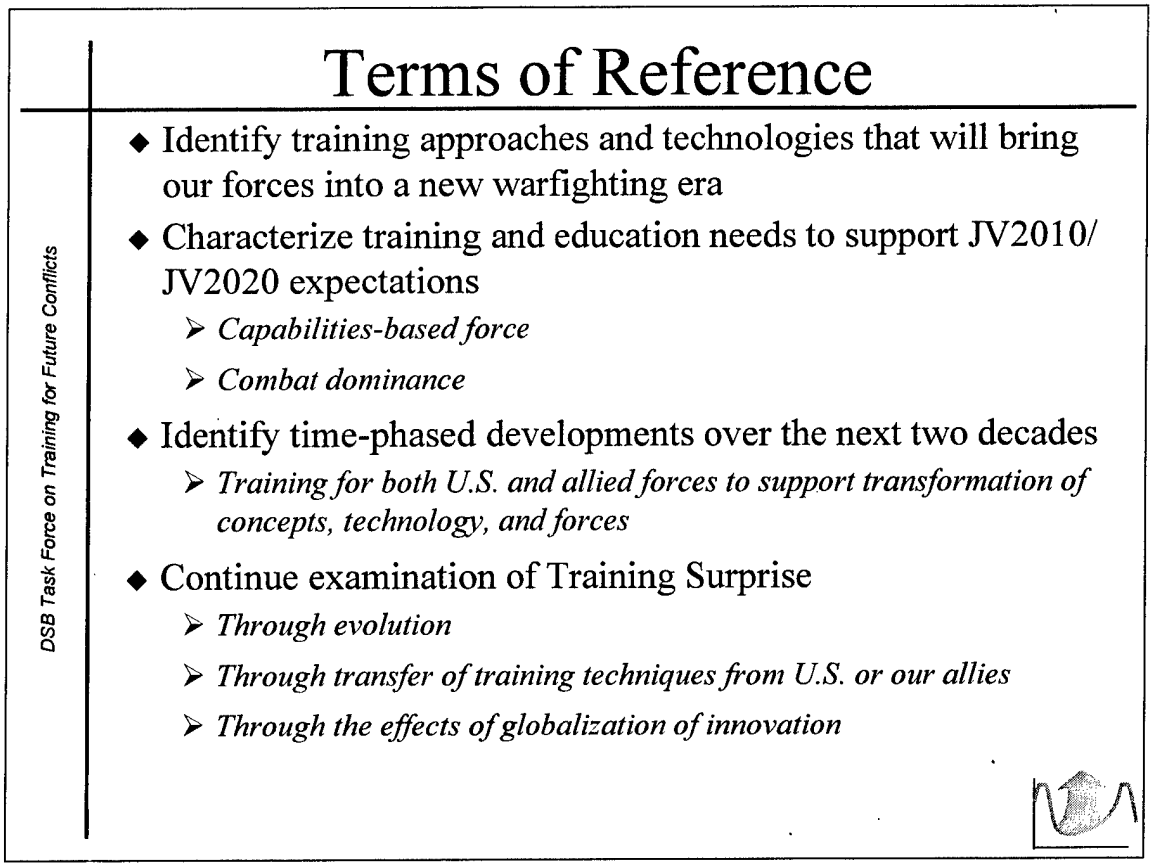


With a nod to Walt Kelly's phrasing, we note that, as this task force searched to define the character of future conflicts, a future conflict found all of us on 11 September 2001. The goals of our task force changed as a result, as did the goals of much of the rest of the nation.



Here are the major components of our charter, which asked us to describe the training changes necessary to support a transformed military. We put the icon in the corner to represent that this chart deals with changes required to support DoD's warfare transformation. In future charts we will use other icons: stacked learning curves to indicate unfinished business left over from our last task force, or the readiness bathtub curve without the green arrow to indicate we are discussing problems, but not yet offering solutions.

THE TERMS OF REFERENCE that initiated this task force are quoted in full in an appendix. Here we summarize.

The central theme of our charter is to explore what kinds of transformation in training may be required to support the broader transformation of our military. A combination of both these transformations is needed to achieve a future U.S. force characterized by Joint Vision 2010/2020 in which new warfare capabilities will emerge. These capabilities will be based on jointness, collaboration, and the leveraging of information within and across echelons.

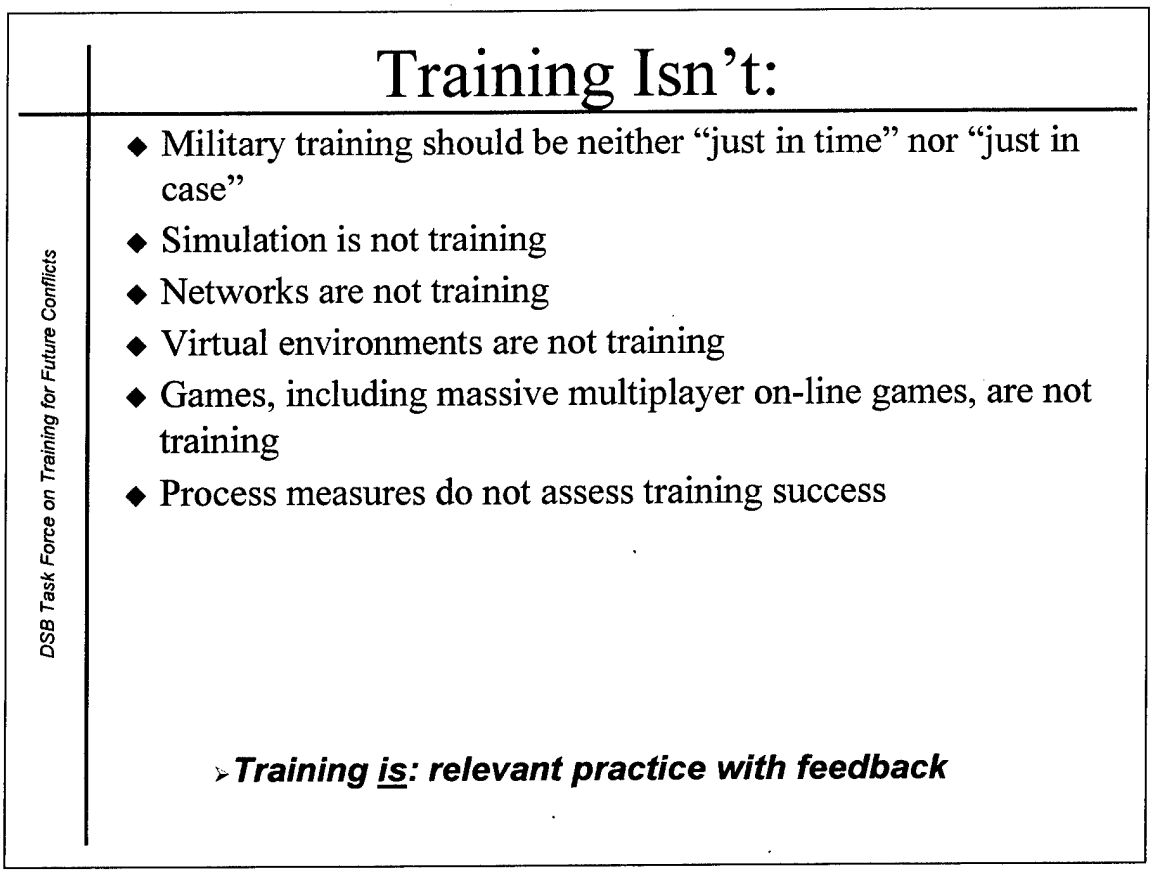
The U.S. transformed training starting in the 1970s and 1980s. The major innovation involved using combat training centers (CTCs) having competent opposing forces (OPFORs), and real-time instrumentation to determine force locations and state, and event pairing. When integrated with after action reviews (AARs) conducted by mentors and the trained forces themselves, these factors underwrote a revolution in learning and training methodology. This large-scale training capability was bolstered by smaller forces using live virtual and constructive simulation (sometimes combined and distributed) and metrics developed from tasks, conditions, and standards.

For almost 20 years no other forces of any nations employed these innovative methods. This first training transformation improved combat capabilities by factors of 5 to 35, rivaling and often exceeding improvements that could be made with new (and costly) generations of hardware. Our first study explored how this was done and the cracks we saw in the process. We predicted that a second training revolution was possible.

The terms of reference for this task force asked us to characterize the elements of a second training revolution that could lead to fully transformed Joint Vision 2010/2020 capabilities-based forces. In addition, it asked for programmatic suggestions, recognizing that the underpinning for training and education transformation cannot be satisfied by simply improving what exists. New methodologies, elements and technologies will be needed.

We were also asked to continue our inquiry into training surprise. As indicated, we were charged to examine revolutionary improvements: those that are the results of direct export of U.S. technologies and capabilities; those that flow from the globalization of goods, services and technologies; and finally, those that are truly independent surprises.

As often happens, when reviewing our work we found that we did not accomplish our entire tasking. A major gap exists in the area of foreign training, both our training of new and unexpected allies and how they might train us. We do, however, make recommendations on how the needed review might be achieved and institutionalized without further DSB action.



This chart lists several common training fallacies. Many myths about training are sustained by common-sense, but not by research. For example, the notion that people learn better when the training process matches their "learning style" is quite appealing but not borne out by quantitative research.

WE START WITH A FEW definitions and observations.

We concern ourselves with training, not education. The object of military training is not to create better-rounded citizens, it is to deliver warfare competence available where and when it is needed. We don't advocate delivering training "just in time." Warfare is a chaotic endeavor and plans to deliver anything just in time are certain to be disrupted in the fog of conflict. Nor do we advocate "just in case training," packing individuals with every bit of knowledge we can force into them. Our new technology has given us far too many facts and options for the brain to work with. We must find a middle ground that delivers competence close enough to use so that it is fresh when required, but does not deliver so much that the user is overwhelmed with so many facts that s/he can't choose what course of action to employ.

We find that there are many commonly held misconceptions that we may as well dispel at the start. First, simulation may help training, but it is not by itself training. Improvements in resolution or simulation fidelity are often pleasing to the senses, but they do not necessarily signify improvements in training. At times they can even decrease the training value if expectations, raised by the beauty of the simulation, are not met—better a line drawing that moves correctly than a million-triangle visualization that doesn't.

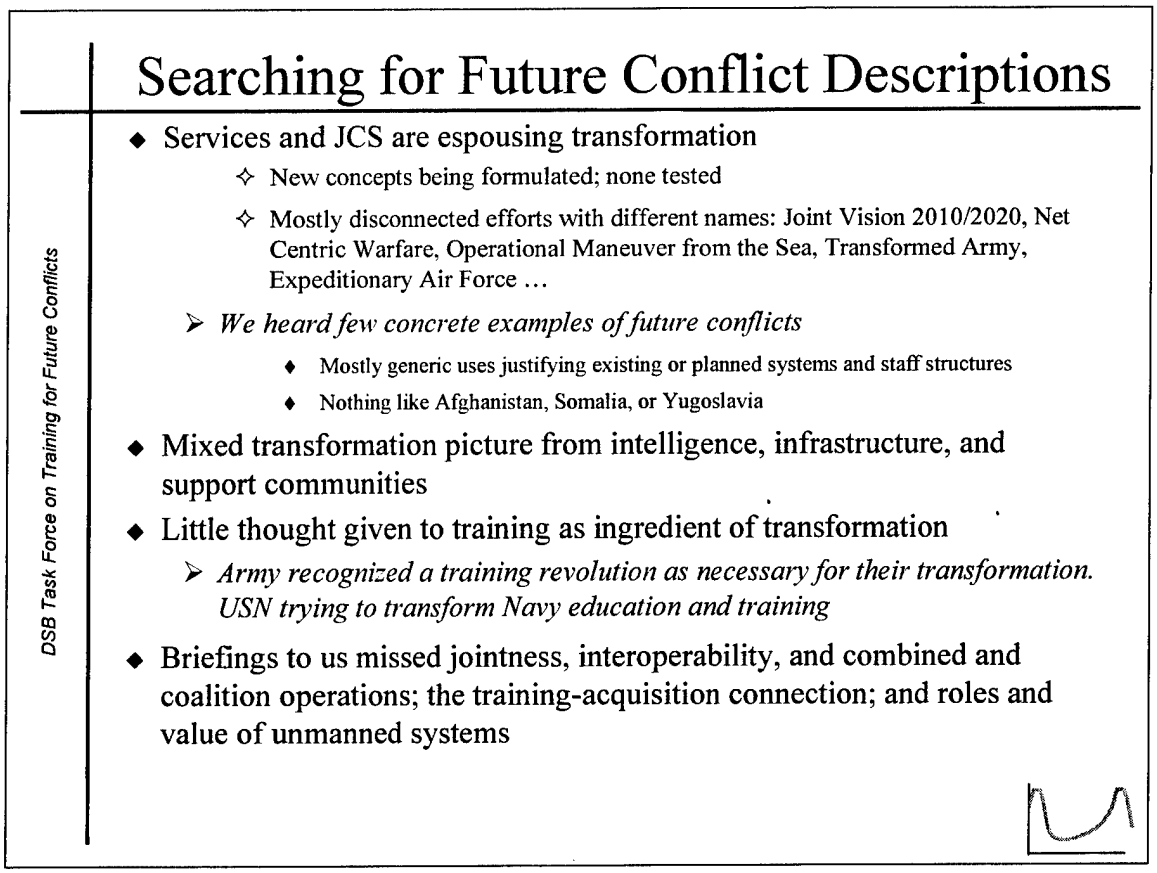
Neither are networking, virtual environments, or are games, by themselves,

training. Training comes when these tools are combined with scenarios that force learning, with practice of relevant tasks within the scenarios, and with feedback during and after the experience. Games can teach, but it is important to ask what they teach. It is possible to wander around for many hours in a wonderful simulation learning few new (or the wrong) lessons. To convert a game or a simulation into training, one must make sure relevant lessons, tailored to the learner's needs, arise from the situation and are practiced, identified, and reinforced.

The notion of using computer games as trainers is currently quite popular, but how, why, and what they teach is a matter of hand-waving, not science. Nor is there understanding in the commercial game world or the psychology community of what makes games compelling and keeps users engaged so that lessons can be taught.

There should be a catalog of sound, motion, color, visual effects, orienting response, levels, pacing, *etc.,* and an understanding how each of these affects learning and user focus. There should be, but there isn't. Given the current incentive structure, nothing is likely to change: game developers can't afford the research and academics can't get grants for frivolous things like game dynamics and game assessment. Since neither the industry nor the academic community is likely to pursue research into the science of what makes games work without an external source of motivation, this area of study is an ideal subject for a DoD Multidisciplinary University Research Initiative (MURI) project. We recommend that OSD initiate such a project.

Games will play a part, even a large part, in future training, given that they can provide practice with feedback that previously touted teaching revolutions could not, as well as provide strong motivation to practice. Nevertheless, without some research into how games actually work, the games-for-training fad may end up as peripheral to real training as did the education revolution once claimed for training films and for television.



In the spring of 2001, we asked a number of organizations for their view of future conflicts. They told us instead about their own progress, leaving out a view of the future that should have, perhaps, motivated the proposed changes. We may not have posed our question well, but an old hand at DSB studies once said, "believe them the first time." Above is what we heard first.

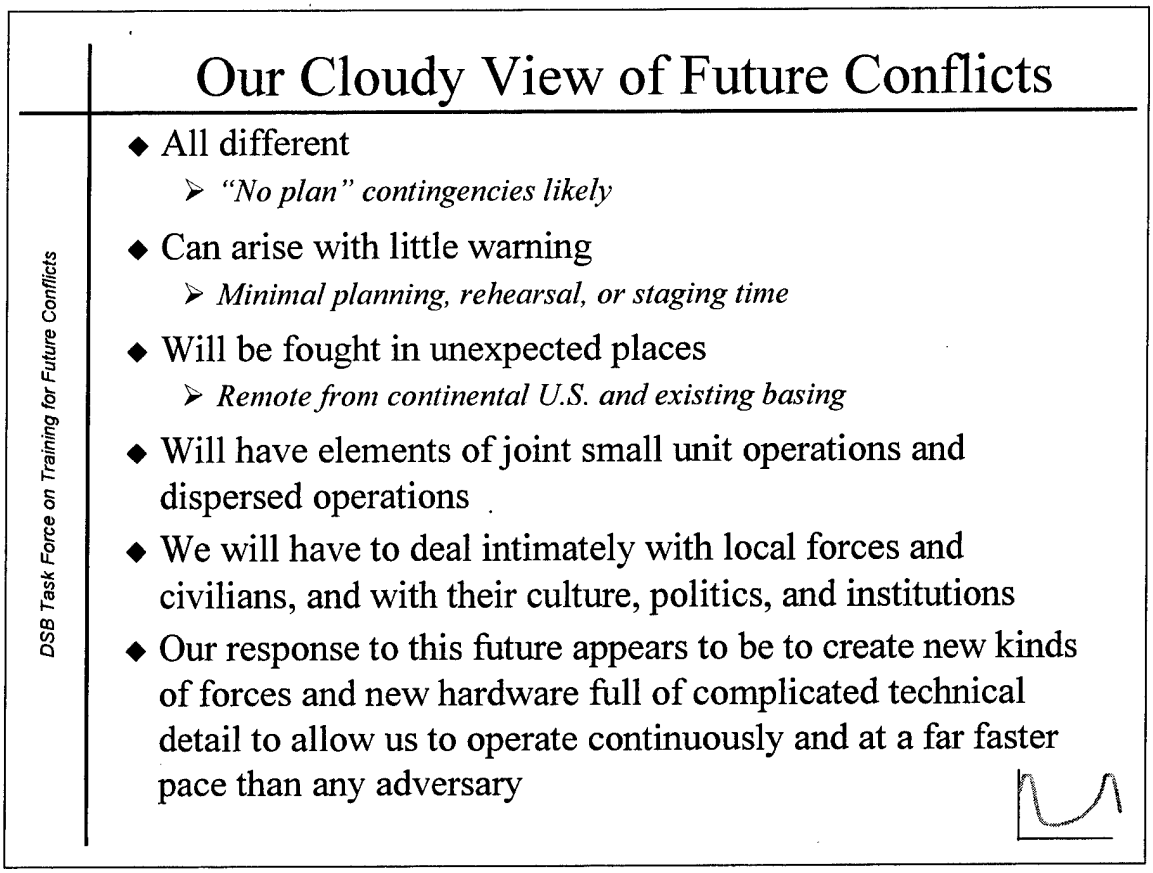
TO DETERMINE FUTURE training needs, we needed a view of the nature of future conflicts. In the hope of avoiding arguments about the validity of our choice of context, we set out to aggregate a vision of the future from those given to us by the Services and the Joint Forces. We asked each Service, the JCS, and a number of support communities to tell us what future conflicts might look like.

As we had feared, the vision was cloudy. All the briefers discussed changes underway or contemplated, but we got more information about proposed changes than we did about the character of future warfare needs that a transformed force might experience.

Moreover, we found mention of other Services was conspicuous by its absence. There were also no references to the use of unmanned systems. Subsequent to these briefings, the Afghan campaign showed the need for and value of both. We also asked for informal speculations on what changes might be needed in training to help achieve the transformation they envisioned. The Army listed a dozen or so accomplishments needed to achieve their goals. When asked which were most important, the briefer considered and then stated that if flawless communication and transformed training could be achieved, they would bring about the other 10. He was unsure how to achieve transformed training, however, and looked to us for ideas. We hope that what we offer here will be of some use.

Also commendable are the Navy's far-reaching efforts to transform education and training for everyone in that Service. We were pleased to note that our first task force's work had some influence on their effort, or at least was used to motivate the process. We hope that this initiative will grow to include the need to aid transformation for future wars was as well as correct current ills.

None of those we asked noted the large impact that the personnel or acquisition communities had on training. Training appears to remain in a separate compartment of our military thinking. The substantial savings that can be achieved by trading it off against the man and equip sides of our military establishment remain neglected even as we attempt to transform.



It was not clear to us that the changes being undertaken are a response to the brave new world of conflicts or are being made instead for the sake of transformation. Nevertheless, here are a few characteristics we expect from future conflicts. We will expand upon them in subsequent charts.

THERE IS NO DEARTH of future visions despite our inability to get them directly from Service and warfare-support briefers. The intelligence community, for example, gave us a comprehensive vision of contentious problems that are likely to arise over the next several decades. These ranged from changing demographics to a newly emerging real global shortage of fresh water. (Shortages of water have been until now mostly ones of distribution, not a worldwide lack. Food and energy shortages will continue to be distribution issues not a global lack.)

Without useable Service and Joint inputs, we resorted to creating our own list of characteristics of future conflicts. Chief among them is that they will arise unexpectedly, and unlike our Cold War experience, there is a fair chance that existing war plans will not cover them. A second major theme appears to be that, at least in conflicts like our 2001/2002 Afghan campaign, the actions of a very small number of our warriors can have a large effect upon the success or failure of the war.

The expected warfare environment may become even more complicated than in the past. The Army Science Board's 2000 Summer Study found, for example, that "In the dynamic battlefield environment of the future, C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance) functions will be critical to the Future Combat System

(FCS) success. The blinding speed and sheer volume of information will overwhelm and inundate the FCS operators and decision-makers."

