SYNTHESIZED ENVIRONMENT:

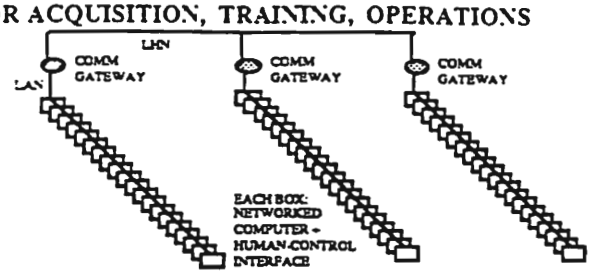
A

STRATEGICALLY UNIFYING

ADVANCED TECHNOLOGY

1

SYNTHESIZED ENVIRONMENT
FOR ACQUISITION, TRAINING, OPERATIONS



- For some purposes in acquisition, training or operations, the human-control interface might emulate a vehicle with controls exactly like those of the system represented.
- For certain purposes, the human-control interface might be (1) personal instrumentation to allow the computer to sense physical movements, and (2) an emulation of a man-portable system component, e.g., binoculars for an artillery forward observer or infantry scout, a MANPAD, a LAW, or a dismounted HAW.
- For other purposes the human-control interface might eschew emulation, and consist of straight-forward audio-visual stimuli and manipulating devices. This genre of interface could be located remote from processor, and could, via the processor and the network, exert control in still other locations.

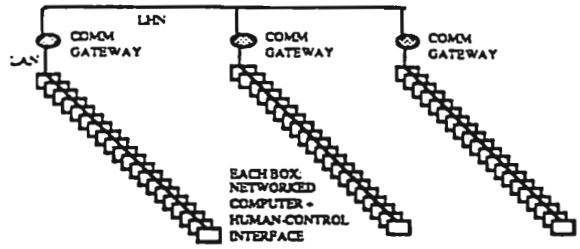
2

The 1985-1989 demonstration of networked simulators, at the SIMNET facilities at Fort Knox and in Germany, successfully proved the concept in principle.

But SIMNET has misled many into believing that the technology applies ONLY to vehicles, and that its cost-effectiveness is related mainly to it ability to stand-in for high-cost mechanisms such as armored fighting vehicles or aircraft.

The technology is much more powerful than that!

SYNTHESIZED ENVIRONMENT
FOR TRANSPOSITION



- **VEHICULAR TRANSPOSITION**
  Enable humans manning a vehicular simulator to interact with (1) the simulator itself; (2) the environment itself, e.g., a digital depiction of battlefield terrain, vegetation, cultural artifacts, friendly and enemy vehcicles, and other perceptual features; all other simulated vehicles for purposes of cooperation, or Virtual Tactical Engagement Simulation, as in SIMNET.

- **INDIVIDUAL TRANSPOSITION**
  Form a portal into a synthetic environment for one person by which he is enabled to interact with vehicles and individuals therein.

- **SCALAR TRANSPOSITION**
  Project controlling human(s) into a microcosm or macrocosm, e.g., molecular manipulation (UNC), telerobotic control of large machines in space (N ASA).

3

The power of the technology rests in no small measure on its ability to conquer geography and to enable common experiences among individuals or teams separated by even intercontinental distances.

The term "transposition" conveys the notion of transporting people into a common environment so that they can experiment, train, or operate together. There the technology makes it possible to observe and record their behavior for subsequent analyses or learning.

Transpositioning is particularly important for military forces, since their inherent geographic distribution in peacetime is dysfunctional for readiness for war.

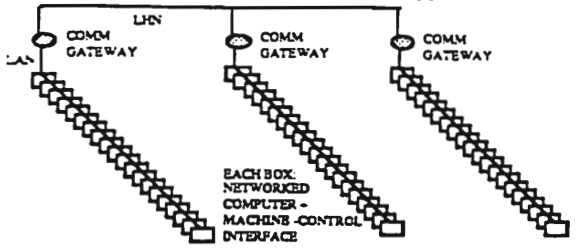
It is also true that military forces have special requirements for transpositioning humans into hostile environments to experiment, train, or operate, whether the hostile environment be a lethal battlefield, or the deep undersea, or outer space.

The term also captures the concept of transfering humans into environments removed in scale: environments in which the principal objects are very much smaller than they deal with day to day, or very much larger.

All of this transpositioning is possible using the same computer architecture and protocols demonstrated in SIMNET.

If the Army but realized it, it made a great buy with its SIMNET investment!

SYNTHESIZED ENVIRONMENT
FOR BEHAVIORAL OBSERVATION



- The recent OSD Simulation Policy Study found that improvments in models and simulations should be predicated on observed behavior of combatants in actual warfare or its closest approximation, Subsistent Tactical Engagement Simulation (TES), such as TOP GUN, RED FLAG, and NTC. SIMNET/CCTT is Virtual TES.