Whether this is a necessary consequence of the future conflict environment or whether it results from our choice of how to meet it, we are moving headlong into a future that is full of technical and procedural detail and, although we swear on stacks of future system proposals that the cognitive demands made by our new hardware and procedures will be less onerous than those of the past, we know in our hearts that they won't be.

The special forces teams that supported indigenous Afghan forces were superbly trained for that work, partly by accident and partly by intent. We can not afford the time, resources, and facilities to train all our fighters in that way. Something else will be needed.

DSB Task Force on Training for Future Conflicts

Unintended Human Consequences:

- Cognitive demands will grow despite requirements to the contrary
  - *Technology will confuse as often as it will support the warrior*
- Transformed services will force everybody—even the most junior—**to think**
  - *Receive, triage, assess, decide, and act on masses of incoming data*
  - *Transformation will replace human functions with machines*
  - *Transformation will replace the sight of your buddy with icons on a screen*
- Current training does not prepare our individuals or units for the new dynamic cognitive demands
- Current individual replacement system will not deliver needed higher levels of cohesion that transformation will demand

The power per person in future wars will increase at the same time that each warrior becomes separated from the direct human contact that has motivated people in close combat since well before Alexander the Great. Add in technology confusion and you have a training problem that may be qualitatively different from any that we have seen before.

THE INCREASED COGNITIVE demands discussed in the previous chart result in a number of unintended human consequences. Chief among them is that our warriors and support personnel will have to thrive in a world that places more cognitive demands upon them than ever before.

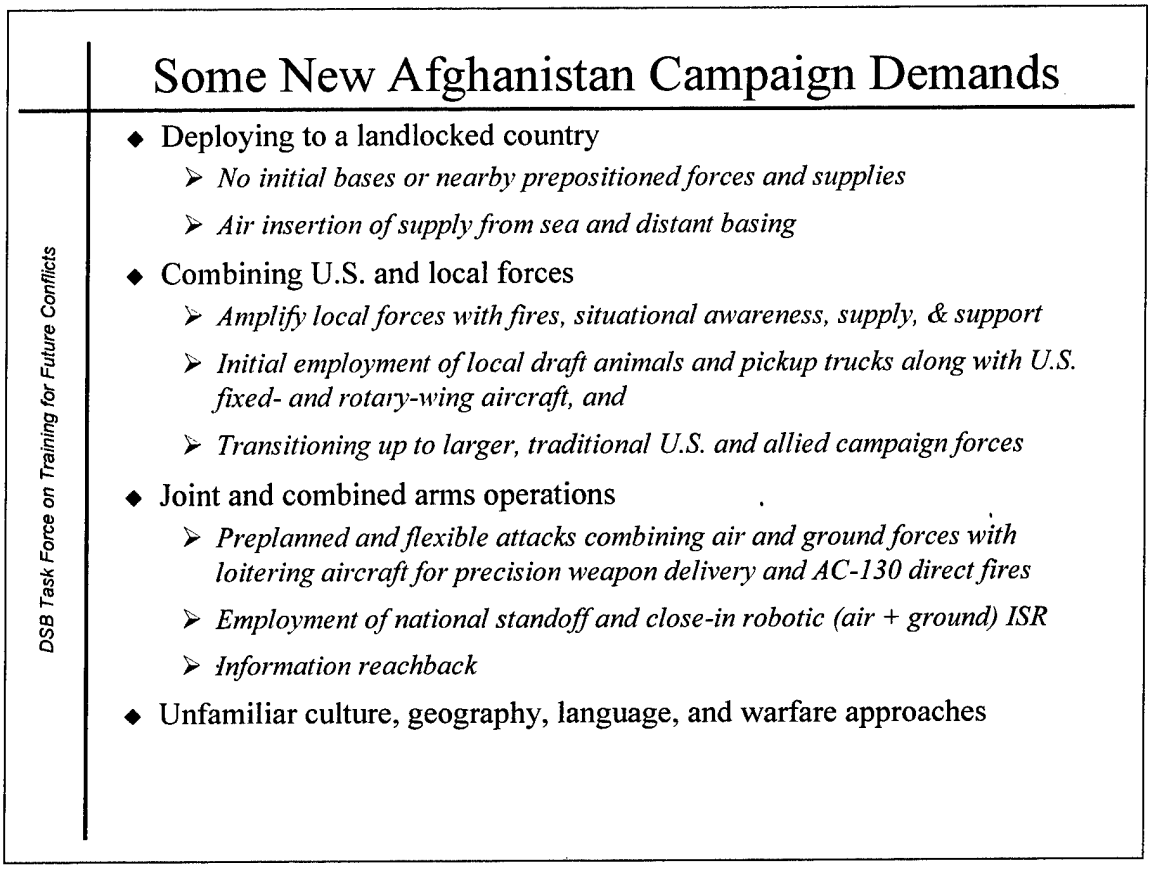
The future warriors may find themselves on a battlefield with no sense of the presence of their comrades except as icons on a computer screen. As they try to fight and to keep track of masses of digital information at the same time, their only help may come from the military equivalent of the paper-clip icon that pops up occasionally in current office software.

The electronic domain has created a class of problems that not only are complicated, detailed, and have no intuitive connection with our non-digital senses, but the domain itself changes so rapidly that we need to learn whole new generations of software commands on an almost yearly basis. If a new kind of training isn't created to help, the warriors will be overwhelmed.

This amounts to addressing the supply side of training: how to get it to the users so that they are competent to perform their tasks as needed. The other way to extricate ourselves from the hole technology transformation is digging for us is to address the demand side of training and create systems that obviate the need to train. In our last report we rec-

ommended structural changes in the acquisition system such that the value of demand-side changes would be obvious and there would be motivation to address them.

We so recommend again. We also add in this report new recommendations for structural changes in the third part of the Title 10 charge to the military services (man, equip, and train military forces for the Combatant Commanders): the personnel system.



Here are some of the characteristics of the Afghan war and new technology that enabled it. Our forces, for example, could call in precision air support from aircraft out of sight miles above them. The same technology, however, also allowed one soldier to call down an air strike on himself and allies because of a failure to understand which coordinates appeared on a GPS display after changing the unit's batteries.

IN THE LAST FEW CHARTS, we made a general case about the character of future conflicts and described some of the human implications arising therefrom. Having set the context, in the next few pages we will expand upon the changing nature of warfare.

Operation Enduring Freedom (OEF) placed new demands on our forces and those of our allies who participated. It also provided the circumstances to apply, in a modest but meaningful manner, the tenets of JV2010/2020 at both operational and tactical levels. Innovation was an important aspect of campaign planning, preparation, and execution. Transformation was demonstrated by network-enabled collaborative activities to bring precision fires to bear, enable precision logistics executed from the air, and permit rapid deployment and sustainment from the sea and from distant land bases. This is to be contrasted with the traditional in-theater APODs, SPODs, and RSOI process. (See the appendix for a list of acronyms.)

Ground forces included those from Special Operations Command and Army and Marine components of Central Command. These forces employed both traditional and non-traditional means to both deploy and carry out operations. Insertion by air directly from ships at sea provided real-world examples of what has been posited as counters to the use of anti-access strategies and tactics.

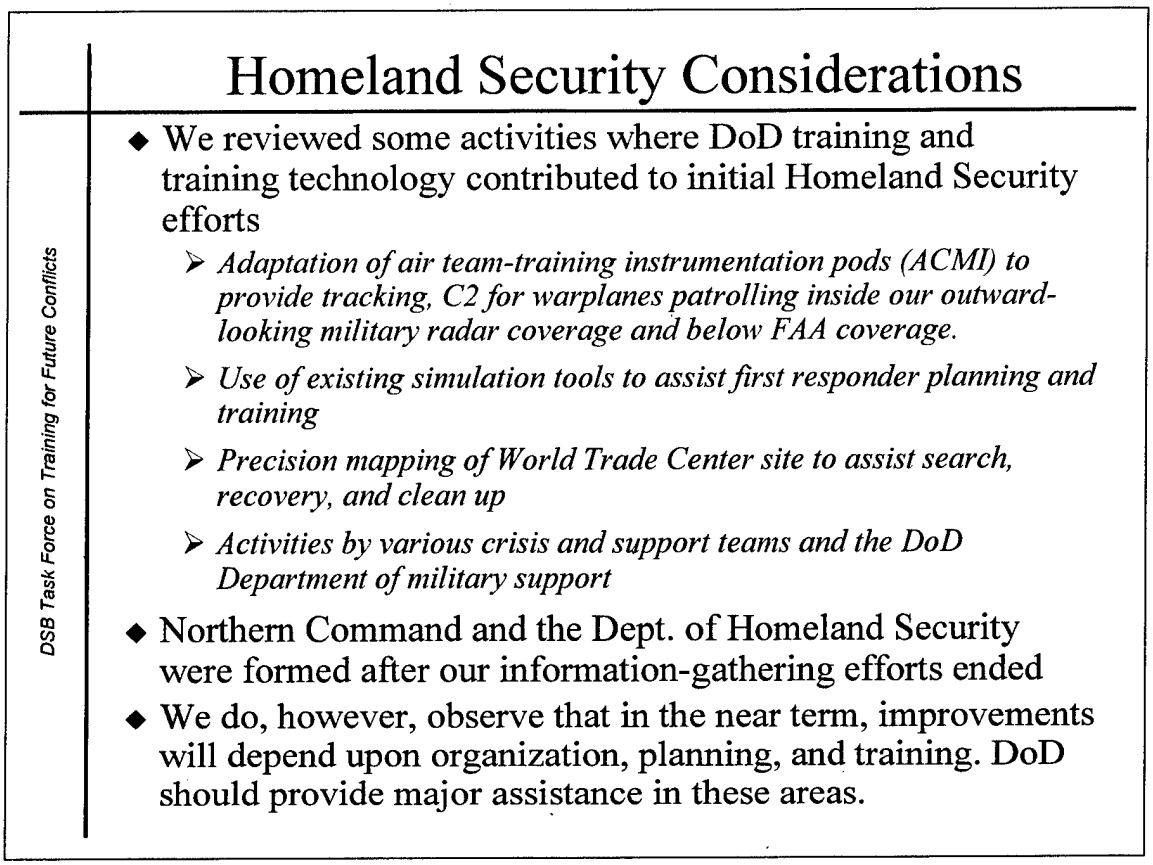
Later in the campaign, robotic capabilities were brought to bear. Hellfire-

armed Predator UAVs operated and commanded using distributed collaboration techniques and achieved the desired engagement performance within the boundaries of the rules of engagement (ROEs). Similarly, ground robots were employed to explore buildings and caves in support of manned air-land operations which also involved ground troops and organic firepower augmentation by attack helicopters and AC-130 gun ships. Fixed-wing aircraft delivered bombs with unprecedented precision.

In all of the aforementioned circumstances, there are lessons to be learned, not only for training for ongoing and near-term operations but also for the transformation of training and education. For the moment, the lessons learned provide mostly insight that has not yet been converted into direct design guidance. Operation Enduring Freedom should be regarded as the "tip of the iceberg" of the possibilities for enhanced and transformed joint operations. Much more can be done to define and explore the possibilities. We need to solidify the easily lost capabilities that resulted from clever "ad hocery." We also need to institutionalize inter-operability collaboration across force components and echelons. The requisite planning and preparation could be accomplished by overlaying available networking and communications on existing training ranges at home stations or CTCs.

There are serious implications for the GIG, WIN-T, JTRS, and related communication systems now in early development and fielding stages. These new systems must not only support operations but also the training for them.

They must, therefore, have (1) an embedded position location capability (where GPS does not function), possibly through multilateration; and (2) bandwidth to carry status and event data. At a minimum, they must also provide information for engagement pairing of real and virtual entities, whether these be manned or unmanned.



If you want rapid improvements, you should emphasize the people who perform the work. Improvements through hardware take more time and are often more expensive. On the other hand, training improvements can be more ephemeral than hardware. This applies to the homeland security area as well as the military.

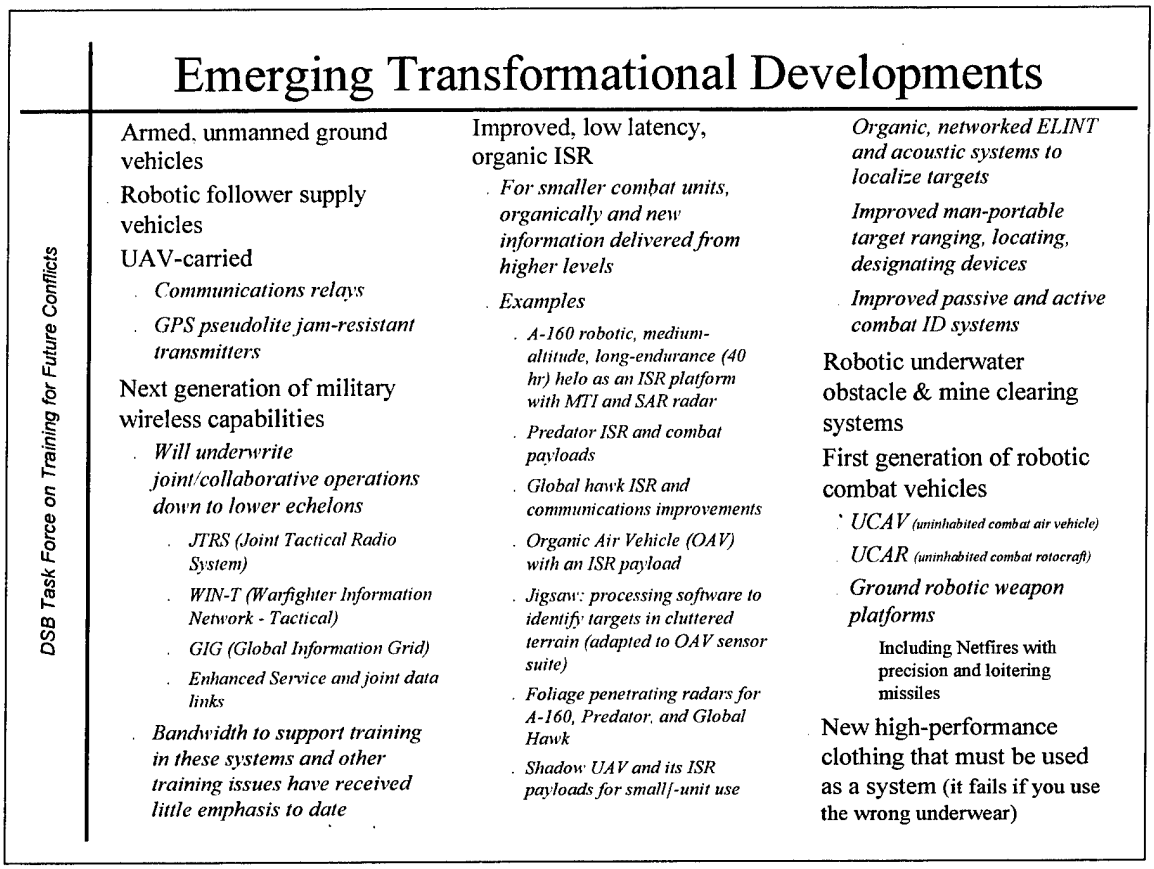
IN THE COURSE of our activities, we devoted one of our sessions to examining circumstances where existing DoD capabilities were adapted to homeland security needs. These are cited in the accompanying graphic as useful examples of both thoughtful preparation by the DoD (implemented totally by the Services) and successful "ad hocery." The greatest insight to be gained from reviewing these circumstances has to do with assessment, planning, preparation, training, and exercising. It is the same insight and conclusion reached by other studies of homeland security challenges, particularly the DSB study: Homelend Defense Against Bioterrorism.

In the near term (3 to 5 years) almost all improvements in homeland security will be derived from the process (planning, training, etc.) cited above, because, with a few exceptions, even important technological improvements will take more time to reach the field. It is as true here as it is for the military: if you want to spend a marginal dollar to improve capability or performance *now*, that dollar should go to the people side of the equation, rather than to fascinating hardware. We therefore recommend that great emphasis be placed on improvements through planning and training.

Fortunately, the DoD is *the* world class planning and training organization. Its capabilities should be brought to bear to the benefit of the first responders: firefighters, police, and emergency, health care and infrastructure control, maintenance and repair personnel.

As the Homeland Security Department is formed and starts functioning, DoD should assist not only with its formidable technology capabilities for the mid- and long-term but also with its planning and training expertise. The National Guard with responsibilities in both DoD and the States appears to be uniquely positioned to accomplish this.

Finally, we note that in a major homeland security crisis the DoD will be called upon in multiple ways. This represents another kind of future conflict situation for which DoD training will be vital.



This "eye chart" is meant to overwhelm the reader. The contents overwhelm us. This, unfortunately, represents only a small fraction of the new technology on its way to overwhelm our warriors who will be engaged in future conflicts. They will need new training to deal with all this and more.

THE COMPANION GRAPHIC lists mixed examples of transformational technologies, subsystems, systems, platforms, and networks. Most importantly it indicates technical circumstances that permit employing such systems effectively, efficiently, reliably, and controllably. The examples are mixed because they range from technology in development (for example, the A-160 long-endurance robotic helicopter, probable fielding in 2008) to robotic underwater mine clearing systems being fielded now.

This listing, which is representative, not all-inclusive, gives special emphasis both to technologies that provide much improved situation understanding and to those technologies that enable swift and precise collaborative integration of the very things sought in JV2010/2020—e.g., precision fires, precision logistics, and dominant maneuver.

Also included in this representative set are the means to organize manned-unmanned action teams (humans plus robots) as well as unmanned-unmanned action teams (robots alone). The presence of both provides greater functional persistence (e.g., for ISR) beyond that which can be accomplished with humans. It also can obviate the need for extended time periods where human manning would be onerous, sometimes risky, or both. Of course, the unmanned systems can at best perform only to the extent that their human designers have built in (and trained) the ability to deal with complexity. It is unreasonable to expect that computer-based reasoning on a par with human capabilities will be a

feature for these now-in-development items. Therefore, the training of humans to employ individual or integrated sets of unmanned devices will be crucial to overall success. The bumper sticker is this: there will be no unmanned systems. There may be no person onboard, but people will have to be trained to operate all the systems for the foreseeable future.

Again we see the need for new methodologies to meet transformational goals. The message remains that a transformation of force capability demands transformation of training.

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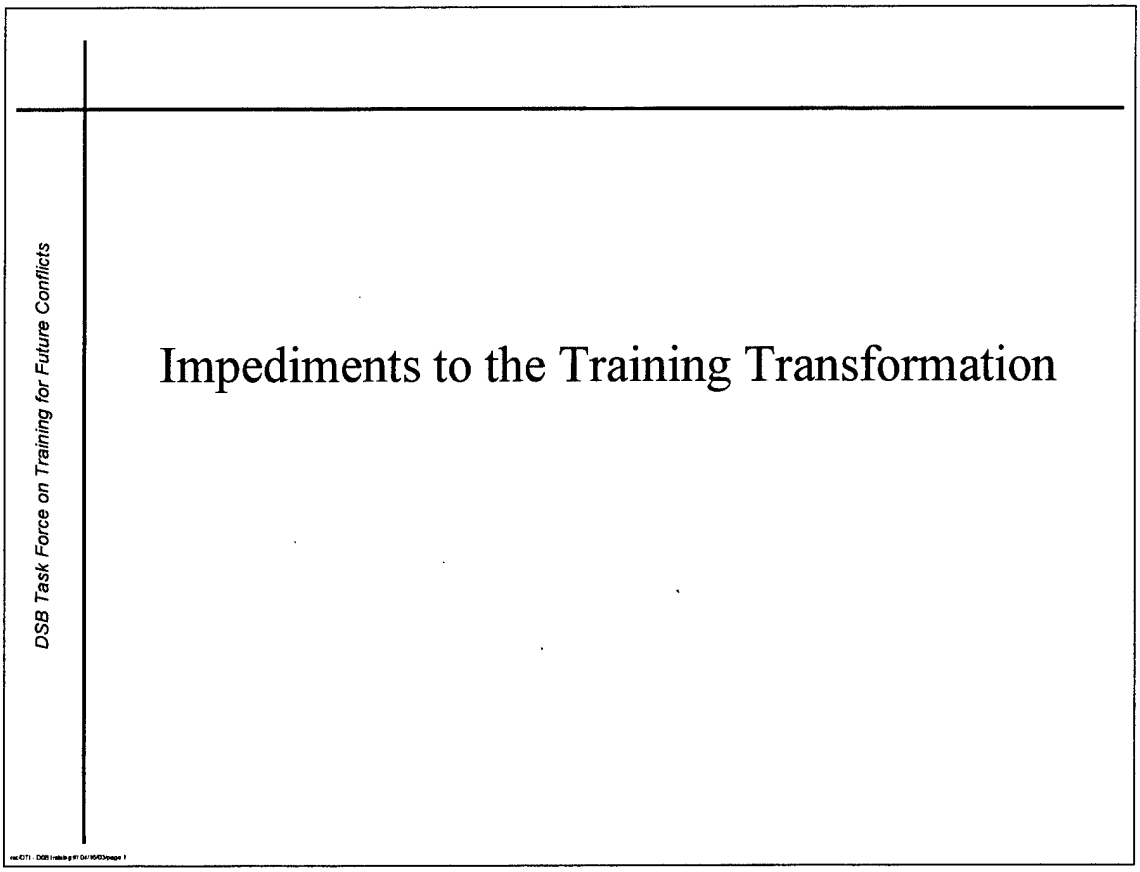
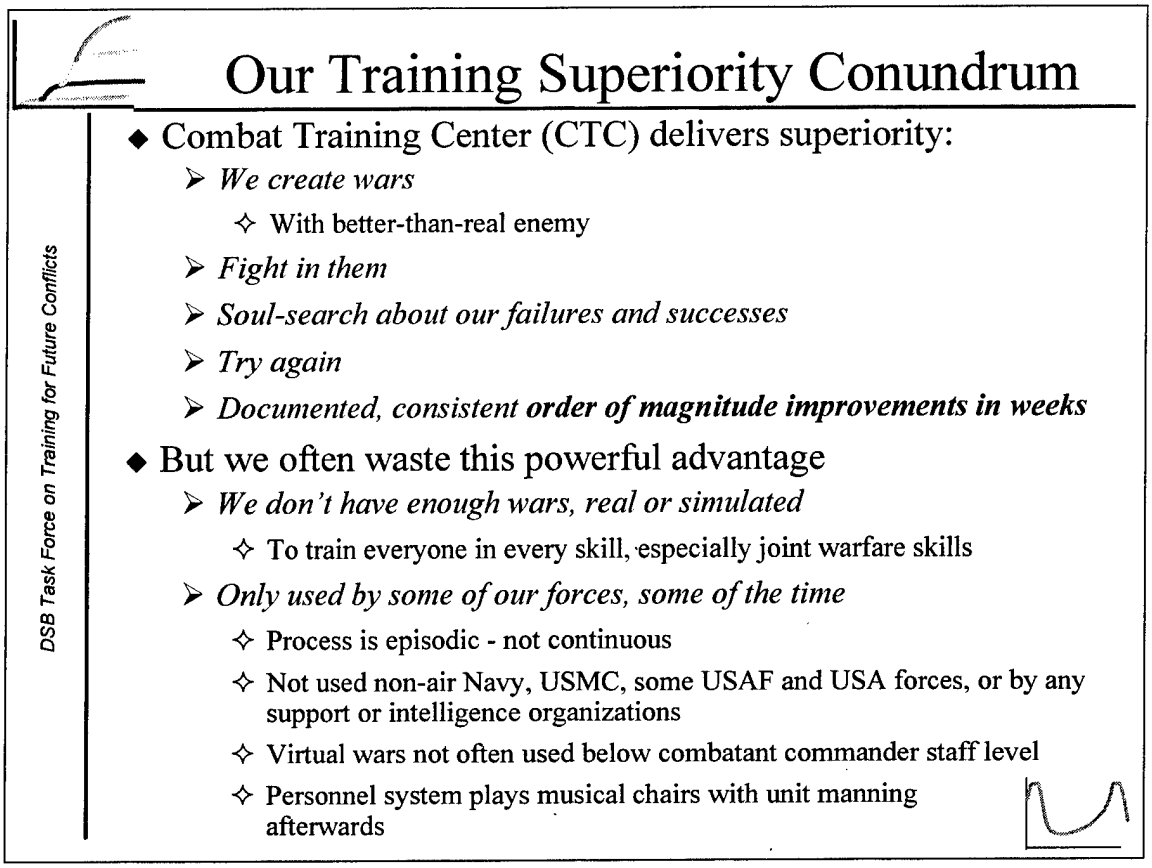


We have discussed a number of reasons why DoD training must be transformed. We will now explore the base upon which we propose to build the new transformation: our first training revolution, which instituted engagement simulation in Combat Training Centers. We will then list impediments that stand in the way of a second training revolution, one to be fully grounded in the digital age.



CTC training works extraordinarily well when it can be used. However, it is currently conducted only at a limited number of fixed sites for specific classes of warfare. Therefore, it can't be used often enough or by enough of our forces on enough of the many tasks our forces will be asked to perform in future conflicts. Worse, because training is thought of as independent of other Title 10 requirements, the personnel and acquisition systems often squander the gains made from this process.

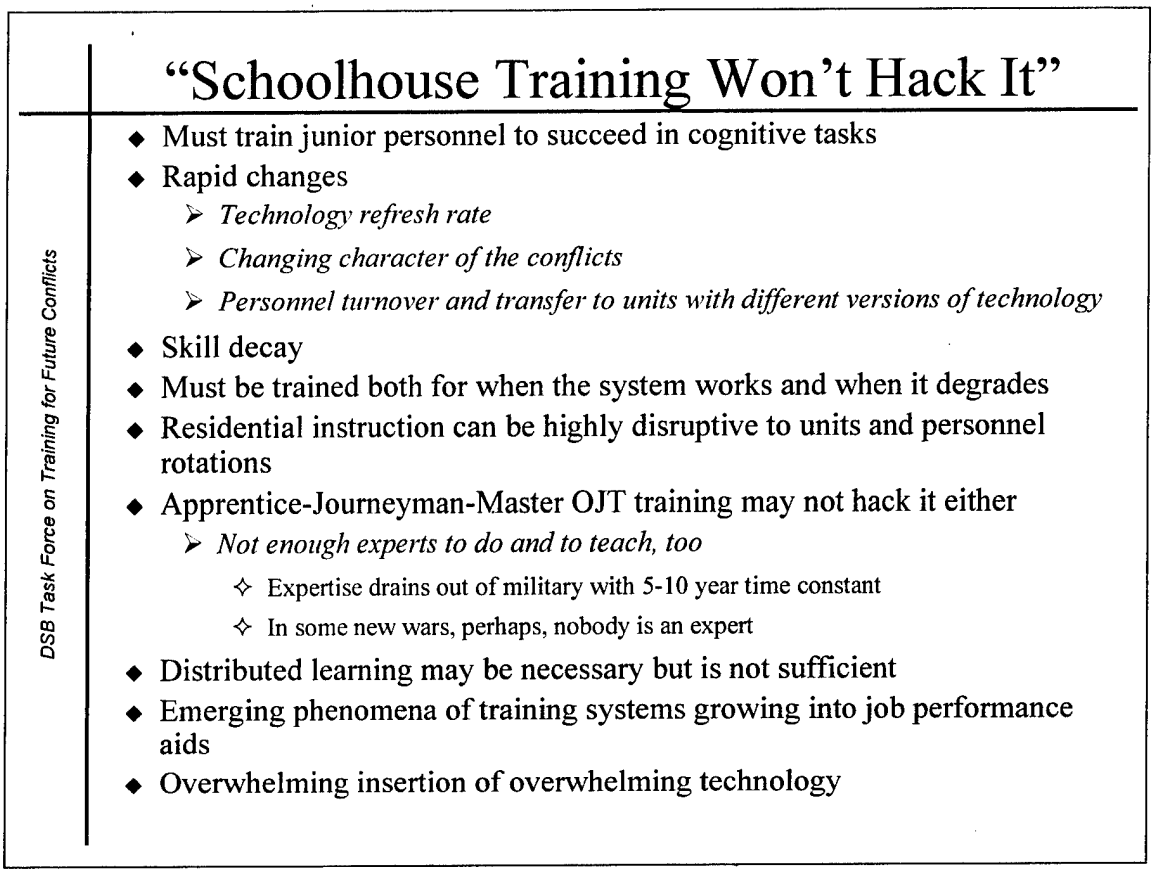
AS DISCUSSED in our previous report, the U.S. training revolution of the 1970s and 1980s involved creating artificial but realistic wars, fighting in them, objectively and self-critically measuring our performance in the war, and then trying again. The results have been spectacular: measured order-of-magnitude proficiency increases achieved in only a few weeks.

Units emerging from this training are the most proficient warfighters in the world. Our 100-hour land-warfare victory in Desert Storm is a testament to this kind of training.

Unfortunately, when a war is not imminent, only one month after a unit completes land warfare CTC training it often has become one of our least ready units. The personnel system plays musical chairs with the people therein, sending the commander and others off to new jobs. This destroys the interpersonal relationships that were so painfully developed in the process of engagement simulation. If war *is* imminent the personnel system can be held at bay. Units remain stable after a visit to a CTC and their peak proficiency decays much less rapidly.

If a conflict arises with little warning, however, many of our units will be at the bottom of the inter-deployment readiness bathtub. Moreover, the CTC paradigm is not universal. It is used only by some of our forces every few years.

Major warfare exercises are often cited as providing training, but they do not include the key elements of a CTC experience. The training experience is limited to a few units and to high level staffs, neither of which get a chance to replay and repair their mistakes.



Residential instruction has a long historical precedent. For some kinds of training it is still appropriate, but lectures are a poor way to instil complex skills. Moreover, moving people in and out of schoolhouses is costly and incredibly disruptive to unit cohesion. Personal computers, networking, and new training technology now make it possible to move knowledge to the student instead of moving the student to the classroom.

"SCHOOLHOUSE TRAINING won't hack it"* to deliver competence in the new world of future conflicts. This includes the technical changes, complexities, and bewildering variety of new and unplanned operational tasks that seem to be demanded every time our military turns around. We must train our forces not only to competence in straightforward tasks, we must train even the most junior levels of our hierarchies to analyze and to think. This can't be done by resident-based training alone.

Nor can schoolhouse training capitalize on the phenomena that we began to see as a pattern: the very best training systems are being modified to become job performance aids. The Interactive Multi-Analysis Trainer (IMAT) discussed briefly in our last report illustrates this. Not only has it revolutionized the way sonarmen can view the environment through which sound passes, but when used as an operational tool it has created a brand new competence: a junior petty officer can now create onboard ship an acoustic search plan that has the potential to actually be useful (a thing that *no one* could have done even 5

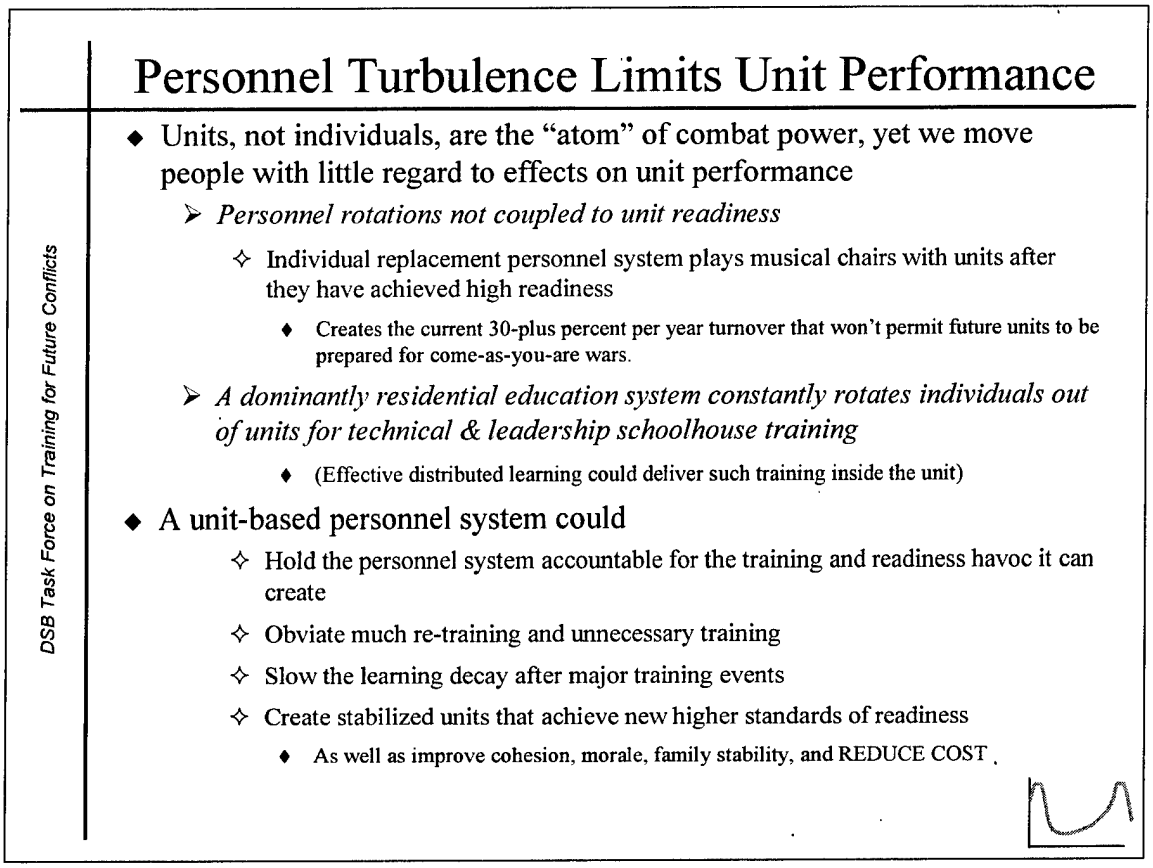
* The quote is from General Paul Gorman (USA, Retired) in reference to how an electronically-delivered course could e-mail former students when the course matter changed, in opposition to how a conventional course ends when the students leave the classroom.

years ago). Another example is the application of an aircraft training system locator now used to track operational warplanes in their new homeland defense role—inside our borders where there are no military radars.

We pay a penalty for trying to keep our military technology up to the level of commercial and consumer electronic technology; what a soldier learned a few years ago may no longer be valid today. Traditional residential instruction doesn't cope well with this issue. Nor can master-apprentice training. It is hard for an apprentice to learn if there are no masters.

Advanced Distributed Learning is a necessary ingredient for fixing this, but, at the moment, ADL supports the delivery of information to a computer near you. The "last meter," from the computer to understanding inside the head of a student, is not yet well covered by ADL. Even without the desire to remain compatible with Microsoft, rapid introduction of new technology can overwhelm our warriors. We note with concern, for example, that the Army's Objective Force Warrior program intends to deliver each new warfare capability to the troops as soon as each subsystem is ready. The training chaos this approach implies does not seem to have been considered by the hardware acquisition organizations.

We can not resist repeating the following unverified anecdote. A soldier suit, created to keep the user warm in the cold and cool in hot weather, was carefully tested and found good. When it was tried out in the field by a regular unit, it failed. The problem was that soldiers were using their own underwear, whereas the suit's design required a special kind of underwear material be used that worked as a system with the rest of the suit so the dew-point was not inside. Technology is forcing us even to teach warriors how to dress. Nothing remains intuitive.



Personnel turbulence disrupts military units, not only directly by sending individuals to residential instruction, but indirectly by rotating people in and out of units with less regard for the unit's needs than for the individual's. Balance is needed, but balance can't come until the issue is raised openly and the effects of personnel rotation upon unit proficiency are measured, reported, and assessed.

COMBAT POWER ARISES from aggregates of people and systems, not directly from individuals, yet the military personnel systems often move people around with little real regard to the effect on unit performance. This might have been unavoidable a century ago, when Army Secretary Elihu Root created the current Army personnel system, but the electronic age now permits changes.

The Army's adoption of the CTC approach to training had the following unintended consequence, touched upon in a previous chart: the importance of a rotation to the National Training Center or its equivalent is so great that the personnel system will "stabilize" the unit until the unit finishes training there. Then the lid comes off and many individual transfers occur. This contributes, in large part, to the readiness bathtub represented by the icon for this report. This may be acceptable if we have a large force and unexpected wars are not the norm. In the future these conditions are unlikely to obtain.

There are Service differences, however. The Navy has similar rapid readiness drops to which the same kind of personnel actions contribute, but the personnel turbulence contribution occurs after an overseas deployment is completed (see the next slide). This probably results in a longer period of high readiness than is the case for the current peacetime Army practice, but it still leaves a large number of naval units in a low state of readiness for substantial

periods of time. In a world of come-as-you-are wars and strained resources, we don't have the luxury of having many of our units at the bottom of the readiness bathtub.

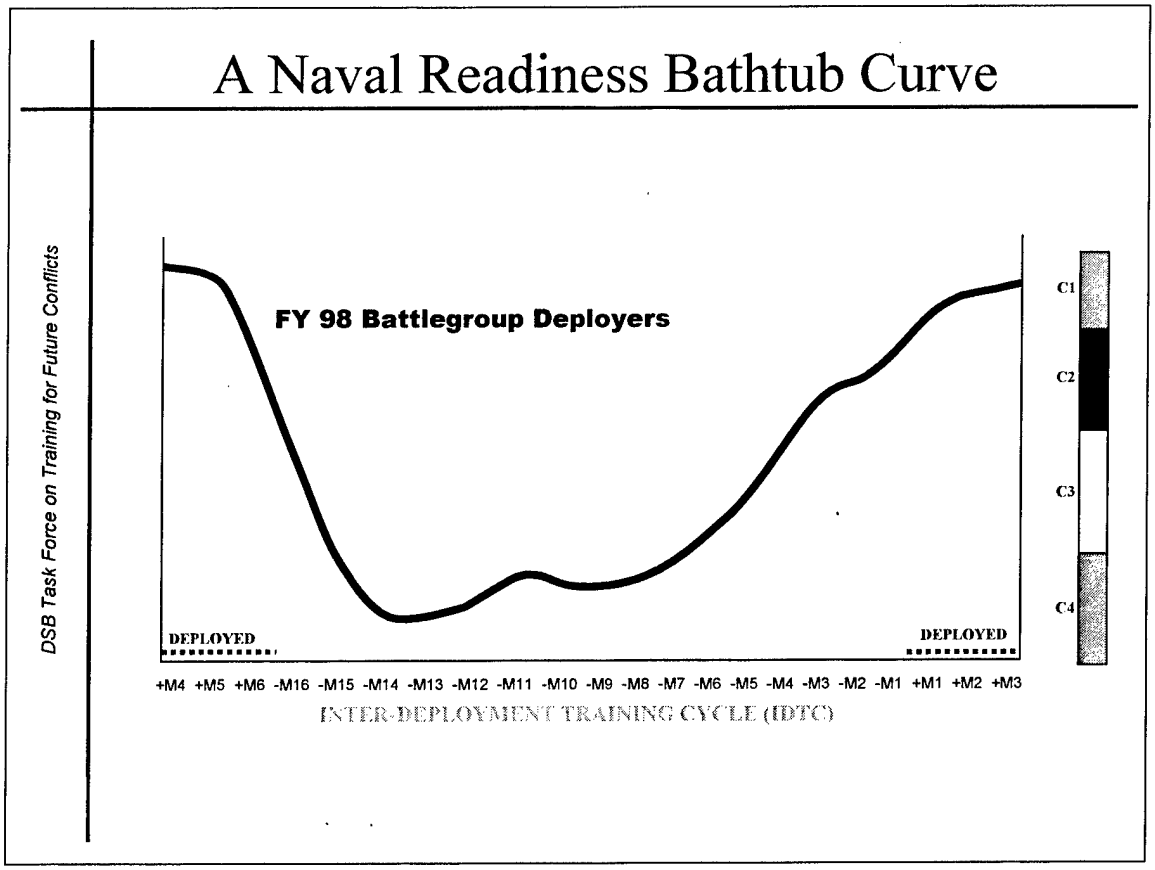
It won't be a simple task to alter the military personnel system such that it will not contribute so severely to creating long periods of low readiness for every unit. We are a nation that cares about individuals and their individual well being beyond just the pragmatic aspect of desiring our soldiers to stay and grow in an all-volunteer force. Nevertheless, new kinds of conflicts and our technical and operational responses to them have created a situation where the personnel system can not remain detached from its effect upon readiness.

The effects and tradeoffs of moving from the current individual-based personnel system to one that is more unit-based need to be explored and measured by those who must worry about both readiness and retention.

It is possible that units might be stood up for, say, 3 years at a time and all people within the unit stay with it for the duration. The Navy's recent experiment of rotating an entire surface ship's crew out to a deployed ship is another possible approach. Other options and hybrids are possible. This task force is in no position to recommend how those trades should be made, only to recommend that they actually be explored. The end result would be to hold the personnel system accountable for the training and readiness damage or benefits it can induce.

The Army Science Board considered some of these issues in their 2002 Summer Study. Details of their findings and recommendations were not available at the time of this writing.

Finally, we note that there are other causes for the loss of readiness described by the bathtub curves. Principal among them is knowledge decay as time passes after training. We will take this up later.



We discussed and displayed stylized readiness bathtub curves in the last chart and in the executive summary. We include this chart both to show an actual curve and to point out that the Navy times its readiness to match expected deployments. Unexpected deployments are a different matter. The colored bar to the right represents the four levels of readiness designated by a "C" rating. C1 is fully ready. A unit in the C4 category is unable to perform its mission. The horizontal scale measure is months relative to the deployment date.