- TES requires all the capacity for "tracking" individual fighting entities within a battle-environment demonstrated in SIMNET. Presently, Subsistent TES works with obsolecent instrumentation, but a technology transfer from SIMNET offers (1) significantly richer data; (2) higher cost-effectiveness; (3) much faster, smoother acquisition that present program could provide; and (4) cost-avoidance which would more than offset the R&D entailed in the technology transfer. Most importantly, SIMNET-like TES instrumentation would enable SEAMLESS SIMULATION--composite synthetic environments for acquisition, training or operations.

4

The most important and urgent application of the technology for training and operations is to modernize Subsistent TES, which is plagued by obsolete means for observing tactical behavior (e.g., most records are analogue, not digital), and by commitments to upgrades which are expensive, ineffective, and uncoordinated (e.g., hardware scheduled soon to be delivered with no provision for software amendments to accomodate same).

The upgrade of M&S is a matter of direct Congressional interest (e.g., Mr. Hamre from SASC), one for which Congress set aside $75 million in FY 91, and on which OSD has yet to act.

The SPS recommended that OSD spend 60% of any money received from Congress on:

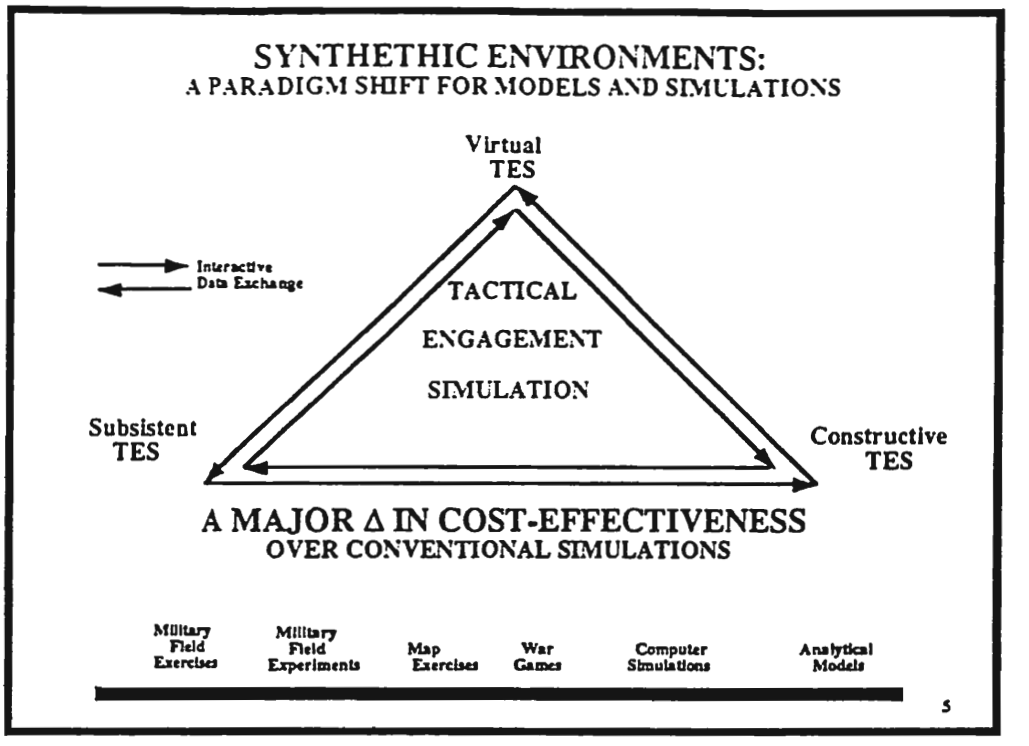
- **TES-supported joint exercises in strategic force projection.**

- **Converting the separate service TES facilities in the SW USA into a synthetic environment for joint operations: a model Theater of War under a unified commander, with USN, USMC, USAF and USA elements all operating therein.**

That recommendation appears particularly timely in the aftermath of the victory in SWA, and the consequent receptivity in Congress for proposals for sustaining the fighting edge of the armed forces despite their being reduced in size.

- **Acting on that recommendation entails extending the SIMNET architecture to encompass Subsistent as well as Virtual TES, making possible realistic portrayal of large, projected joint task forces, and large arrays of enemy forces., in SEAMLESS SIMULATION (slide 7).**

- **Moreover, data from the SW USA Theater of War could be used to inform models for Constructive TES (next slide).**



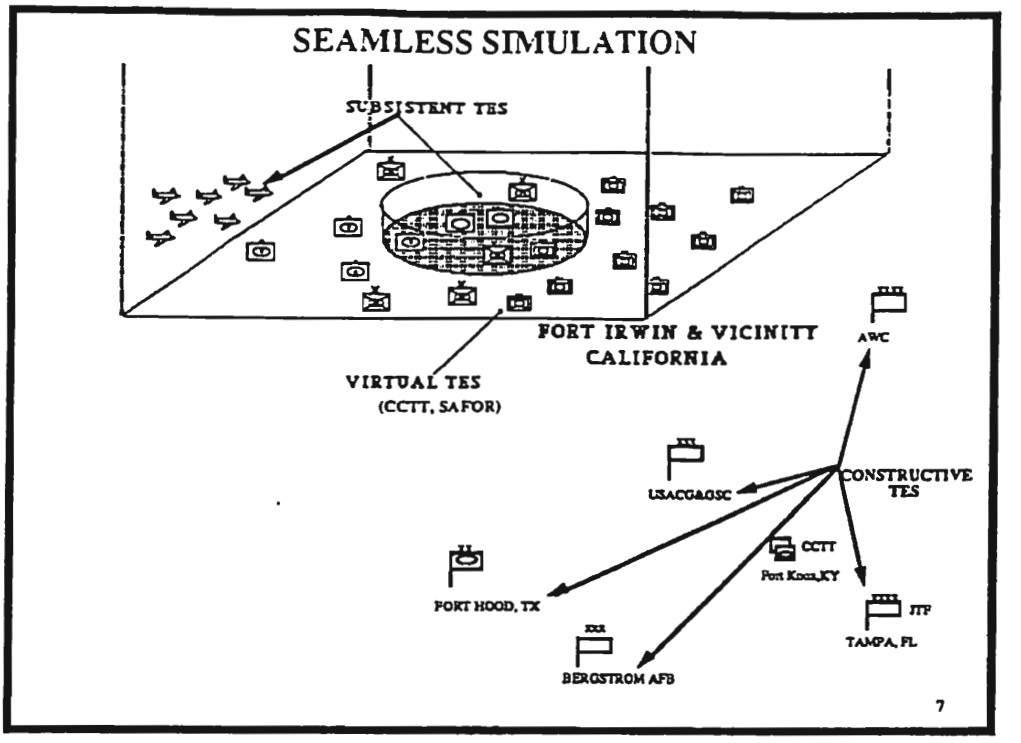
TES has been proven, properly practiced, to be an extremely powerful training technology. SIMNET was **virtual TES**, and has demonstrated that it can support TES in land, sea, and air environments.

Ahead lies the application of sensing networked processors to **subsistent TES**, especially in the TES sistes of SW USA.

But note that this technology can and should complement or replace such forms of training as CPX, TEWT, CFX, MAPEX, and the like.

Moreover, since both **virtual TES** and **subsistent TES** can be a rich source of digitally -describ information on the behavior of warriors in high stress situations approximating combat, they are a uniquely valuable source of information for constructing computer-models of battle -**constructive TES**- that can be employed for semi-automated forces, leader development, training in battle-staff integration, operational analyses, plan rehearsal, and analyses related to acquisition.

It is possible to employ interactively **virtual, subsistent, and constructive TES** so that the formats would be transparent to participants, a seamless simulation of battle involving forces of all the armed forces, operating under a <u>unified command in a theater of war</u>.



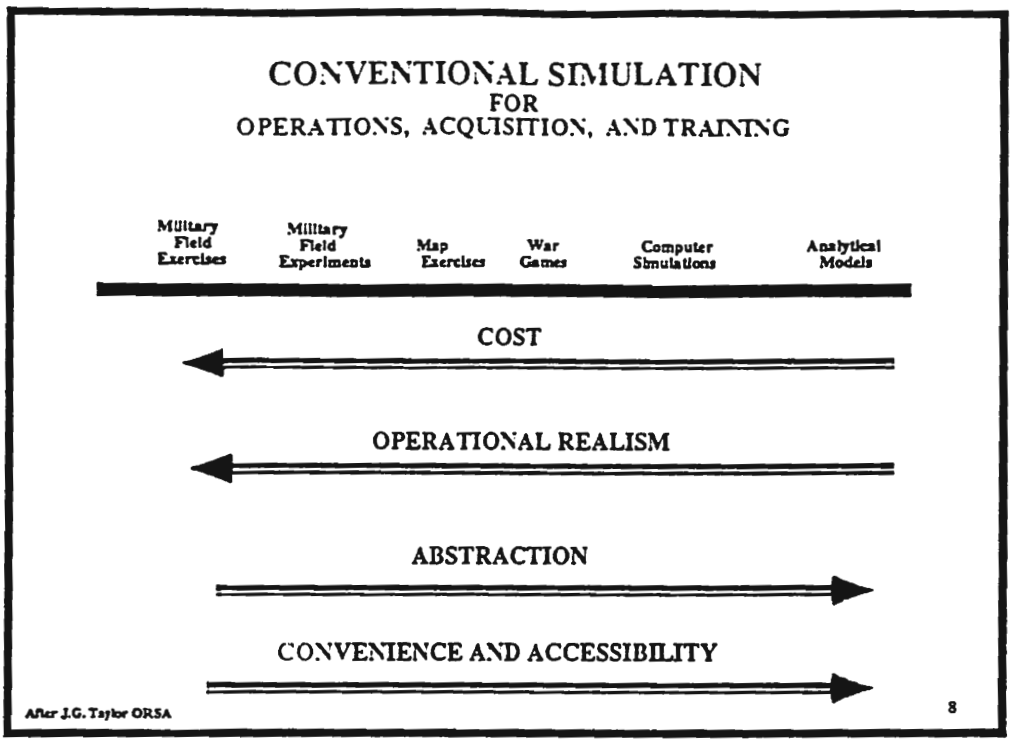
The sketch portrays a real place, Fort Irwin, CA and its environs, within which there are functioning thousands of networked computers.