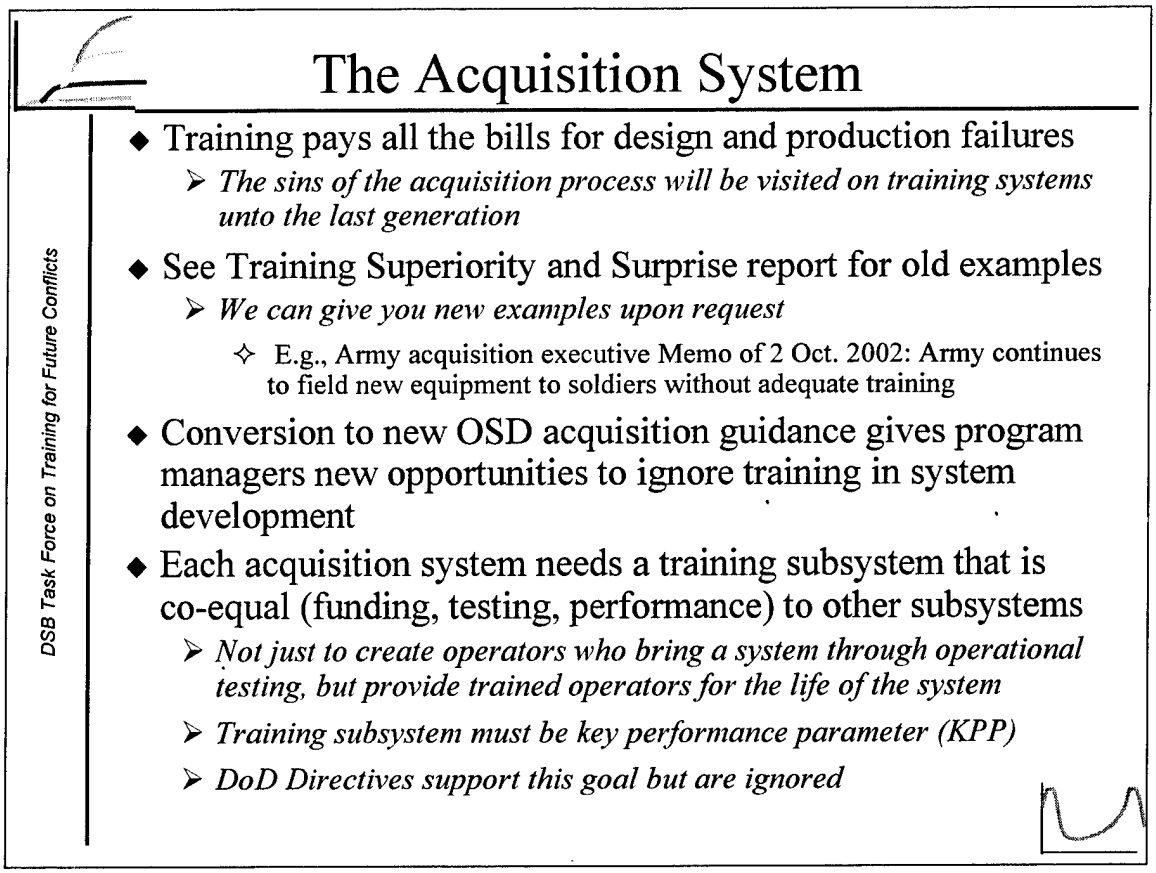
ON THE LAST PAGE we noted the Navy's recent transfer of a whole crew to a ship that was already deployed overseas. In addition to saving maintenance costs, fuel, and wear and tear on the ship by making it unnecessary to sail across a broad ocean twice, there are also personnel benefits. Properly done, the crew will be better trained upon arrival at the deployed ship than they would have been had they spent weeks and weeks of steaming time to make the ocean transit.

While this is a revolutionary experiment for the surface forces, the ballistic missile submarine force has used this kind of multiple crewing since about 1960. Approximately every 3 months the crew changes with one crew manning the submarine and the other taking time off and then training for their next deployment. This results in a 6 month cycle. Despite all this, however, each time a crew takes charge of a boat, about a quarter of the people are new to that submarine.*

* The target tour length for an individual is mandated as 3 years. Few stay beyond that length of time because the personnel system declares this would be bad for their careers. Some individuals must move on sooner for medical, humanitarian, or other reasons. Thus the average tour comes closer to being 2 years and the turnover rate per 6 month cycle is 25 percent.

The response to this situation has been massive amounts of conventional training, both schoolhouse and on-the-job. It is an expensive solution.

The point of the foregoing is this: a Service may be reluctant to alter its personnel system for more reasons than tradition. Merely calling for a change won't make it do what we hope it will. Unintended consequences will result from any changes. Those consequences and the desired benefits must be explored carefully. We do not recommend instant change; we don't yet know what that change should be. Rather we recommend that USD (P&R), with advice from the Services, take time to consider the alternatives and tradeoffs, then take action and finally monitor the results closely.



This chart comes under the heading of old business. It is, however, unfinished business. These issues will only get better piecemeal, unless structural changes are instituted. Designating a training subsystem into each acquisition program to be co-equal to, say, a propulsion system is a key element. Establishing a high-level training performance report card is the other key.

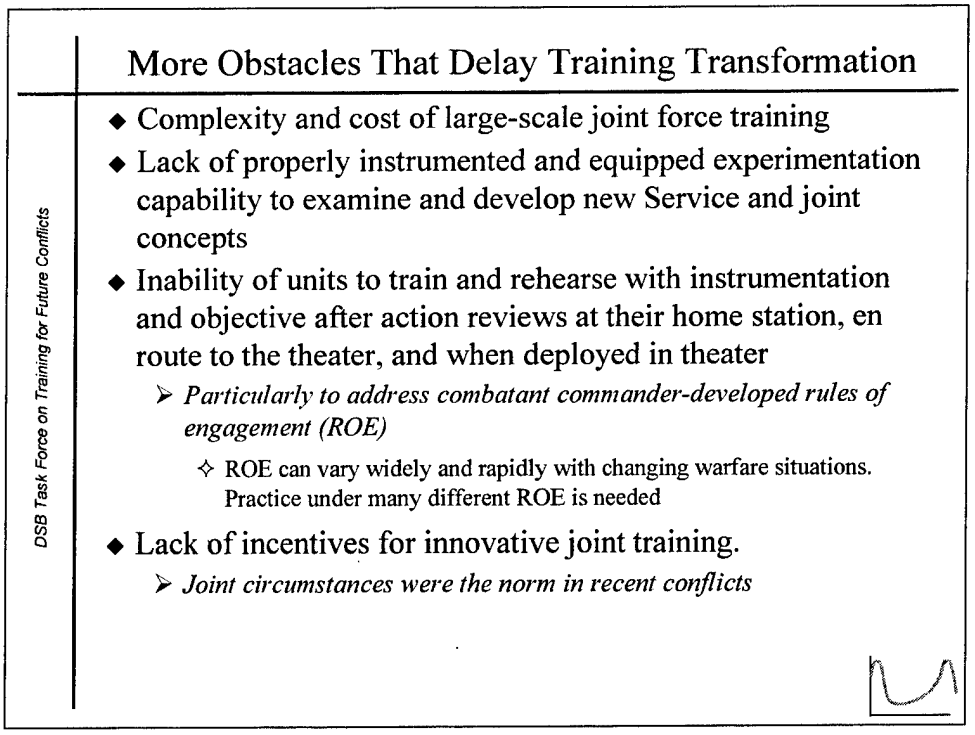
READERS FAMILIAR with our previous report—*Training Superiority and Training Surprise*—will find nothing new in this chart, and that is, of course, the issue. It still remains the case that the best place to put a marginal dollar to improve military performance is in training, and the best way to squander our hardware investments is to ignore training during the development of hardware systems.

Systems continue to be created and then fielded with little consideration for the costs that must be incurred during the life cycle to train the weapon's users. More subtle, but equally wasteful, is a failure to calculate whether an ordinary user is likely to be able to operate the weapon system to deliver the performance planned by the hardware designers.

The memo from the Army Acquisition Executive, identified in the chart , states: "The Army continues to field new equipment to soldiers without adequate training.... Systems are being fielded: without necessary training aids, devices, simulators, and simulations needed for sustainment training... [and] to training installations (1) late, (2) in the wrong quantity, or (3) in a different configuration than that fielded to units."

This happens regardless of such regulations as DoD Directive 1430.13: "the training system that supports a new defense system ... shall be assigned the same priority as that of the parent system ... should be available in time for the fielding of the parent system."

Since the requirements unambiguously exist, we need something more than directives to get the acquisition process to recognize the havoc it plays with training and the savings it could achieve if training were considered during design and production. Thus we renew our recommendation that the Secretary of Defense require an annual training report card. This should lead to making visible the interfaces between training systems and the processes of acquisition, logistics, personnel, military education, and command and control. Only if the connections among all these to readiness are routinely exposed at a high level, will there be a chance that someone with authority will force these factions to integrate.



Our wars are joint; our incentive structure isn't. For training, as elsewhere, this leads to many words of support and few actions.

THERE ARE OTHER obstacles that impede a training transformation. The first (CTC) training transformation in the 1970s grew out of multiple needs. The first was the desire to achieve better performance than that demonstrated in Vietnam. The second was the realization garnered from experimentation on a small scale that large-scale instrumented, OPFOR, AAR, and Observer-Controller (OC) based training was feasible and, although somewhat expensive, affordable. While none of the Services would abandon such training, they are acutely aware of such training's limitations and burdens.

Unfortunately, we are not getting the full benefit of these fixed training sites. Often units go to CTCs and conduct learning and training that should have and could have preceded the visit. Embedded and local home-station instrumentation is a needed ingredient to prevent this waste. All of the Services have attempted to use local and netted virtual means to improve matters, but they have achieved limited success because the instrumentation is available in small numbers and is not configured to cover support functions such as logistics, intelligence, or force protection. (We applaud, however, the recent change at the National Training Center that introduces force protection issues into its training.)

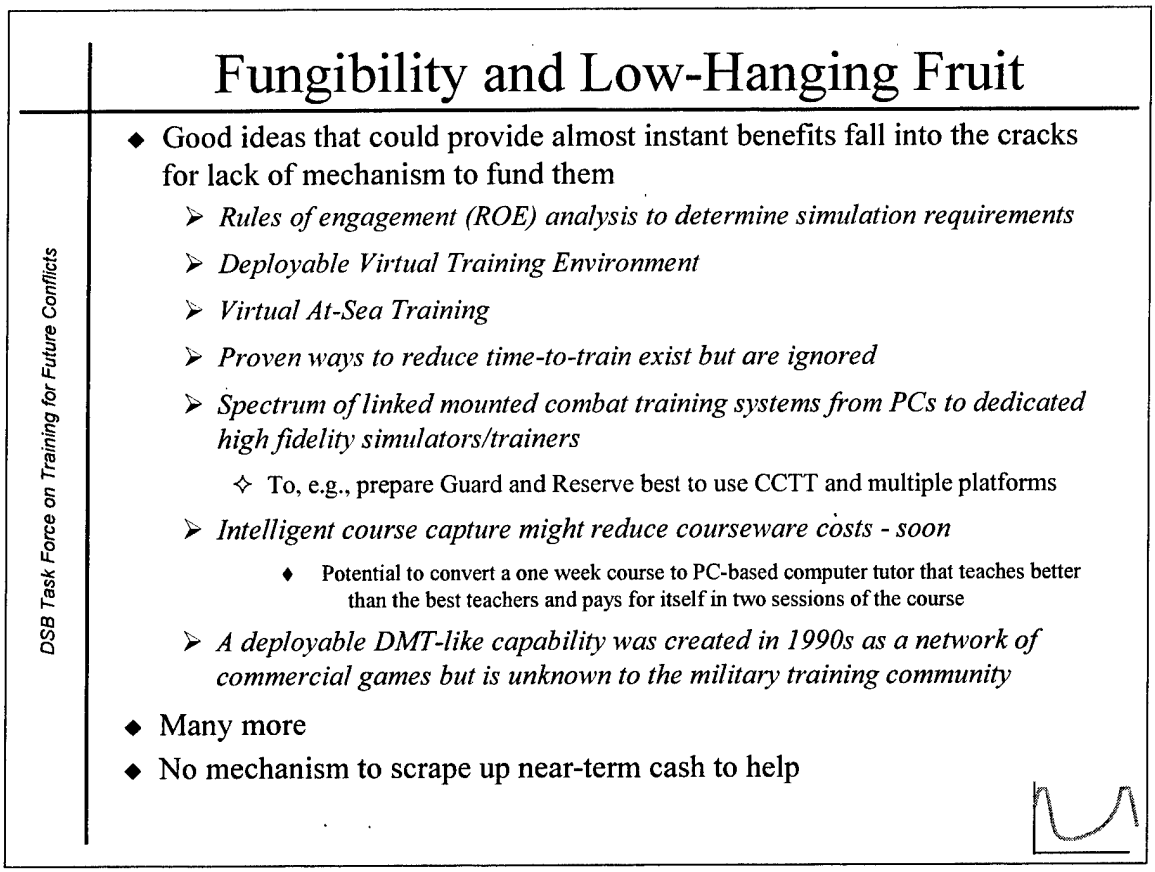
This puts a clamp on how much a unit can grow in a CTC. Without home-station instrumented training and experimentation capability, much better rehearsal at the remote training site is inhibited. In particular it defers until the very end examination and refinement of training for specific rules of engagement (ROE). This is important because ROEs change with the character of each war. They often change *within* a conflict. Unless units practice with different types

of ROE, their responses in a real conflict may be inappropriate.

In the not too distant past, affordability could be cited as something of a show-stopper. This matter is discussed with specifics at the end of this report, but suffice it to say that it is no longer a show-stopper.

Finally, we note that, as with the personnel and acquisition systems, the goal of joint training is not supported by the current incentive structure. Existing personnel systems are unable to track joint training in all but its joint assignment context. This circumstance is being changed with the advent of the OSD-led Defense Integrated Military Human Resources System (DIMHRS) program now in adoption and transition. Such tracking is possible within the basic software, Peoplesoft, which provides a substantial number of the building blocks for DIMHRS.

The larger challenge is cultural and adjudicative. Much useful joint training could be accomplished through networking existing facilities, bases, and CTCs. The obstacles are related to training interruption and control priorities. Perhaps Combatant Commander priorities could be employed to focus integration, eliminating the need to learn only in true combat settings.



We found many relatively low-cost projects that could have near-term payoffs, but because training authority is diffuse, there was no champion who could reprogram money to make them happen. There should be a funding mechanism available to allow us to pluck low-hanging training research fruit.

***FUNGIBLE**: adj. returnable or negotiable in kind or by substitution.*

Although you may be tired of reading it, we continue to assert that training can have as large an impact upon warfare performance as can hardware. Training research budgets, however, are a minuscule fraction of hardware research budgets. Highly promising opportunities are left out in the cold in consequence. We saw a number of these.

We will discuss the Deployable Virtual Training Environment and Virtual At-Sea Training in separate charts. These and others are listed here.

We found that the software that drives some sophisticated mounted-combat trainers can now be ported to personal computers. With a small investment to make the porting, a substantial portion of the training value provided by the higher fidelity trainers could be made available to organizations like the National Guard whose units, on the average, experience Close Combat Tactical Trainer (CCTT) training only 30 minutes per year. The lower fidelity systems could prepare units to get the most out of higher-level trainers as well as teach lessons that those users would never have a chance to learn otherwise.

Large training device suppliers resist this process and some customers are afraid that they will miss something with the lower fidelity approach. As a result, good training that could be delivered is not delivered.

One of our interim recommendations shortly after the atrocities of 11 September 2001 was that air distributed mission

training (DMT), like that being slowly introduced into the Air Force (and now the Navy), should be available on aircraft carriers and remote air bases. DMT currently is installed in hanger-sized facilities on land. We suggested that some form of that capability be shrunk down to shipboard size. We subsequently found that a former Navy pilot had created, for a series of game centers, a multiple aircraft simulation capability that had many of the desired features. Unfortunately, his third round of venture capital funding fell through when the dotcom bubble burst. The hardware is now in mothballs and the knowledge of how to do the networking with commercial components is drying up. There is no one with money and authority to rescue this.

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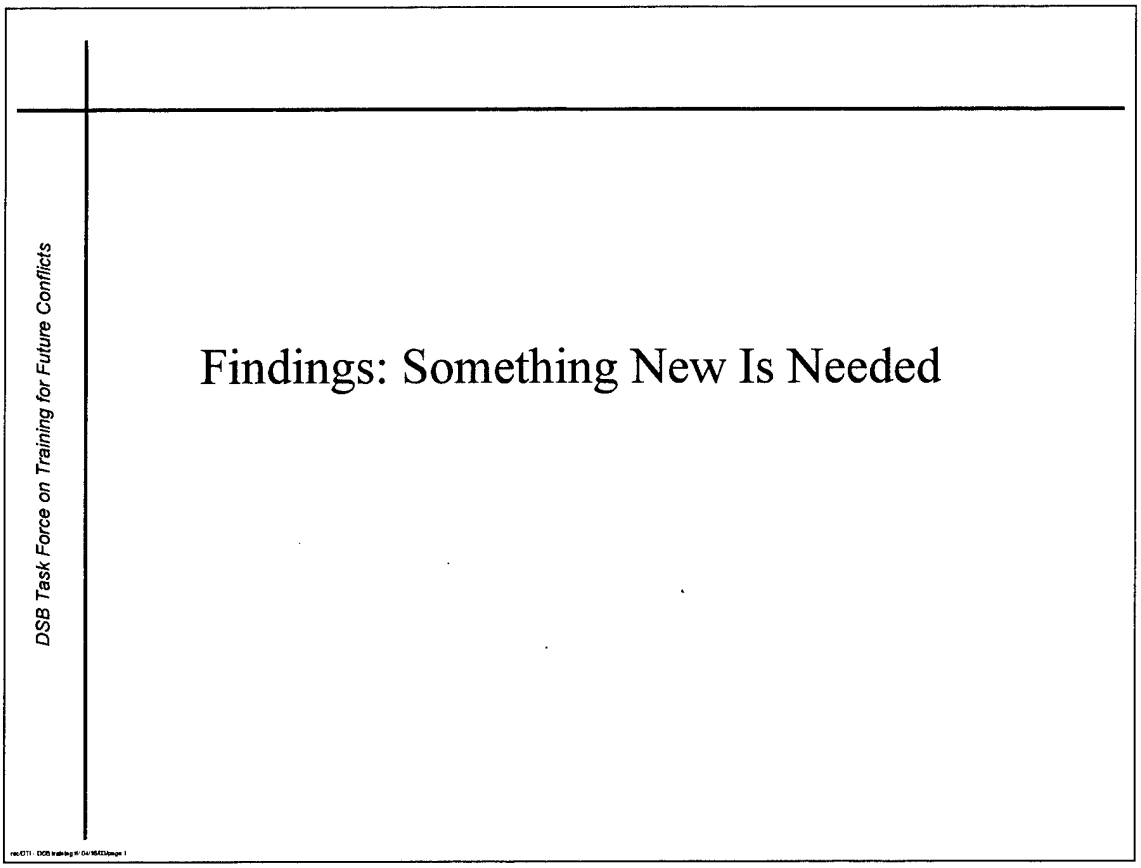
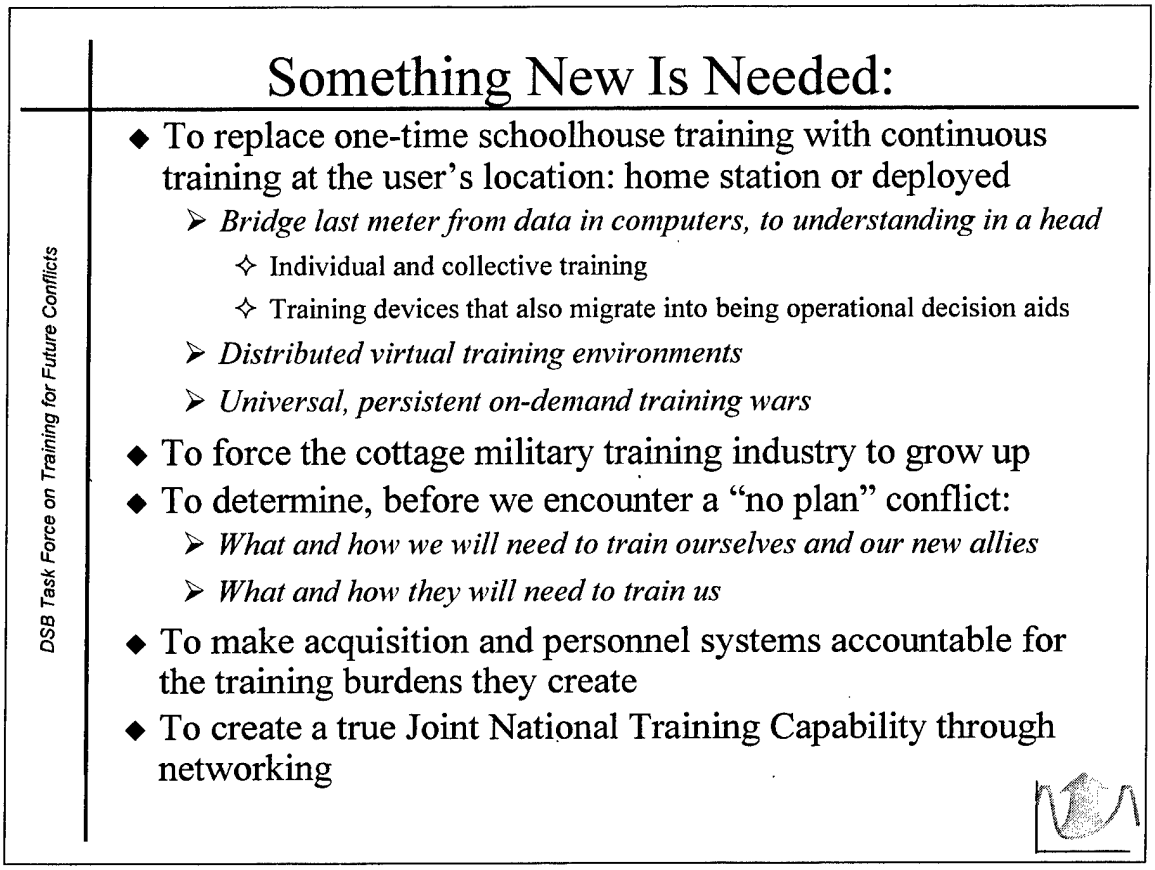


If schoolhouse training won't hack it," something new is needed. In this section we offer some suggestions about what the new somethings might be. In the past, the film industry and then television were held out as the key to a revolution in education or training. They failed, in part, because the best training requires practice with feedback. We hope, with some justification, that the electronic revolution will fare better.



Here we list some general themes framing the changes needed for future training. In the next few charts we will offer specific examples of new approaches that could improve the delivery of competence, the cost of delivery, and the acquisition of the knowledge that must be transferred. There are more approaches; our observations are representative, not comprehensive.

LECTURE-BASED, resident training has such a long history it is hard to recognize that this process can be part of the problem. It is hard to modify a large, diffusely administered system that all of us have partaken of for a substantial fraction of our lives. In such a case, to get beyond the status quo one needs to create a new motivation structure that fosters change. The DoD will have to attack this from the areas of both performance and cost. This issue has also been addressed by the Army Science Board 2002 Summer Study (in draft).

Lectures have been shown to be a very poor method of transferring information and skills. In many classroom settings a student has an average of three direct interactions with the instructor and the subject per hour. A tutored student has over 100.

If, as we claim, training is relevant practice with feedback, then we must find ways to get the practice. Computers can be made to support many interactions to cover much of the "practice" part of training over a wide range of militaril tasks. Making the practice relevant to the students' level of knowledge and their needs is harder.

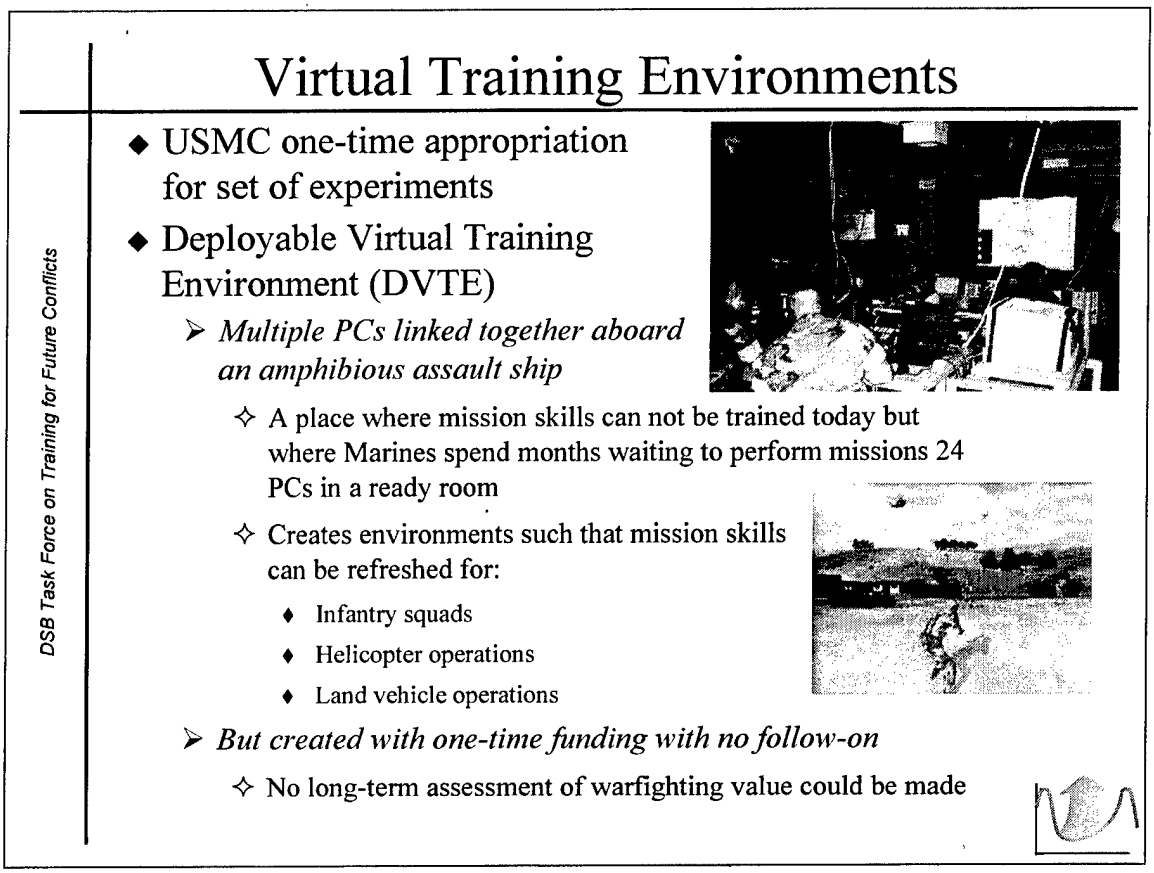
If the "last mile" communication problem is ever solved, the data to support computer training can be resident in a local personal computing device, but

we still need to bridge the "last meter" from the bits and bytes in the computer to understanding in the head of a student or user.

"Intelligent" tutoring systems and networked wargaming have the potential to bridge this last meter for individuals and units and make practice relevant. However, the current state of the art appears too expensive to convince the residential instruction community of its value either as a major supplement to schoolhouse training or in lieu of it. Research is needed to decrease costs.

Local computer-based training systems have the potential to become job performance enhancers. We note that the IMAT acoustic trainer, which we mentioned in our last report, continues to move in that direction. Others will follow.

We will touch elsewhere on each of the other major bullets in this chart, but the comment on training as a cottage industry needs a sentence or two here. Currently innovations in training come piecemeal and are not transferred from one system to another. Standards and methods of sharing innovation will be needed if "intelligent" (i.e., computer-based) training is to succeed.



This is the Marine Corps' land warfare equivalent of our recommended air warfare trainer-in-a-seabag. Marines can do many pushups while waiting on an amphibious assault ship, but until DVTE they could do no coordinated mission training. DVTE gave one pick-up team of Marines a chance to do it—once. The process must be continued and expanded.

WHILE WE NOTED that experience of a virtual environment, by itself, is not training, it can permit kinds of training to be conducted when and where it has never been possible before. A Marine Corps project, the result of one-time funding, is a case in point.

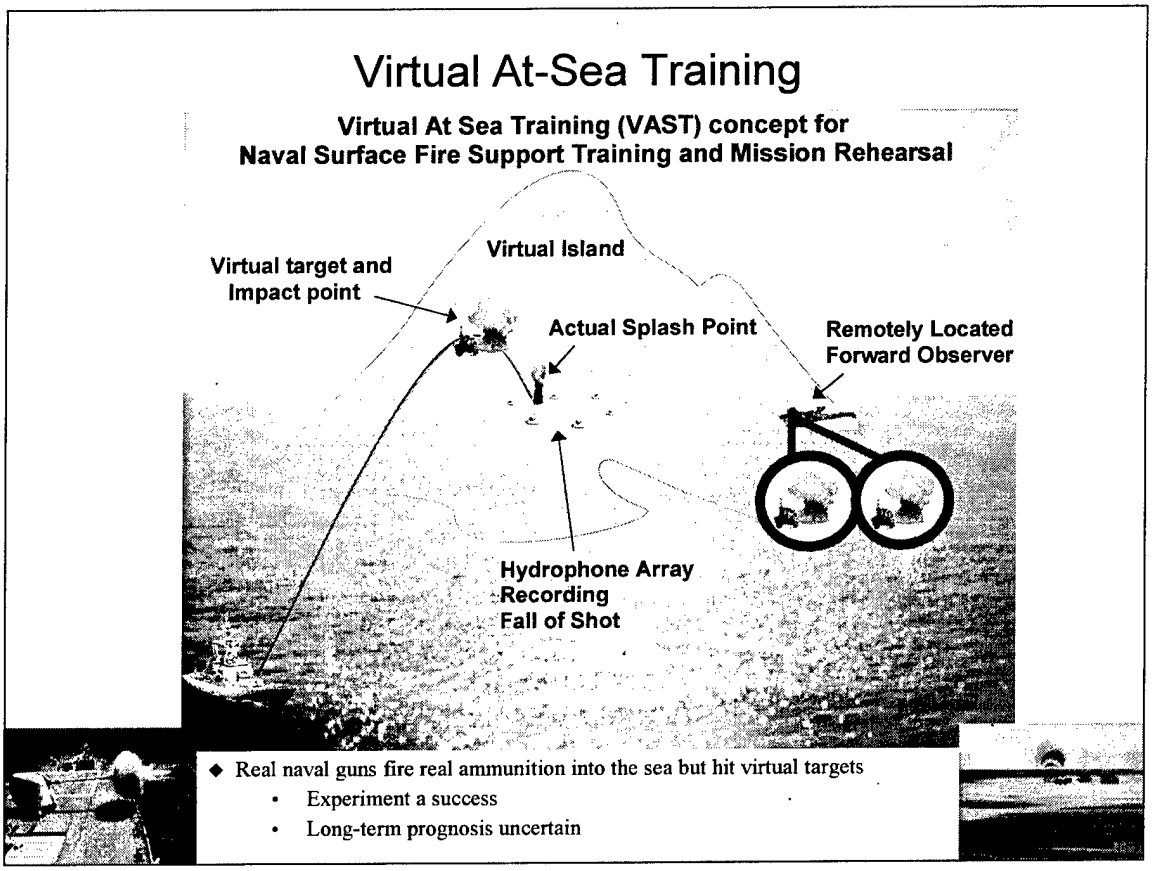
Marines on shipboard have the same problem as carrier-based and remotely deployed pilots have; they can perform some kinds of training, but there is no place where they can conduct coordinated mission-level practice. The Deployable Virtual Training Environment (DVTE) project attempted to see if they could remedy this situation by linking a number of standard laptop computers into a single warfare environment and trying it out on a large amphibious assault ship, U.S.S. *Iwo Jima* (LHD 7).

We recognize that DVTE won't help refresh how to shoot a rifle or exercise one's running muscles, but it can be used quite effectively to teach lessons about reconnaissance, use of smoke, how not to get shot, what to do when a weapon system is degraded by hardware failures, inter and intra squad coordination, etc.

In this one-time demonstration, with the help of many people creating training situations and facilitating after action reviews, DVTE appears to have worked quite well. Long-term assessment of how the lessons learned translate to success on a battlefield, however, was precluded by the one-time nature of the funding.

This work should be continued and expanded.*

* To avoid possible confusion, we note that the DARPA program, to be discussed in the following few pages, will attempt to create or incorporate environments like DVTE and *then* autonomously insert the training, currently mediated by real people, at the front, middle, and back end of the virtual war experience. Creating an acceptable virtual environment is necessary before the training can be inserted. The DARPA program hopes to move beyond the environment and into training that will require a minimum of external human intervention.



A real naval gun shoots. A real shell lands in the ocean. Where it would have fallen on a virtual target is calculated and inserted into the view of a real forward gunfire observer. The parts that require training are real; much of the rest is simulated but can be exercised separately. We could wish that future funding were as real as the gunfire and the communication networks.

ANOTHER FORWARD-LOOKING but underfunded effort we encountered was the Navy's Virtual At-Sea Training (VAST) project. Initiated in late 2001, when the availability of land targets for naval gunfire became in doubt, the Navy developed an approach to allow practice with real ammunition fired by real naval guns, but the shot falls innocently far out to sea. The first test occurred within 30 days of the go-ahead order.

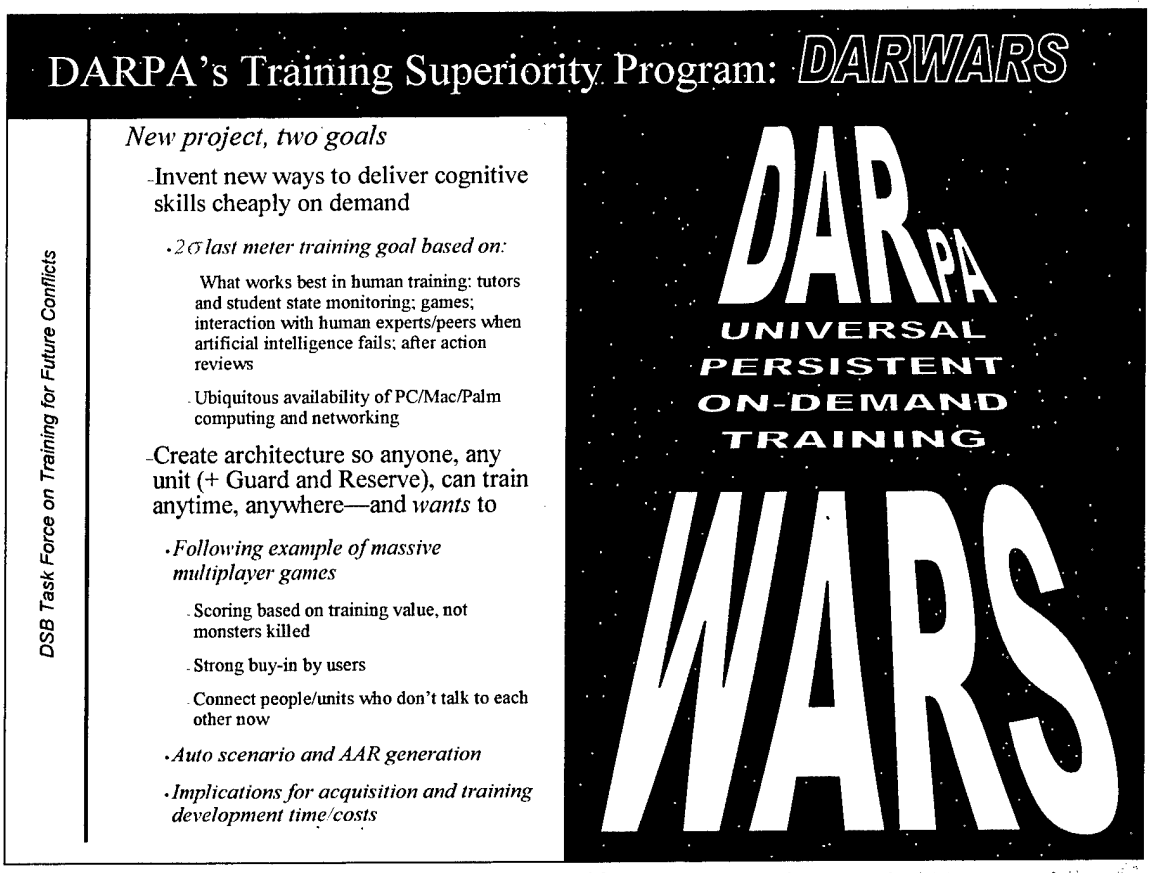
GPS-equipped buoys were deployed that recorded impact sounds as the shells hit the sea surface. From this information the trajectory of the shell was calculated. The trajectory was used to determine where on a virtual landscape the shell would have hit.

Damage effects were calculated and imposed upon a picture of the virtual scene as a forward observer would have viewed them using, for example, an unmanned air vehicle's camera. The human observers reported the fall of shot back to the ship using the real communications networks. The gunners made adjustments and the process was repeated.

Note that every part of the actual fire support process was exercised for real except the impact and explosive behavior of the weapon, the observation sensing, and the telemetry of sensed data to the forward observer. The only unique components of this system are buoy sets and software.

The intent to supply three deploying ships with this system in the fall of 2002 has been delayed to spring of 2003.

Continued concern about land firing ranges make it likely that this concept will be developed further. Concepts for expanding this approach into air warfare and anti-submarine warfare (ASW) are also being explored at the $1.1 million level in FY 04, but only $250,000 is currently budgeted beyond that.



One co-chair of this task force left the commercial world to create a training superiority program in DARPA. The probability of success is uncertain; this is outside DARPA's usual technical inclinations. The goal is to create an environment where every echelon can, and will, train continuously in a virtual war.

DARPA IS STARTING a project to create a technical environment that may foster solutions to issues raised in this report and its predecessor. This is not accidental: one of the co-chairs of these task forces (Chatham) jumped ship from the contractor world shortly after the atrocities of 11 September 2001 to create the program in DARPA. Money is just beginning to flow as we complete this report, so we can offer only the usual rose-colored hype surrounding the initiation of a project.

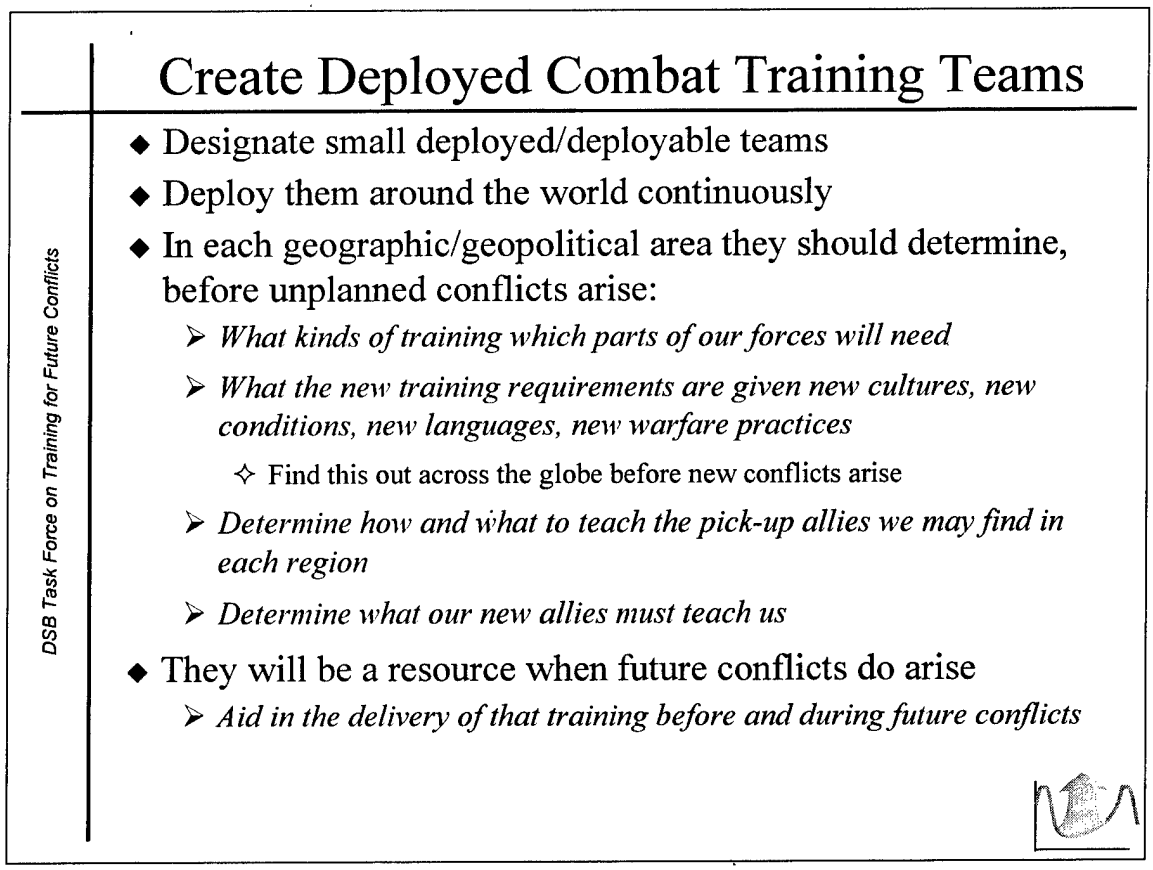
The program, nicknamed DARWARS, is based upon two observations already discussed: (1) an unintended consequence of transformation is that new warfare tasks will require substantial cognitive skill, and although "school-house training won't hack it," the ubiquity of personal computers and network connections might help; and (2) we don't have enough opportunities to train in all the ways we might need to be trained for future conflicts.

Some things that *do* work for training are human-human interactions (the average student of a good tutor is better than 98 percent of classroom students); putting emotional context into training with, for example games; repetition of tasks where *performance is measured*; and the use of after-action reviews, mediated, in part, by the trainees themselves. Using these approaches, DARPA intends to create training development tools that will allow (mostly) automated and inexpensive devices to teach cognitive skills to everybody quickly.