Some of these are mounted on real armored fighting vehicles, air defense weapons, and other weapon systems involved in **Subsistent Tactical Engagement Simulation**. Some are on dismounted combatants, similarly involved in TES. In these applications, each functions much like a computer in SIMNET, except that it takes inputs not from the driver's foot pressure on the accelerator or the brake, or from the gunner's hand pressures as he lays the gun, but from sensors which ascertain where it is located, and how the entity to which it is attached is behaving. Like the computer in SIMNET, it send messages on change of state to the network.

A distributed computing architecture should be much superior to the central processor-based instrumentation now in use, updating much more frequently, and providing far more precise information.

But the environment is also "populated" by entities not actually present, Two units are on CCTT simulators at Fort Knox. Others are units whose location and activity is controlled and reported through Semi-Automated Forces, SAFOR. Some friendly, some enemy, these units lend to the battle realistic breadth and depth now quite absent, and furnish to particularly sentient participants, such as the flight of CAS aircraft just entering the environment's air space, positional and tactical cues they would otherwise be denied. The distributed network faithfully reports and displays these stimuli at the right time and place, via the appropriate communication mechanism: radar, IR viewer, HUD, etc. This is **Virtual TES.**

But the units within the environment are responsive to C3I exercised from afar. The diagram illustrates this point with the command post symbols for a division in Texas, a corps headquarters at Fort Leavenworth, a field army headquarters at Carlisle Barracks, and a JTF headquarters at Tampa, Florida. These elements fight their war informed not only by information from the Fort Irwin & Vicinity battle-environment, but by models which portray other activities within the Theater of War. This is **Constructive TES.**

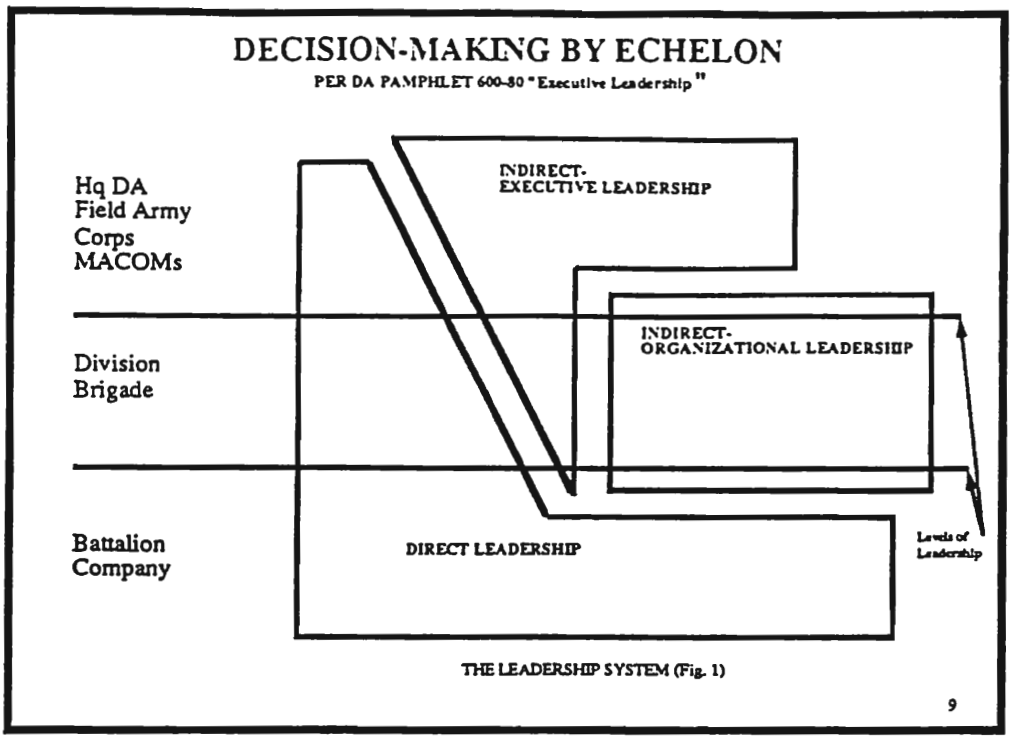


It will be difficult, if not impossible to rely upon large maneuvers or field exercises to prepare the next generation of generals and admirals.

Map exercises or war games, even when these are supported by computers, are not very useful for emulating how a large organization functioning under stress, or adapting to war-like friction and fog.

Indeed, computer simulations and analytical models, as this construct suggests, are often simply too abstract to be useful in development of senior commanders, howev well they might support procedural training of staffs.

The state of the art is procedural trainers for staffers.



Army doctrine defining the leadership appropriate for senior officers points out that:

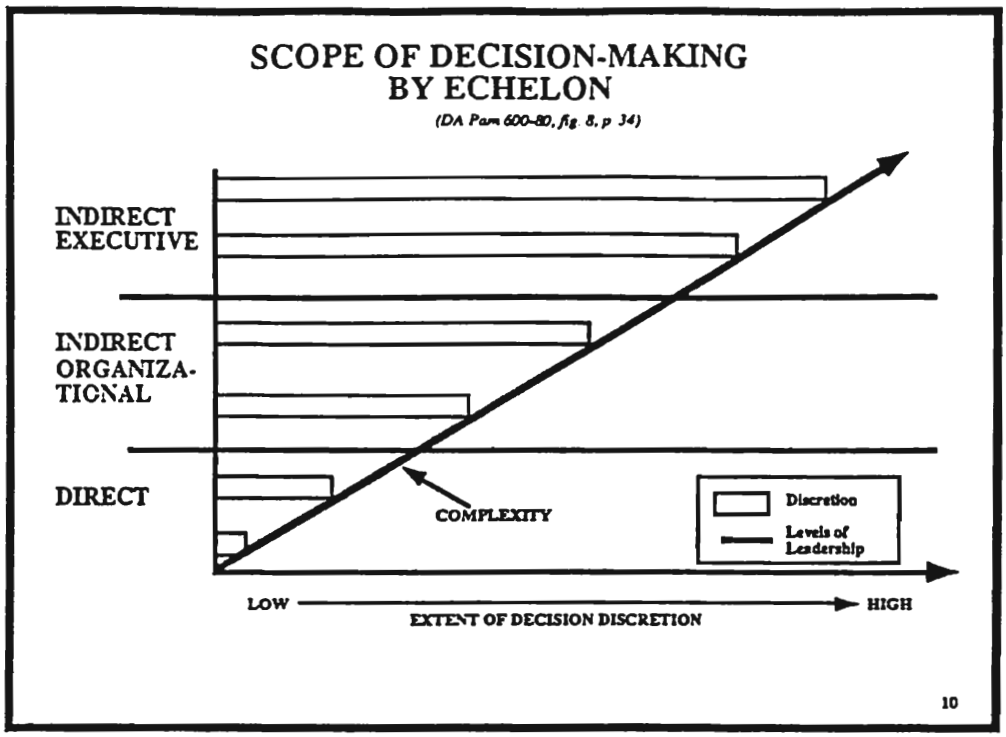
Executive leaders gain the frames of reference for decision-making as they grow in maturity, experience, and skill, over the duration of a career. They progress through three levels of leadership, each with systematic changes in the nature of leadership tasks and the associated complexity of issues involved in decision making.

In the course of this development, there is an orderly progession from simpler to more complex. Leaders first learn to lead individuals and groups of individuals in direct leadership tasks. They then learn how to exercise indirect leadership of organizations. Finally, they develop indirect skills to lead large organizations which must commiunicate effectively across cultural boundaries...

Executive leaders must evaluate the entire organization in terms of its total internal functioning and its relationship to the larger environment...A critical task for executive leadership is devising and maintaining sources of information that allow them to "sense" how their organization is performing. These systematic sources of information are the leader's "feedback loop." At the executve level, both internal and external feedback loops are requirements for effective leadership...

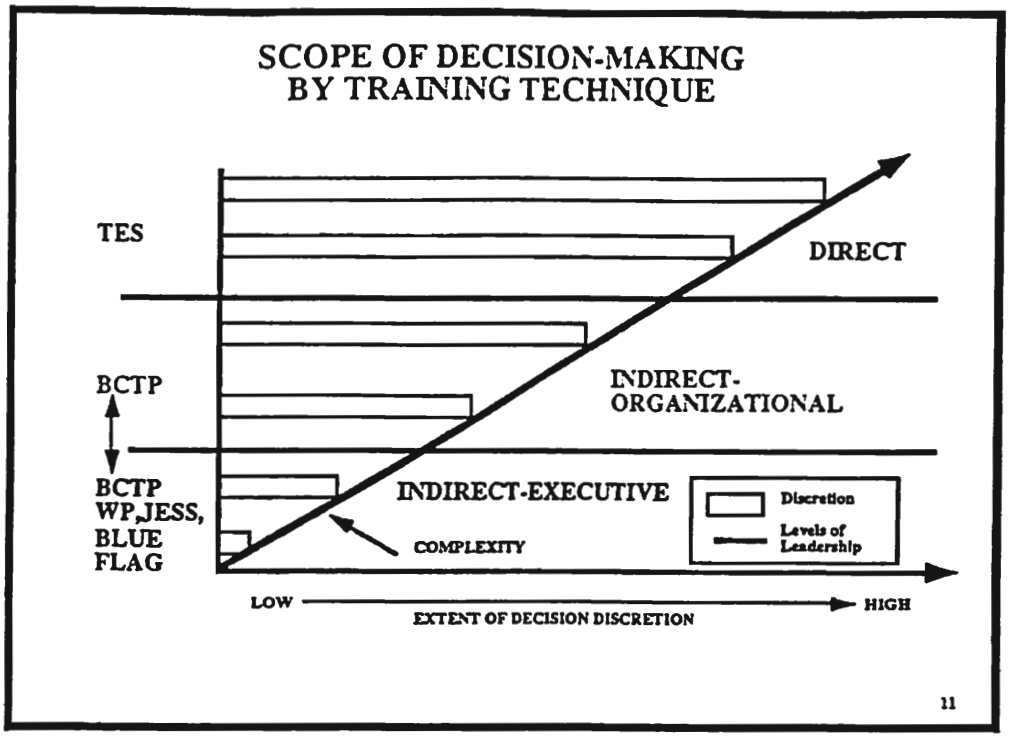
The Army has a requirement to train the next generation of its senior officers to perform as executiove leaders --strategists-- in an era of strategic uncertainty.