DARPA chose several high-impact training areas to focus the work of the tool developers: deployable distributed air mission training, rapid tactical language training (to put a limited vocabulary and knowledge of culture and gestures into the brain behind the trigger finger), and aid for the information technician on ships or bases. These have been dubbed "last meter" training devices because they are designed to bridge the last meter between data on a computer and understanding in the heads of our warriors.

The second observation, that we don't have enough wars to train all our forces in all the warfare skills they need, leads to a new training architecture. One way of describing America's existing CTC training is that it creates an artificial war in which our forces practice. It had been one of our task force's goals to see if that kind of training could be bottled and exported electronically to all echelons all the time. We didn't know how to do this when we wrote our first report. There is a chance that we do now, and this CTC-in-a-box goal is the chief focus of the DARWARS project.

At a lower level, the focus is to tie the initial last meter training devices together with a multitude of other training systems. We take our cue from the massive multiplayer game world, where tens of thousands of participants at a time enter into a virtual world. Some games have 400,000 subscribers who exhibit a fierce sense of ownership in their world, a world in which the average user spends over 20 hours per week. Players create joint warplans. Some develop secure communication sites. Others write software that they contribute gratis to "their" world. DARPA hopes to create that kind of passion for participation in a set of universal training wars that will be available to anyone, any echelon, any time. Training development costs may be reduced by user inputs. DARWARS may also help the acquisition/training problem by providing an environment where new concepts can be tested.



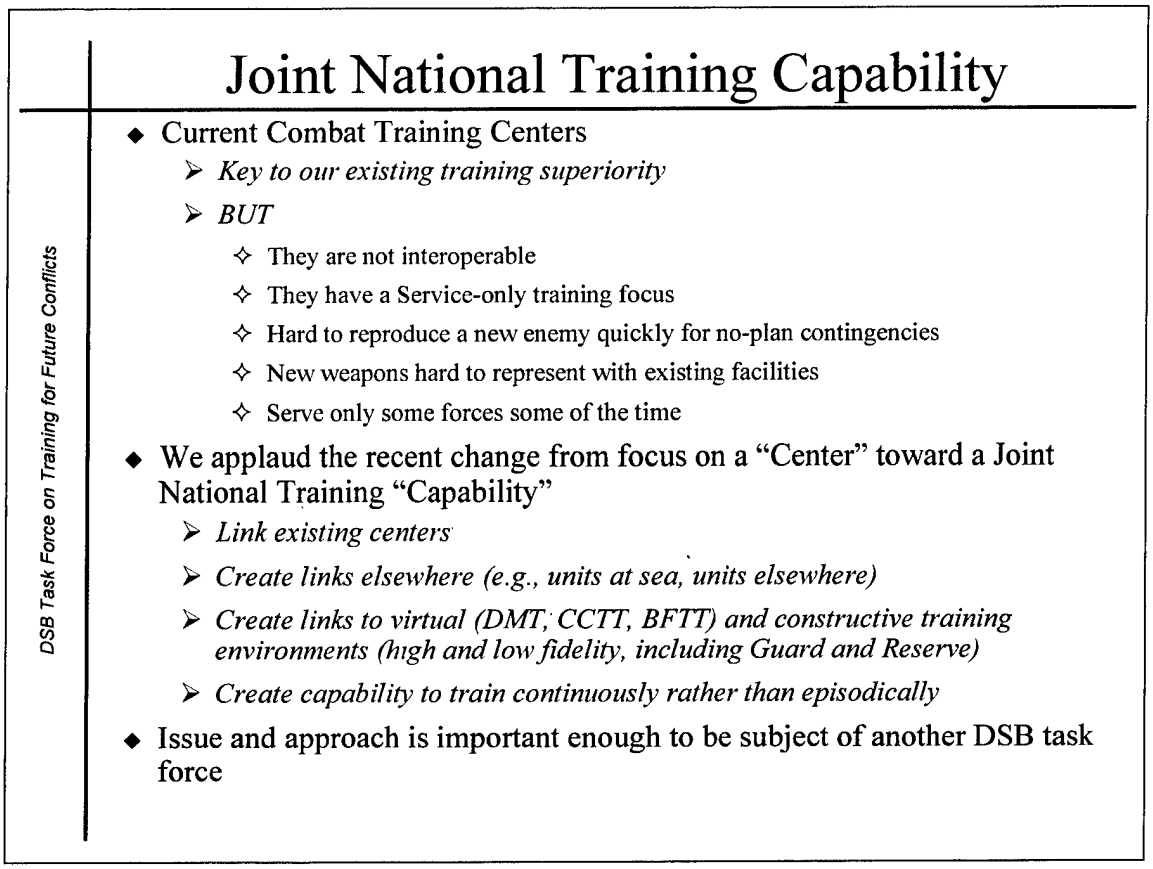
This chart actually comes under the category of a recommendation. We know of nothing like this today. There are other special teams that prepare our forces to go into unexpected parts of the world—medical units, for example. There should be deployed teams to do the same thing for training.

WE NOTED that our Afghan campaign required us to conduct war in new and unexpected ways. We heard from the first special forces team that entered the war zone that they had unique training experiences that suited them for a war they never expected to fight. For example, they had exercised with Uzbekistan special forces the year before. Despite this experience, however, even this team had much to learn on the ground. Other special forces teams did not have the same kinds of experiences. Moreover, these kinds of opportunities are limited to special forces training and are not commonly available to other forces and their supporting units.

We believe that steps should be taken to identify these kinds of lessons (before a conflict becomes imminent), catalog them, and prepare them for delivery on short notice to the forces that would soon enter a future conflict. To accomplish this we recommend that several small, permanent teams be created to search out what kinds of training would be required were we to be drawn into conflict in unexpected parts of the world. This approach is not unknown in other areas of military preparation. The Navy, for example, has three permanently forward-deployed medical units that roam the world identifying the medical problems that our forces might encounter were they to be sent to unexpected and new theaters of conflict.

The teams should represent all the possible forces that might enter a conflict; thus they should probably be chartered by several of the Combatant

Commanders (formerly CINCs) or by the JCS. They would determine what specific kinds of training we would need to apply to our forces and to our newly acquired allies. The methods for delivering this training will probably differ depending upon the technical sophistication of those who will be fighting and the local infrastructure and culture. Moreover, these teams should determine what kinds of training our allies would need to give to our forces. Finally, when a conflict starts these Deployed Combat Training Teams could assist in delivering the training to all concerned.



Any good study group recommends more things to be done, and so it is with us. One way of improving upon the crown jewels of our first training revolution is to connect the existing CTCs together such that they serve as joint, not Service-only, training centers. We recommend DSB involvement in this effort.

GIVEN THE KEY ROLE that CTCs play in our training superiority it is reasonable to ask how this process might be enhanced for the future. Our recommendations in *Training Superiority and Training Surprise* dealt mostly with how to restore the existing CTCs to their ~ 1990 level of performance. Progress has been made on that front.

An issue not addressed directly by our last task force, however, was how to use this base to create a real *national* training capability, one that is not as exclusively single-Service oriented as the existing Navy air, Air Force air, and Army ground centers. Such a capability should also bring in other forces not yet served by such a center. For example, there are no Navy (non-air) or Marine Corps CTCs. The Marine Corps live-fire training, while a vital part of making a Marine, does not include an instrumented range, an opposing force, or the after action review process—all of which are key to the CTC success in the Army and both tactical air forces. Additionally, a JNTC should include logistics, intelligence support, and command and staff training.

Linking the existing centers is probably a good starting point, but there are enormous issues about how such a linked facility should be configured, utilized, and paid for. Scheduling the use of the individual centers is already hard; insuring optimum use of a combined training capability will be harder. Moreover, the more participants we add, the

harder it will be to ensure that every person and unit experiences this kind of training often enough. Anytime something joint is created, funding issues loom. Funds planned for the joint project that do not directly support the parent Service are always in jeopardy.

There are also the technical tasks attendant to connecting systems that were not originally designed to work together. We can hope that in the process of working out these issues the even harder issues of actually fighting in a joint environment may get highlighted as well.

For these and a host of other reasons, including the request of the USD (P&R), we recommend that the next DSB training effort explore these issues.

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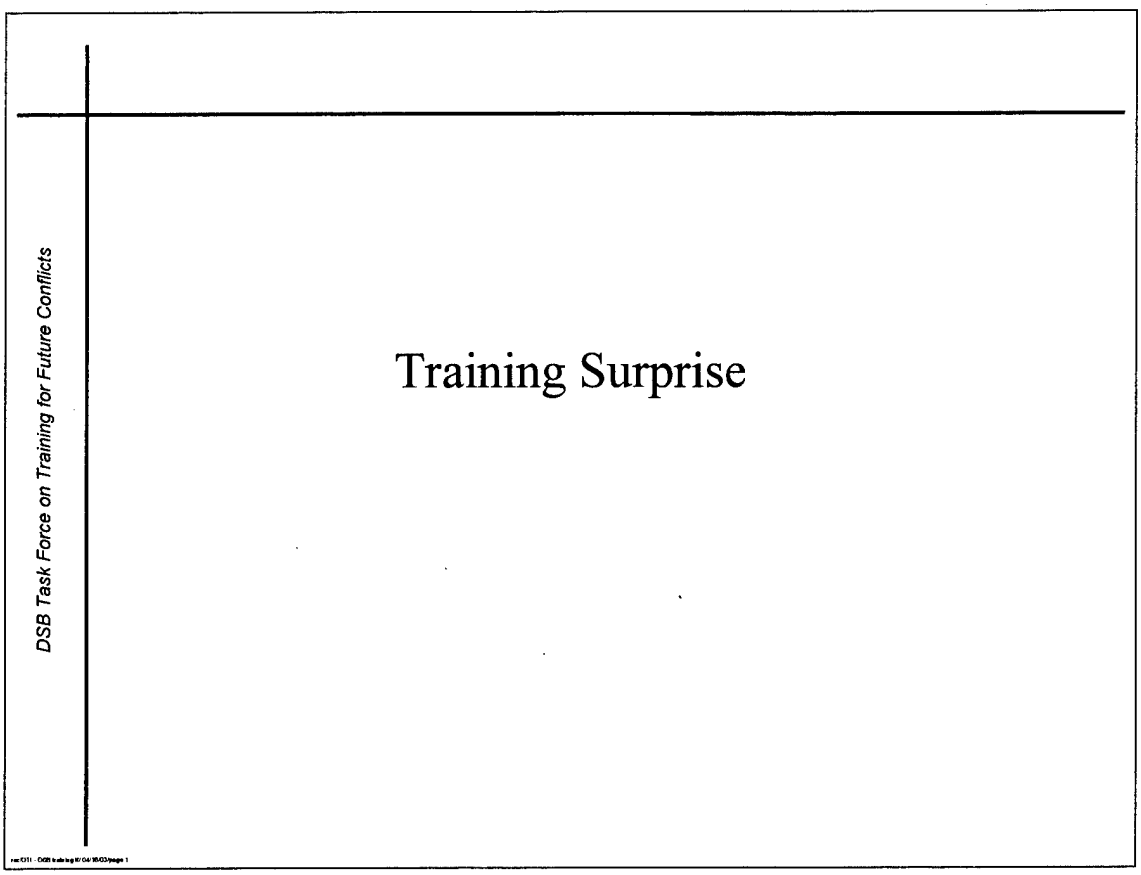
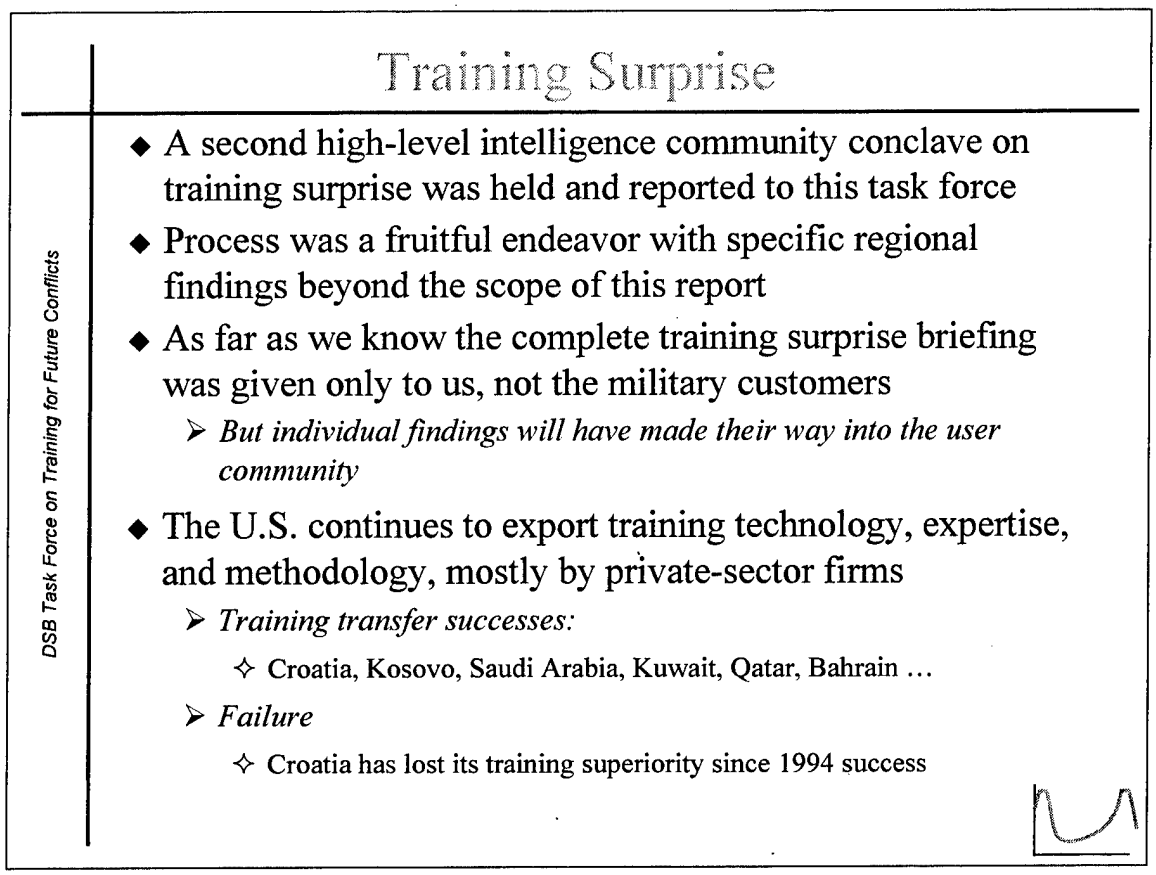


We were charged to follow-up our last report's observation that a potential adversary could improve its warfare competence dramatically without our knowing it by using advanced training approaches. The next chart is an unclassified summary of our latest findings in this area.



Training surprise has occurred. Fortunately, we have yet to be on the receiving end of the surprise. To prevent that from happening, the DoD and the intelligence community should cooperate in searching for indications that it might be happening. Top-level involvement is needed to sustain such an effort.

OUR PREVIOUS TASK FORCE raised the issue of training surprise. Technology surprise is a serious worry throughout our technologically oriented Defense management. As this task force attempts to raise the importance of training superiority, we are obliged to consider the flip side of that coin: Can we be surprised by a new competence created by an adversary applying the training principles that have done so well for us? We, therefore, have continued the search for examples and patterns of training surprise. In addition, the task force also continued to assess the circumstances and effect of the export of training technology, methodologies, and expertise.

In the first instance, partly at our request and partly on their own initiative (led very capably by MG John Landry, USA Retired) the intelligence community has continued the search and has found interesting examples of both improvements and losses in capability. There are continuing examples of "unusual" ongoing training. These ought to be brought to the attention of OSD (at least to P&R), the Combatant Commanders, the Service intelligence and training elements, and to the Deployed Combat Training Teams which we recommend in this report. While we have not made a complete audit, we have not seen this occurring, and certainly not on a regular and institutionalized basis.

The situation on the export side of the equation is equally unsettling. We continue to apply only light control to the export of training technology, methods and expertise. In one case, a U.S.

firm is providing OPFOR services for air combat training to the UAE. One reason for this stems from the resource limitation in the Air Force to provide these services—an understandable circumstance in today's environment. There are examples of our allies incorporating all the elements of our first training transformation (including those in the AAR process), although this can be culturally challenging. Germany, for example, appears to be moving toward establishing a large CTC in its eastern region. It is uncertain how joint or combined this will be and how it will relate our CTC at Hoenfels.

On the other side of training surprise, it is equally important that we not overestimate readiness by failing to understand how ephemeral human competence can be. Our new review of training surprise uncovered the circumstances that now exist in Croatia. Earlier, in the 1990s, Croatian forces were assisted by U.S.-directed training expertise to create a new military organization. This training had a high payoff in the very near term as the Croatians quite capably drove Serbian forces out of their territory in 1994 (as contrasted with their failure to stem invasion a year earlier).

The latest estimate of their capability has, however, been downgraded. Their forces have lost competence due to a lack of continuing commitment to training. Training inferiority can quickly supplant superiority if the training process is not continued or if it is misapplied.

This is a lesson that should not be lost on us: *what we have today can disappear in only a few years.*

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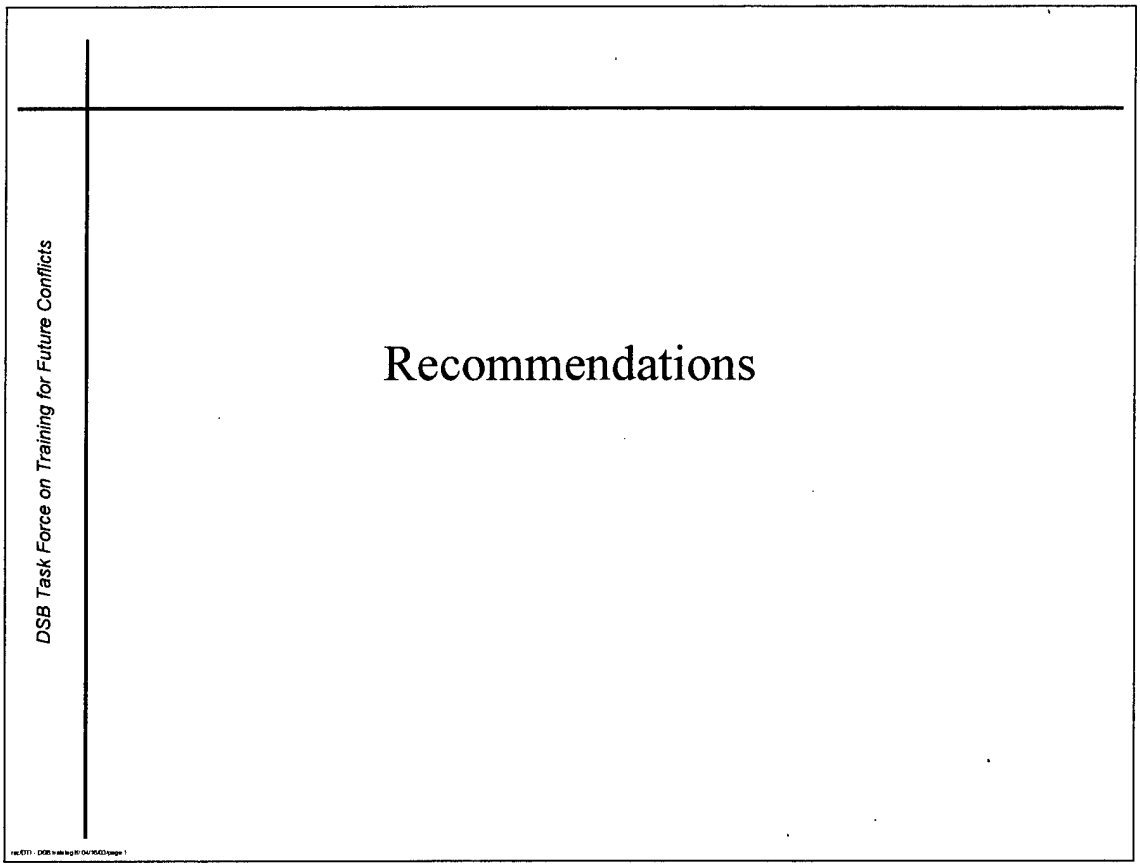
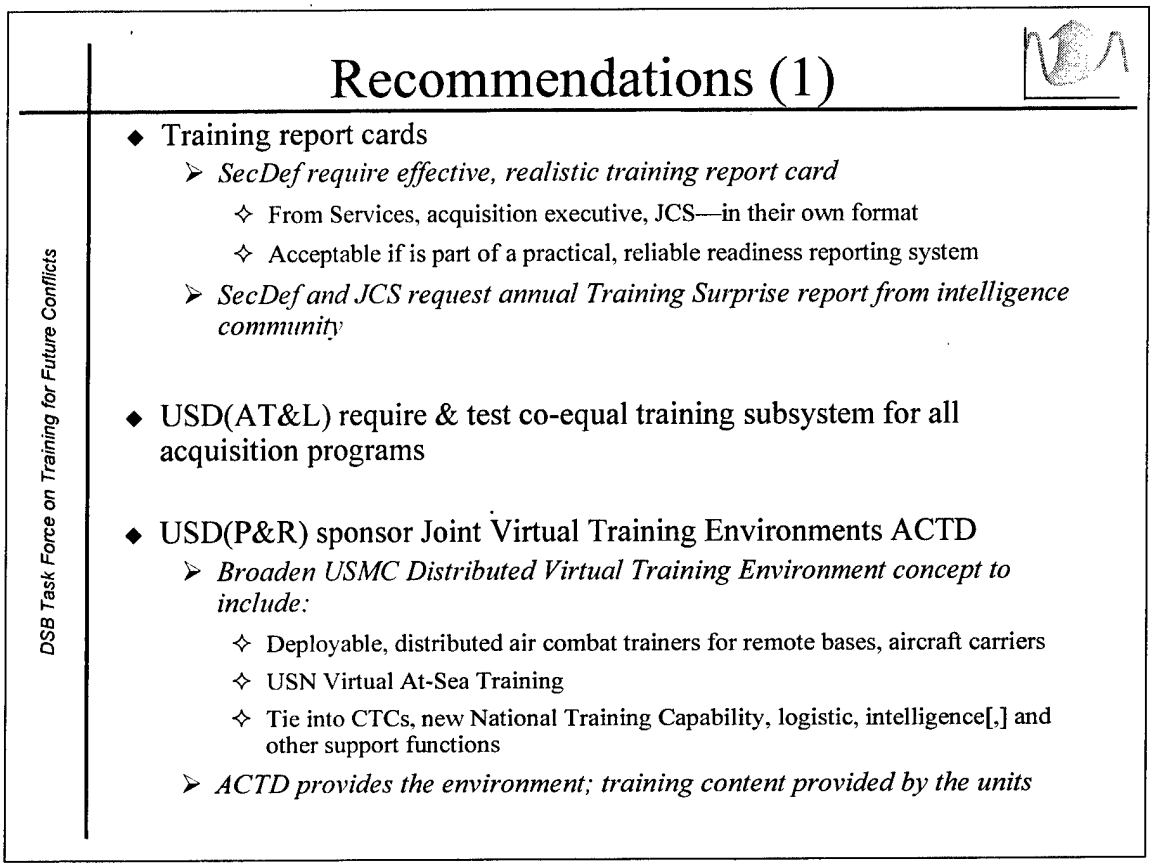


We offer technical, structural bureaucratic, and funding recommendations. Learning from an omission in our last report, this time around for each recommendation we have identified a "stuckee," a specific individual or office that should be responsible for its implementation.