N.B. THE ARMY PERCEIVES THAT THERE IS AN IMPORTANT COMPONENT OF <u>DIRECT</u> LEADERSHIP AT ALL LEVELS, AND RECOGNIZES THAT AN <u>EXECUTIVE</u> LEADER MUST BE ABLE PERSONALLY TO PROBE FUNCTIONS DOWN TO BATTALIONS WITHIN HIS COMMAND.



This depiction of the differences among leadership by echelon conveys both appreciation that leaders at the executive level deal with inherently complex, long range problems as well as short term issues, and that the decisional discretion allowed leaders at the three levels varies accordingly.

Do Army's tactical training means emphasize these distinctions?



Regretably, the answer is that current Army training techniques provide **maximum** decisional discretion for the Direct Leader, and **minimum** decisional discretion for the Executive Leader.

In short, Army training technique is in an INVERSION CONDITION, which makes innovation imperative.

The Army ought to bring its training technique into congruence with the doctrine expressed in DA Pam 600-80.

How should it go about doing that?

OBSERVATIONS OF SIMULATION
EUCOM 1989-1990

1. Commanders do not lock themselves into a fixed organization level or level of conflict, but vary their attention level among echelons (levels of granularity) as the battle demands. The degree of this variable focus is a function of the commander, his experience, his personality...there is no fixed rule. It is learned, it is experimented with, it is perfected. It could be called leadership style. Therefore, battle simulation technology should not force any commander to behave unnaturally, but should rather serve to develop and extend his style.

2. Most existing battle simulations support practice with procedural skills. Yet, practice of the operational art transcends procedural tasks, and entails mastery of much more complex skills and knowledge, and development of a relevant leadership style. Therefore, the amount of practice for leaders at higher echelons is bound to be many times greater than current BSim support.

3. Therefore, continue to develop networked simulations, and design simulated environments appropriate for what is to be learned. Synchronization, integration, long range planning —the battle simulation should let commanders do what they would do in battle.

12

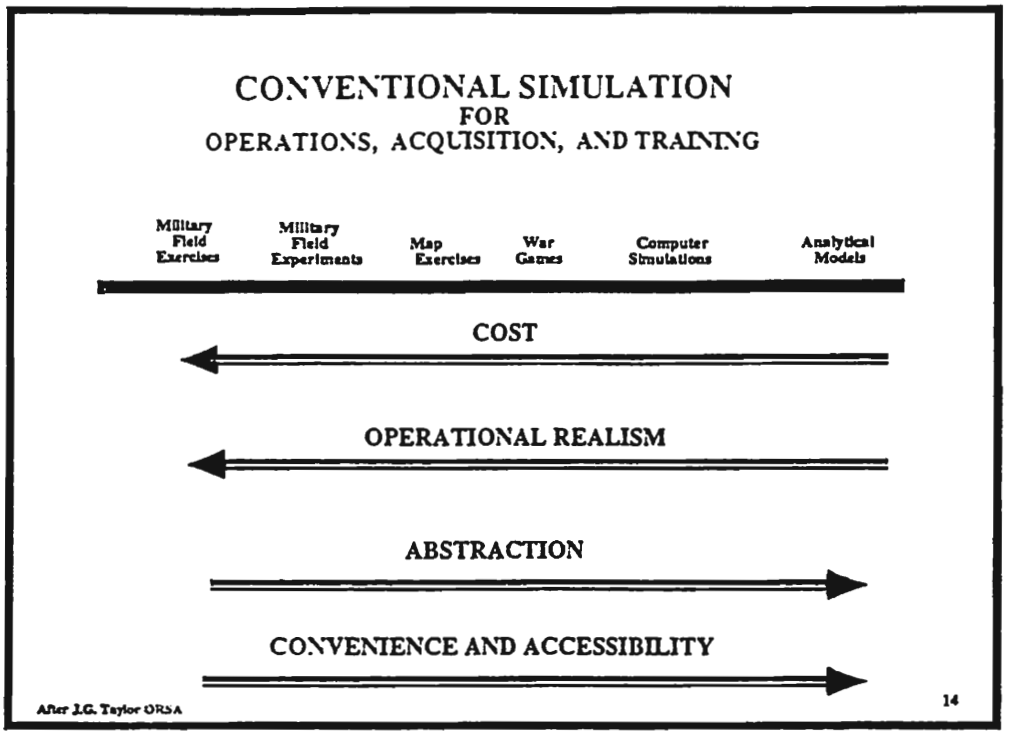
One qualified observer, not an Army officer, noted that simulations EUCOM was working with did not well support the training of higher commanders. His views are quite congruent with DA Pamphlet 600-80.

WHAT IS BEING LEARNED OR PRACTICED?

COMMAND AND STAFF PROCEDURES	Focus on proper execution of procedures, familiarization with operational style of particular units and commanders. Not free play, often scripted, or controlled to illustrate points Many mistakes, false starts Attempt to minimize use of troops as training aids
MASTERY OF WARFIGHTING SKILLS, OPERATIONAL ART	Focus on orchestration and integration Freeplay against intelligent, sentient opponent Chaotic, many mistakes Include as much of organization as possible

13

That observer held that the lower set of learning tasks and conditions are the proper design criteria for battle simulation when used to train higher commanders , or to evaluate an operation plan.



Short of actual war, the U.S. has had to raise and train forces using various forms of simulation ranging from Field Exercises with large bodies of troops, to computer models capable of analysing a specific weapon system in combat.

Conventional models and simulations suffer severe disadvantages, rendering them ineffective for an era of strategic uncertainty, rapidly advancing technology, and availability to friend and foe alike of means for targeting over vast expanses of the earth's surface and aerospace, and for striking targets precisely with devastating effectiveness over very long ranges.

E.g, it would be simply infeasible to set up field exercise, maneuvers, sufficiently extensive to stress space-based reconnaissance, or a system like J-STARS, and to evaluate accurately the capability of a joint task force to use data from such collection means to concert an air-land battle. Theater-level computer models of war that aggregate forces on both sides could only provide a crude emulation, unreliable either for training, operations, or use in making acquisition decisions.

Moreover, since conventional simulations rely principally on proving ground data on the effectiveness of materiel, or data from past wars, and rarely reflect observed behavior of serving warriors employing current materiel in combat-like circumstances, they are often unreliable for training, operations or acquisition.

<u>The entire Department of Defense needs a better approach!</u>

STRATEGICALLY UNIFYING CONCEPT

- Aware, sensing, networked processors can:
  - Create or control environments
    - --Battle-environments, e.g. SIMNET
    - --Micro-environments, e.g., HEL's exoskeleton
    - --Macro-environments, e.g., NASA's telerobot in space
  - --Enable transpositioning into and among environments
  - --Instrument tactical engagement simulation (TES)
    - *Virtual TES, e.g., CCTT
    - *Subsistent TES, e.g., CTC
    - *Constructive TES, e.g., JANUS (A)/NTC
  - --Enhance anthropogenic fidelity of battle simulations (BSim)
- Ergo, that technology can:
  - --Serve RDT&E by refining requirements, and verifying man-machine interfaces early in development
  - --Extend military medicine via virtual combat casualty care
  - --Provide common instrumentation for SWUSA "Theater"
  - --Instrument TES anywhere
  - --Support introduction of robots integral to land combat units
  - --Serve as C3I, IFF for Airland Battle

15

DARPA is faced with opportunity to offer the armed services a main-line technological intervention which can be presented to DoD, to Congress, and to the public as being **central to the new era of strategic uncertainty.**

For the first time, DARPA can offer a grouping of information systems technology with communications, tactical and strategic, that enables a wholly new range of effectiveness in research and development, test and evaluation, operations analyses, and training.

Synthesized environment offers advanced simulation. But simulation is but one form of control over humans exercised by the technology. It has been demonstrated to be effective in transpositioning humans onto virtual battlefields, or into real environments remote in scale to human experience. But it has also been shown capable of interacting with human intelligence(s) to assist or supplement psychomotor reactions for control of machinery, such as the University of Utah "ferocious arm" apparatus. Further, distributed computing networks seem inherently suited to observing or controlling distributed military forces.

In concept, at least, it should be possible to treat any combatant force as a distributed network, and monitor entities within the resultant environment just as SIMNET vehicles are monitored. That monitoring could proceed without volition, or even awareness on the part of the combatants, but could provide enormous leverage upon such difficult problems as identification of friend from foe (IFF), steering combatants away from friendly fires or mines, locating combat casualties, performing instantaneous triage, and dynamic focusing of logistic support to meet computer-perceived demand.

Here may be the long heralded convergence of simulation with C3I!!! A unit within which all combatants were equipped with one or more networked, sensing, sentient processors would make C3 easier by orders of magnitude, IFF assured, and I-dissemination vastly more efficient.