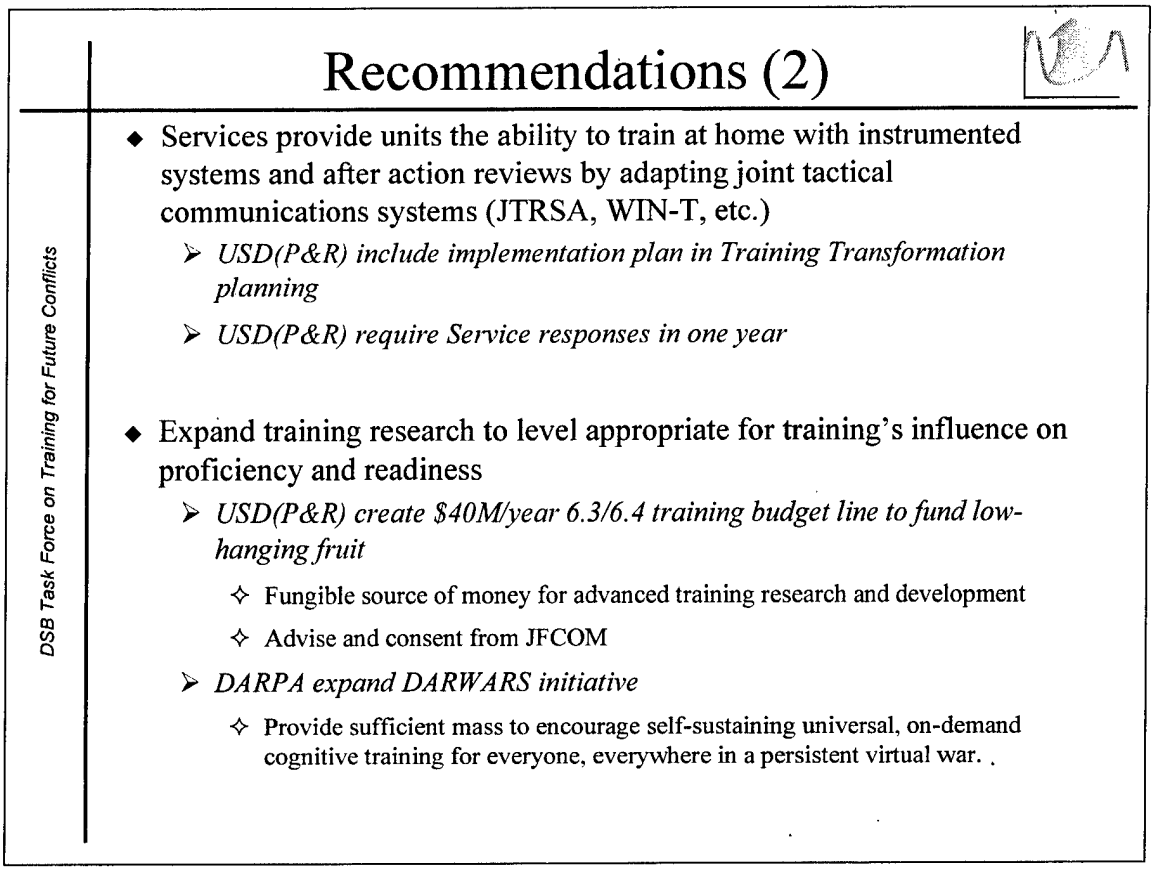


Report cards force us to pay attention to areas that we might otherwise ignore. Despite their pain and bother they provide visibility. We need to institutionalize this visibility for training, both ours and that of potential adversaries. The training subsystem in acquisition is unfinished old business from our last task force. A training ACTD is also old business, but here we make the recommendation much more specific: create a large-scale set of joint virtual training environments.

OUR FIRST RECOMMENDATION aims to raise the visibility of training by requiring report cards on our training and that of our potential adversaries. We acknowledge that reports are burdensome to write and often tiresome to receive, but the process of creating and reviewing them forces us to think critically. It also brings out issues that we might otherwise ignore, given the multiple demands upon everyone's time.The current Under Secretary of Defense for Personnel and Readiness has chosen to champion training. The next holder of that office might not, unless structural changes are made to insure that training issues are visible. Moreover, there are others at high levels who need to hear the message that their efforts can be all for naught if they don't pay attention to human competence, not just hardware performance. Thus, we again recommend that the Services, the JCS and the Intelligence Community deliver a training report card (in whatever format they choose) to the Secretary of Defense at least annually.

The acquisition community must participate. We recommend here that they create a part of the training report card. We would be satisfied if, instead, they were forced to read and review, at the highest level, the training status reports of the Services, JCS, and Intelligence Community. Either way, it would bring the people versus hardware tradeoffs to the attention of those in the DoD

who spend the most discretionary money. Further, the acquisition executive should insist that a key performance parameter for every system be the creation and testing of a training subsystem—co-equal to all other subsystems—that will insure trained operators throughout the system's life-cycle. Failure of that subsystem should be viewed as equally disastrous as a failure of a propulsion system or warhead. We noted the progress in virtual training environments with the Marine Corps' Distributed Virtual Training Environment and the Navy's Virtual At Sea Training. The technologies are mature enough now to expand them into an Advanced Concept Technology Demonstration. We recommend the USD(P&R) sponsor such an effort. It would contribute to the recommended Joint National Training Capability and make inroads toward filling up the readiness bathtub.



(1) Readiness would not fall off as quickly for land and air forces if they could practice on an instrumented range at home. New communication systems could fill this need if we get to the acquisition community early. (2) Training research funding does not match the value that training has on military performance. We recommend a start toward fixing this.

NEW FLEXIBLE HARDWARE and systems are being developed that are intended to make significant inroads into unifying the communication process across the Services. These systems, which include digital radios, could be capable also of automatically providing position and timing information equivalent to that provided by expensive instrumentation installed at major training center ranges. That capability could be used to allow units to train at their home station in ways that can only be done now during an expensive and rare deployment to a CTC.

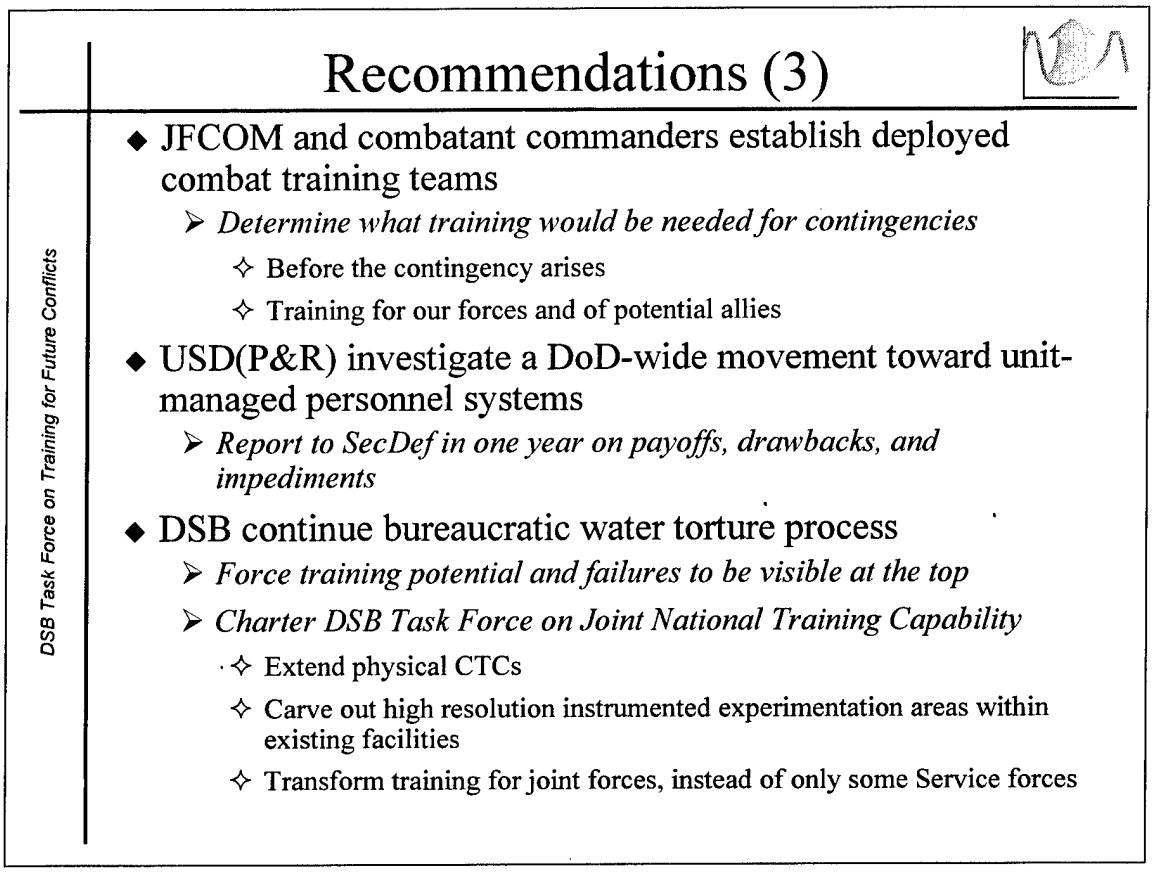
If we get this inserted into the acquisition process early enough, the incremental cost of delivering this capability will be small. If we wait, the backfit costs may become prohibitive. There is another aspect to this. Whether or not the home-station instrumentation is developed, bandwidth for training must be reserved and planned for in the design of the communication systems.

If, as we assert, training has as large an impact upon warfare performance as does hardware, and it can be gained *or lost* more rapidly than hardware capabilities, then it is important to understand how the training process works. As we noted in our last report, however, funding for training research, which could give us this understanding, is miniscule in comparison to its impact, as well as miniscule in comparison to other kinds of defence research spending.

One example of our lack of knowledge was noted at the beginning: games for training are a hot subject, but the fad is not supported by a real understanding of when and how they teach or why they are compelling. If we are to use them effectively, we must understand them, and it won't come unless the DoD pays; there is little incentive among game developers or academics to do so. We recommend that USD (A&T) institute a DoD Multidisciplinary University Research Initiative (MURI) project in this area. We should also study how to capitalize on the over $9B/year investment made by the digital gaming industry each year in creating new games and gaming systems.

We also pointed out that a substantial number of training developments that could have near-term payoff fail to get funding because there is no source of fungible money to finish the job. We therefore recommend that a large and visible program element be created to support training research.

DARPA's DARWARS initiative is based upon an assumption that if new training technologies and on-demand training wars for everyone can be demonstrated to enough Service and Joint users, then the users will join in the process. The ARPANET and SIMNET are examples of the success of this kind of approach. At the moment, however, the project is probably too small to achieve a critical mass of support to make it self sustaining. We therefore recommend that the project be expanded to include more "last meter" training systems, persistent-world training networking, research on what compels and teaches in games, and what makes people become aces in military tasks.



We should create a structure that helps us plan in advance for the training *needs of unexpected come-as-you-are wars. We should explore how to hold the personnel system accountable for the readiness consequences of its systems. Finally, the DSB should continue make training superiority visible to those who sign checks in the Pentagon.*

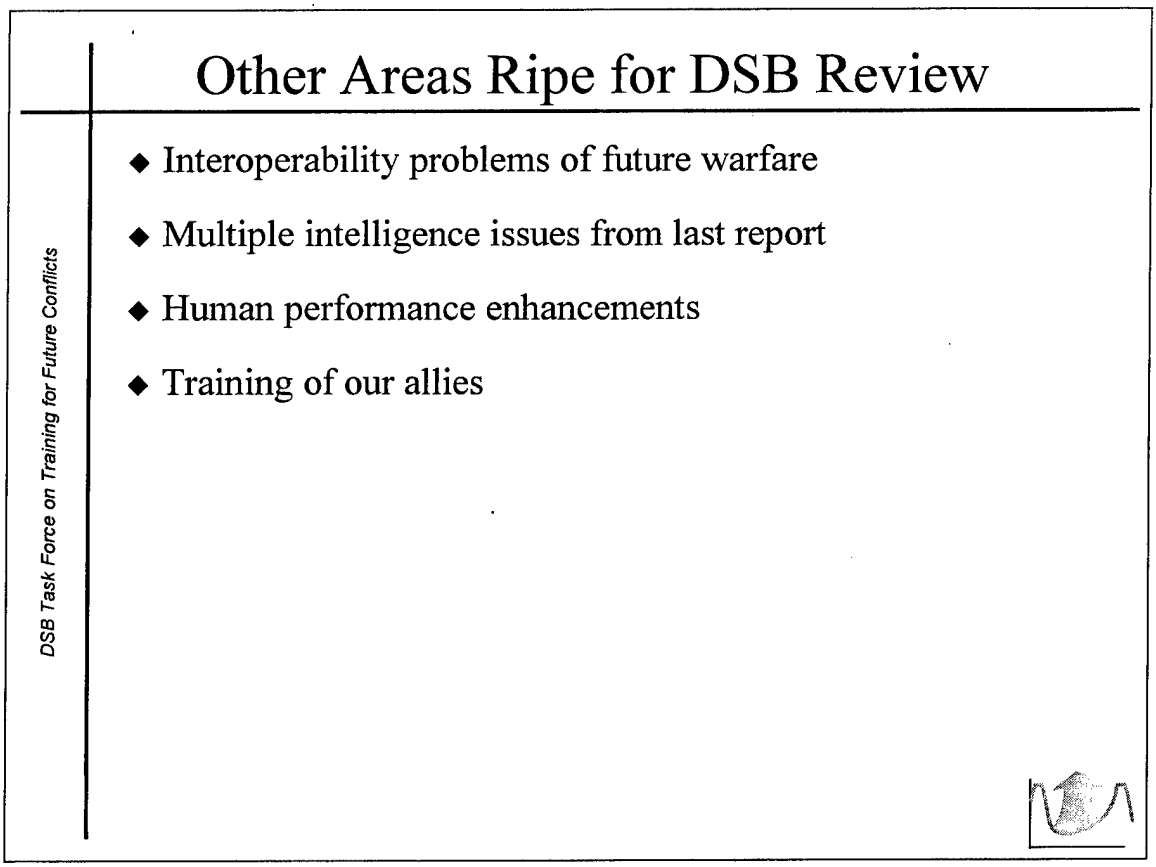
IF, AS WE PREDICT, a fair portion of the future conflicts our military will encounter will take place in unexpected areas where the language and culture is unfamiliar, then we should seek to identify the new training needs that will arise. We recommend that a few standing teams be established and charged with the task of determining what we will need to train ourselves, what we will need to train our new allies, and what they can teach us. The teams should also prepare to distribute the initial training as a conflict develops.

Making changes to the military personnel system will not be easy. Each service process is steeped in tradition and even minor alterations could have a substantial impact in individuals' careers. We do not claim to know how to reform the Services' personnel systems, or if the unintended consequences of such reforms would be worse than the status quo, but we would be remiss not to emphasize that personnel policies have a huge influence on both the instantaneous and average readiness of our forces. Our training systems pay for the damage that the personnel systems inflict. The bother to benefit ratio should be explored. We recommend that USD(P&R) explore the trades and report their conclusions to the Secretary of Defence within a year.

Lastly, we recommend that the DSB continue the process, begun 4 years ago, to raise training awareness to the level enjoyed by its Title 10 companions,

"man and equip." USD(P&R)'s current interest is in how to create and sustain a Joint National Training Capability and he believes that DSB involvement will help in the process. We agree. Our military needs to create a true *national* training capability and our recommendations on a Virtual Training Environments ACTD and on home-station training would support such a capability.

Finally, we believe that *any* continued DSB efforts in training will have the salubrious effect of keeping high-level focus on how training can improve warfare readiness, or how failure to consider training can materially degrade proficiency.



In the process of poking into training deficiencies and potentials, we found several other areas that require top-level review.

A PROMINENT FEATURE of the Afghan campaign of 2001/2002 was how dependent forces of one Service were upon services provided by the others. Army special forces on the ground used Army systems to call in air strikes from Navy aircraft which were refueled by Air Force tankers. Our allies on the ground used commercial satellite telephones to talk among themselves and commercial hand-held radios to interfere with enemy communications. Donkeys and John Deere mini-tractors were used to haul material dropped in under Army parachutes from Air Force aircraft. The Army, which defines position by grid squares, must call in air strikes from the Air Force, which uses degrees and decimals of degrees, or the Navy which uses degrees, minutes, and seconds.

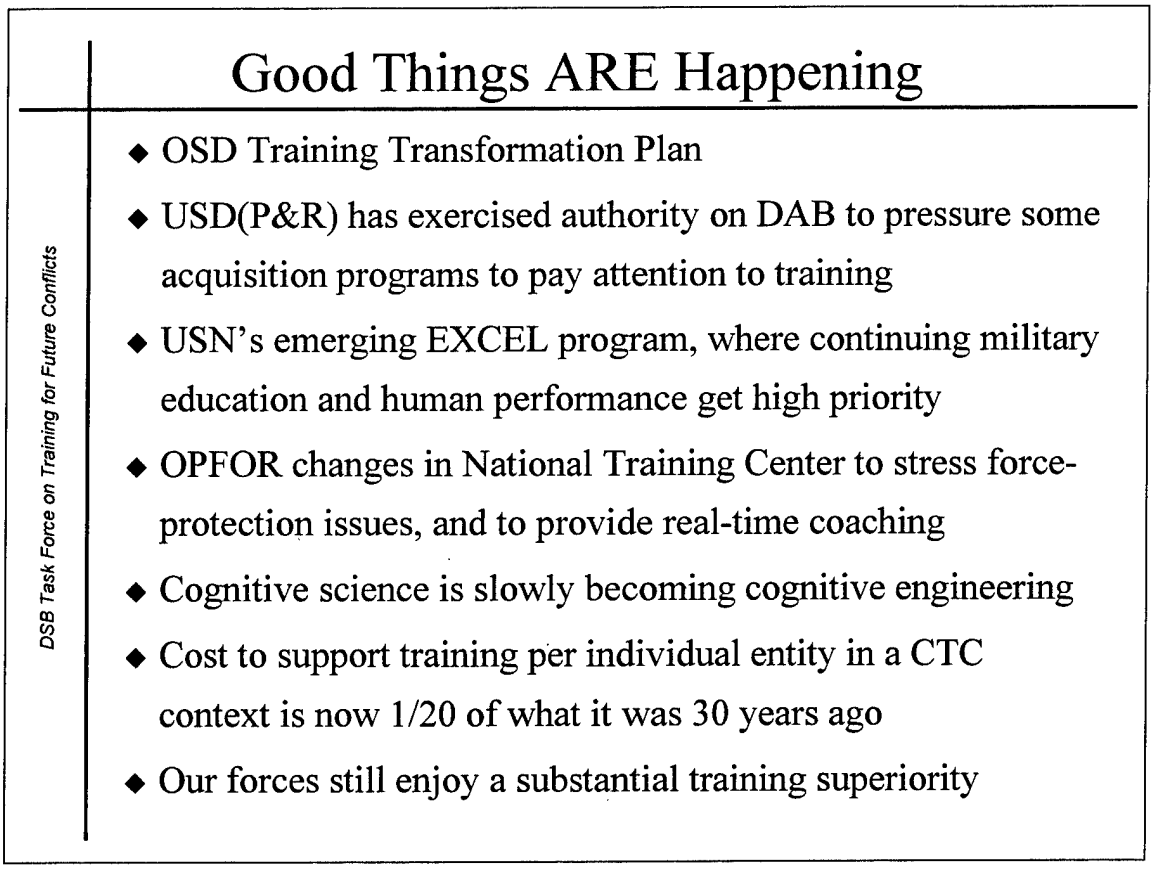
Making systems that were designed and deployed in isolation work together within a Service is almost impossible. Cross-Service or cross-nation interoperability is a huge and growing problem, and technology advances have, at least up to today, made things not easier, but more complicated and fragile. The problems would benefit from a global review.

In our last report we pointed out that dependence upon IQ-based selection tests wastes a great deal of human capital. Other reliable, repeatable measures have been shown to correlate to human success as well as or better than IQ. In one theory, developed by Sternberg, three measures were defined: analytic, practical, and creative "intelligence." Use of these independent measures

could help us select individuals for military service and for specialty training within the services far better than our current analytic-intelligence-only approach. The potential benefits of such a selection process within and across the Services needs review.

Also largely unexplored are other kinds of human performance enhancements that don't come under the umbrella of training. This involves not just teaching better than the best teachers, but looking at what might be done to make our forces, not just all we think that they can be, but better.

Finally, the area of our charter that we slighted, only touching upon it with our combat training team recommendation, is the training of our allies and how they might train us. We missed this area and recommend that this oversight be remedied by further DSB work.



We still enjoy the training superiority that won our first war in Iraq in only 100 hours of ground operations. In 2001 we sent a handful of superbly trained forces into a completely different kind of war and succeeded there as well. The success in the 2003 Iraq war is becoming apparent as we complete this report. We offer these words in the hope that they may help contribute to making our warriors as well prepared to win future conflicts.

OUR MILITARY has a training superiority that is just as powerful as our technological superiority. Moreover, some recent changes raise hope that we will continue to enjoy it. We list a few of those in this chart.

An increased emphasis on training at the top levels may be opening the policy path to a real training transformation. Equally encouraging is USD(P&R)'s use of his new position on the Defense Acquisition Board to pressure for fielding training subsystems synchronously with hardware and also for reducing the practice of using training resources to pay for acquisition errors.

The Navy emphasis on continuing professional education and human performance is also exciting. Like most revolutions it will be hard to implement in a large organization. We look forward to its success.

We also commend changes at the National Training Center to create a contemporary operational environment.

In the last year some of us have noted, particularly in creating DARPA's DARWARS program, that cognitive science, which used to be primarily an area of research, is beginning to be applied to practical problems. We are at the early stages of this transformation, and may be deluding ourselves in the hubris of the start of a new endeavor. We hope not.

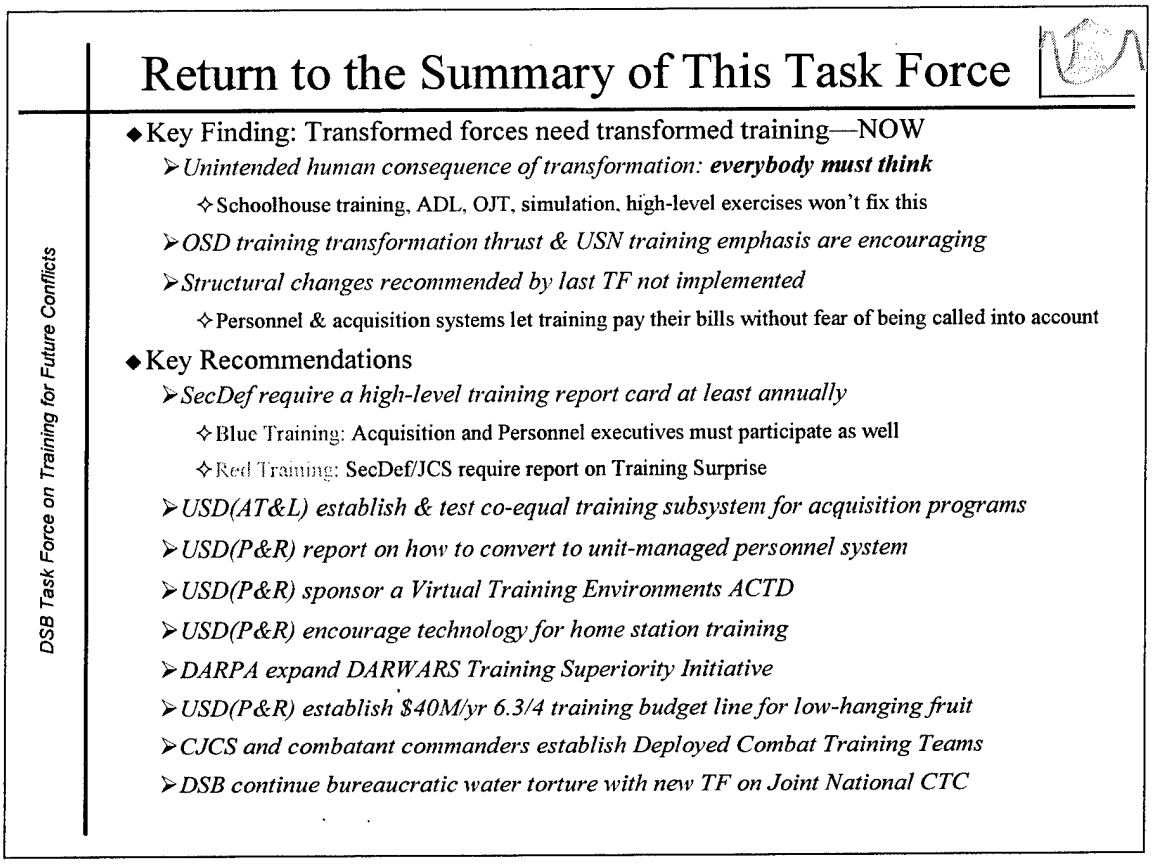
We proudly present some actual numbers in this chart's bullet about costs. We dwell on them here because they go directly to the heart of the affordability challenge.

In achieving the first training transformation—the creation of fixed combat training centers in the 1970s—three hardware items were particularly costly: (1) position location, timing, and event instrumentation; (2) data control and safety networks; and (3) the information management and display capabilities to support the AAR process. The highest cost items, however, were the people that stood behind the hardware. These included government, military, and civilians support (usually technical and software) personnel.Today improvements in cost-performance of hardware and software have dramatically reduced people support costs. In the 1970s, instrumentation was expensive. Position location was accomplished with many towers and radio multi-lateration. Processing and system-unique network hardware and systems to keep everything synchronized cost even more. In 1975 the Army hardware and software costs per instrumented entity approached $500,000. In mid-1990s constant dollars, this would amount to about $1.5 million.

Today GPS can provide positive location and timing. Cellular phones and their transceiver-on-a-chip technology have driven down communications and data link costs by more than an order of magnitude. Processing costs have dropped by five orders of magnitude. Moreover, these items are now embedded into the platforms vice appliquéd, and their reliability drastically reduces support and support-manpower costs.

By the end of the 1980s, a complete instrumentation package cost $50,000 per entity. This in turn reduced the support and personnel costs by a factor of two or more. The late 1990s, ACMI pods took us further.

Costs for CTC-like training are a much less significant issue today than in the past, but beware: the benefits may accrue both to our forces and to those of potential enemies.



Success in conflict is the goal. Training contributes substantially to this goal. It is approached mostly in isolation from the other contributing factors: hardware performance, personnel policies, and operational procedures. As the nature of the conflicts we will fight changes, we can not afford to let each area transform without reference to the others.

THIS CHART IS THE SAME summary we used at the beginning. The following words are different.

Training superiority, created by the Combat Training Center process, was a revolution in creating warfare proficiency. It remains a uniquely American phenomenon. It is ours to lose and for others, at our peril, to gain. We currently only use it for some of our forces and only some of the time.

Our task force's principal finding is that there may be ways to maintain CTC-level proficiency continuously. This may be accomplished by making changes to the personnel system, by electronically exporting the cognitive aspects of the CTC experience as envisioned in the DARPA initiative, and by moving training toward the unit and away from residential sites. The funded initiative to create a Joint National Training Capability will also help, but a number of problems will have to be addressed to prevent it from creating the same uneven readiness over time that current fixed CTCs create.

We also find that the nature of future conflicts, or at least our current operational and technological answer to future conflicts, will require continuous high cognitive proficiency from our warriors. To develop ways to achieve this we must fund and support training research and development at higher levels than we do now. The results are likely to pay for themselves quickly, not only in hard-to-measure proficiency gains, but in re-

duced training and training support costs.

Changes within the traditional (diffuse) boundaries of military training establishments will not be enough. The transformation of tactics and hardware must no longer be made with minimal consideration of their effect upon the humans who will have to deal with them.

The same applies to personnel policies. Key to making this happen is institutionalizing some form of top-level attention. The recommended training report cards should help. We hope that a continued DSB focus on training will help, too.

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THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

21 SEP 2001

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference- Defense Science Board Task Force on Training for Future Conflicts

You are requested to form a Defense Science Board (DSB) Task Force to identify new training methodologies and techniques that ensure U.S. forces can achieve the capabilities envisioned in Joint Vision 2010/2020.

U.S. forces are expected to fight future conflicts in revolutionary new ways. If they are to achieve the capabilities envisioned in Joint Vision 2010/2020, they will need to be trained in new ways. Your Task Force should identify the training approaches and technologies that can bring our military into this new warfighting era. You should recommend actions for our forces and the acquisition community that will foster those training changes you highlight.

Particular attention should be given to several aspects of this exploration. The first is to identify and characterize what education and training is demanded by JV 2010/2020 but which is markedly different from what is being done today. Next the study should address the development and demonstration time phasing over the next two decades for the combined triad of:

- technology modernization;
- operational concepts;
- training.

A time-phased building block approach should be described which addresses both U.S. and allied forces vis-à-vis new and legacy equipment requirements.

The Task Force should give emphasis to joint and interoperability training and experimentation -- training as we fight. It should also address issues raised in the Quadrennial Defense Review as these apply to training for future conflicts. In addressing solutions to problems and related recommendations, incentives should be identified where appropriate.

In addition to the areas cited above, the Task Force should expand its efforts to identify those approaches and techniques that potential enemies might take that could

prepare them to revolutionize their warfare capabilities, thereby achieving a training surprise against the U.S. or its allies. This expansion should include, but not be limited to, unique training/education developments which might be spawned by allies or an adversary, training techniques and methodologies which might be transferred from the U.S. or through third parties, and finally the possibilities emerging as a result of the globalization of military and information technologies, related commercial services and their application by other nations.

The Task Force should produce a final report by July 2002.

The Study will be sponsored by the USD (AT&L). Dr. Joe Braddock and Dr. Ralph Chatham will serve as co-chairmen of the Task Force. Mike Parmentier, Director for Readiness and Training in OUSD(P&R), will serve as Executive Secretary, and Dan Gardner will be his staff focal point for the Task Force. Maj Roger Basl, USAF, will serve as the Defense Science Board Secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

E. C. Aldridge, Jr.

Appendix 2

Membership

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Membership

Co-Chairmen:
Dr. Joseph Braddock
Dr. Ralph Chatham

Members:

Mr. Paul Chatelier
Dr. John Christie
Mr. Neale Cosby
LTG William Etnyre, USMC (Ret)
Dr. Dexter Fletcher
LTG Paul Funk, USA (Ret)
VADM Lee Gunn, USN (Ret)
LTG William Hilsman, USA (Ret)
GEN Paul Gorman, USA (Ret)
Dr. Sung Lee
RADM Fred Lewis, USN (Ret)
Mr. Richard Lindhiem
GEN John Loh, USAF (Ret)
Dr. Joe Markowitz
Dr. Warren Morrison
Dr. Harry O'Neil
MG. George Steiner, USA (Ret)
GEN John W. Vessey, USA (Ret)
Dr. Gershon Weltman

Government Advisors:
Mr. Clyde Owan, NIC
Dr. Jerome Smith
Dr. Sandra Wetzel-Smith
Capt Art Gallo, USN

Executive Secretary:
Mr. Daniel Gardner, USD(P&R)
Mr. Michael Parmentier, USD(P&R)

Defense Science Board Secretariat:
LtCol Roger Basl, USAF

SAIC Support:
Richard Balzano
Mark Mateski
Cara Sievers

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Appendix 3

Briefings and Visits

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Briefings and Visits

JCS	
• JV2020	BG Bundy, Deputy J-7 Col Rankin, J-7
Air Force	
• Expeditionary Air Force	MG Buchanan
• Distributed Mission Training	BG Morehouse
• Air Operation Center as a Weapon System	BG Morehouse
Army	
• Army Battle Command System Training	LTG (Ret) Hilsman
• Army Transformation Foundation & Objective Force Concepts	Col (P) Combest, TRADOC
• Transforming Professional Military Training	BG Brown, TRADOC-DCST
Navy and Marine Corps	
• Review of Navy Training	VADM (Ret) Gunn
• Future Naval Operations	VADM Cebrowski
• Future USMC Concepts	Lt.Col. Hibbert, MCCDC
• Future Training & Education Concepts	Lt.Col.Brandl, TECOM
• Future Training Technologies	Dr. Bailey, TECOM
National Guard	
• Programs & Issues	LTG (Ret) Hilsman
• New York Nattional Guard Civil Support Teams	LTC Domenici, New York Nat'l Guard
• JANUS-Based Collective Training Scenarios	Maj. Minchin, New Jersey Nat'l Guard
OSD	
• Perspectives on Readiness & Training	Dr. Mayberry, DUSD(Readiness)
• Advanced Distributed Learning and QDR Implications	Mr. Parmentier, ODUSD/R&T,PP
• DMSO Initiatives	Capt. Lilienthal
Operation Enduring Freedom	MG (Ret) Jenkins
Afghanistan Operations	Capt. Nutschu
JFCOM	
• Perspectives on Future Training	Mr. Moore, JFCOM
• Transforming Joint Training	Mr. Woods, JFCOM, J-7
Logistics Community	
• Future Concepts	MG Kelly, J-4 R&D Division
• DLA Past, Present and Future	Christine Gallo, DLA
Transportation Community	
• Future Concepts	LTG Brown, USA, TRANSCOM DCINC

Future Operations and Training	
• Future Operations and Training	Dr. Krepinevich, CSBA
• Future Training	GEN (Ret) Hartzog
• Training (T2) Strategic Plan	Mr. Parmentier, ODUSD/R&T,PP
Intelligence Community	
• Intel Community Training and Initiatives	Mr. Wagner, CIA
• Global Trends	MG (Ret) Landry, NIO
• Training Surprise	Mr. Neary, DIA
• China's Aviation	LCDR Overbaugh, USN (NMIC)
• Update on China and "Training Surprise"	MG (Ret) Landry, NIO
Mission Capable Readiness System	
• Capability Based Readiness and PERSTEMPO Research	Mr. Christie, IDA Mr. Tilson, IDA
Wargaming	Mr. Willis, DARPA
Interoperability	RADM (Ret) Walsh
Distributed Mission Training Update	Mr. Gardner, ODUSD(R)R&T,PP
DARPA	
• Propose Training - Superiority PGM	Dr. Chatham, DARPA
Technology Innovations	
• Joint Cognitive Ability and Readiness Management & Analysis	LTC Morris
• Leadership Research Issues	LTG (Ret) Miller, Oracle Defense Operations
• ICT Initiatives	Mr. Lindheim, Institute for Creative Technology
• Recent Findings on Distance Learning	Dr. Wisher, Army Research Institute
• Manprint	Dr. Keesee, Army Research Laboratory
• Virtual At Sea Training	Mr. Scherr, ONR
• JTRS, FCS, WIN-T and GUARD Net	LTG (Ret) Hilsman
• Army Transformation Initiatives	COL (Ret) Reddy
• Intelligent Tutoring	Dr. Van Lehn, University of Pittsburgh
• Adaptive Behavior Systems	Mr. Horvitz, Microsoft Research
• JSIMS Status	BG Seay
• Homeland Security Training	MG Cortright (Oklahoma TAG)
• JFCOM Homeland Security Civil Support	COL Sick, JFCOM
• Rules of Engagement Study	Dr. Knarr, IDA Mr. Cosby, IDA Mr. Johnson, IDA Capt. Nutsch
• Precision Targeting "2001 DSB Summer Study"	Capt. McNarg , OSD Mr. Kuhn, DTI

Visits

- **ADL Co-Lab Tour** (Alexandria, VA)
- **Iowa NG Tech Center** (Camp Dodge, IA)
- **Institute for Creative Technology** (L.A. CA)
- **Air Force Research Laboratory**, Warfighter Training Research Division (Williams AFB Mesa, AZ)

  - AF Distributed Mission Trainer
  - AH-64 and RPA Distributed Mission Trainer

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Appendix 4

Acronyms

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Acronyms

AAR	After Action Review
ACMI	Air Combat Maneuvering Instrumentation
ACTD	Advanced Concept Technology Demonstration
ADL	Advanced Distributed Learning
AF	Air Force
AH-64	Apache twin-engine, four bladed, multi-mission attack helicopter
APOD	Aerial Port of Debarkation
ARCI	Acoustic Rapid COTS (commercial off-the-shelf) Insertion
ARPANET	Advanced Research Projects Agency Network
ASD	Assistant Secretary of Defense
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CCTT	Close Combat Tactical Trainer
CDR	Commander
CIA	Central Intelligence Agency
CINC	Commander in Chief
CJCS	Chairman Joint Chiefs of Staff
COTS	Commercial Off the Shelf
CSBA	Center for Strategic Budgetary Assessment
CTC	Combat Training Center
DAB	Defense Acquisition Board
DARPA	Defense Advanced Research Project Agency
DARWARS	DARPA's Universal Persistent On-Demand Training Project
DEPSECDEF	Deputy Secretary of Defense
DIA	Defense Intelligence Agency
DIMHRS	Defense Integrated Military Human Resources System
DLA	Defense Logistics Agency
DMSO	Defense Modeling and Simulation Office
DMT	Distributed Mission Training
DOD	Department of Defense
DTI	Directed Technologies Inc.

DUSD	Deputy Under Secretary of Defense
DVTE	Distributed Virtual Training Environment
ELINT	Electronic Intelligence
EXCEL	Naval Task Force for Excellence through Commitment to Education and Learning
FAA	Federal Aviation Administration
FCS	Future Combat System
GIG	Global Information Grid
GPS	Global Positioning System
ICT	Institute for Creative Technology
IDA	Institute for Defense Analyses
IMAT	Interactive Multi-Analysis Trainer
IQ	Intelligence Quotient (Analytical Intelligence)
ISR	Intelligence, Surveillance, and Reconnaissance
JANUS	Joint Army Navy Uniform Simulation
JCS	Joint Chiefs of Staff
JFCOM	Joint Forces Command
JSIMS	Joint Simulation System
JTRS	Joint Tactical Radio System
JV2020	Joint Vision 2020
KPP	Key Performance Parameter
LHD 7	USS Iwo Jima; WASP-class Amphibious Assault Ship
MCCDC	Marine Corps Combat Development Command
MTI	Moving Target Identification
NIO	National Intel Office
NMIC	National Military Intelligence Center
OAV	Organic Air Vehicle
OC	Operational Capability
OEF	Operation Enduring Freedom
OJT	On-the-Job Training
ONR	Office of Naval Research
OPFOR	Opposing Force
OSD	Office of the Secretary of Defense
PERSTEMPO	Personnel Tempo (time an individual spends away from home station)
QDR	Quality Deficiency Report
R&D	Research and Development
ROE	Rules of Engagement

RPA	Reserve Personnel, Army
RSOI	Reception, Staging, Onward Movement, and Integration
SAR	Synthetic Aperture Radar
SECDEF	Secretary of Defense
SIMNET	Large Scale Interactive Simulator Networking; Simulation Network
SPOD	Seaport of Debarkation
TF	Task Force
TRADOC	United States Army Training and Doctrine Command
UAE	United Arab Emirates
UAV	Unmanned Aerial Vehicle
UCAR	Uninhabited Combat Rotocraft
UCAV	Uninhabited Combat Air Vehicle
US	United States
USA	United States Army
USAF	United States Air Force
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
USD (P&R)	Under Secretary of Defense for Personnel and Readiness
USMC	United States Marine Corps
VAST	Virtual At Sea Training
WIN-T	Warrior Information Network-Tactical