In and of itself, then, the technology illustrates **development proceeding from simulation!**

SYNTHESIZED ENVIRONMENT:

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STRATEGICALLY UNIFYING

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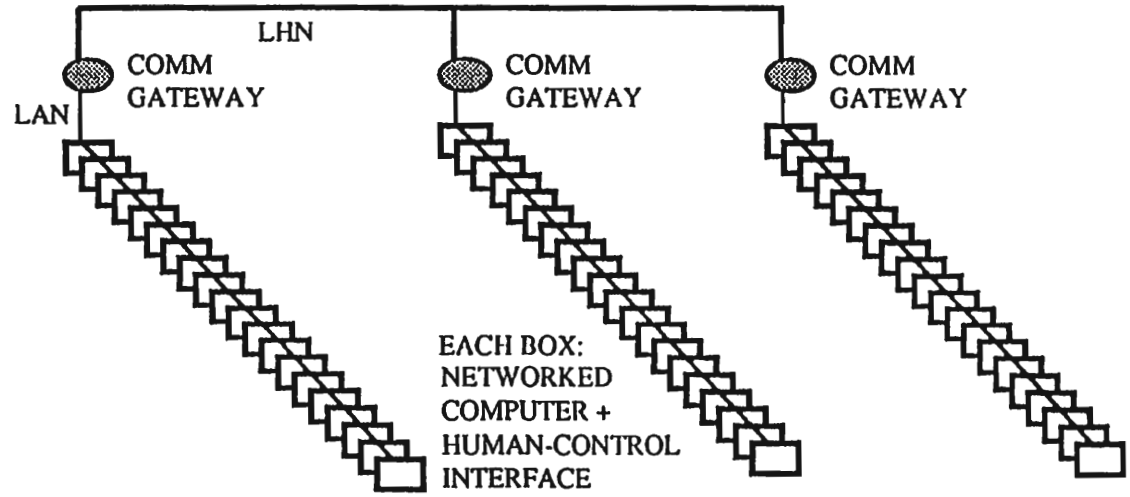

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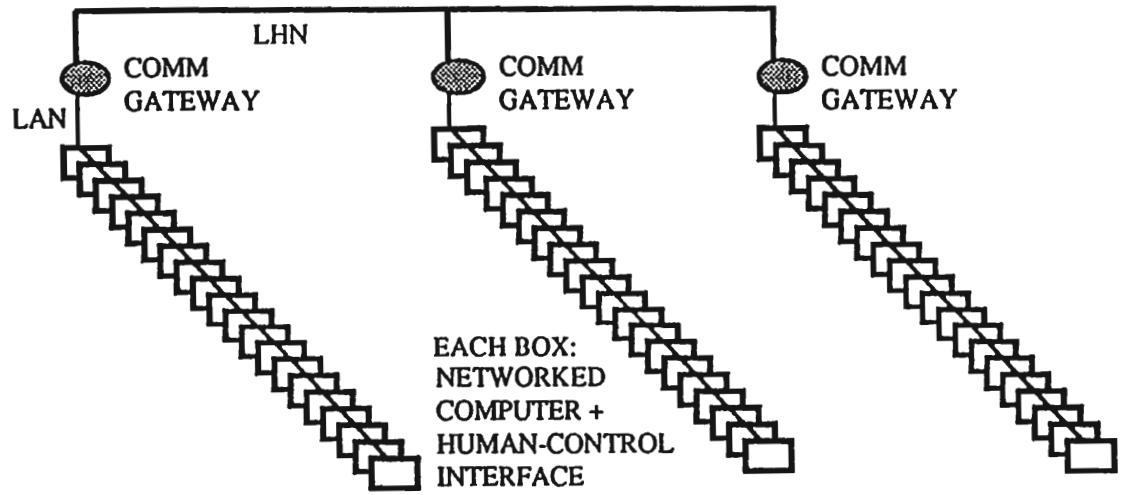

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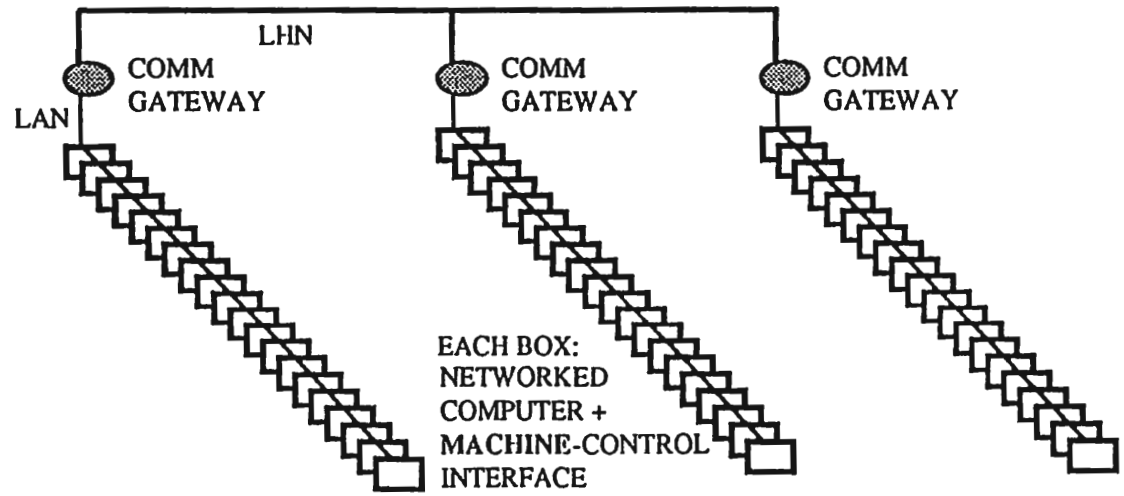

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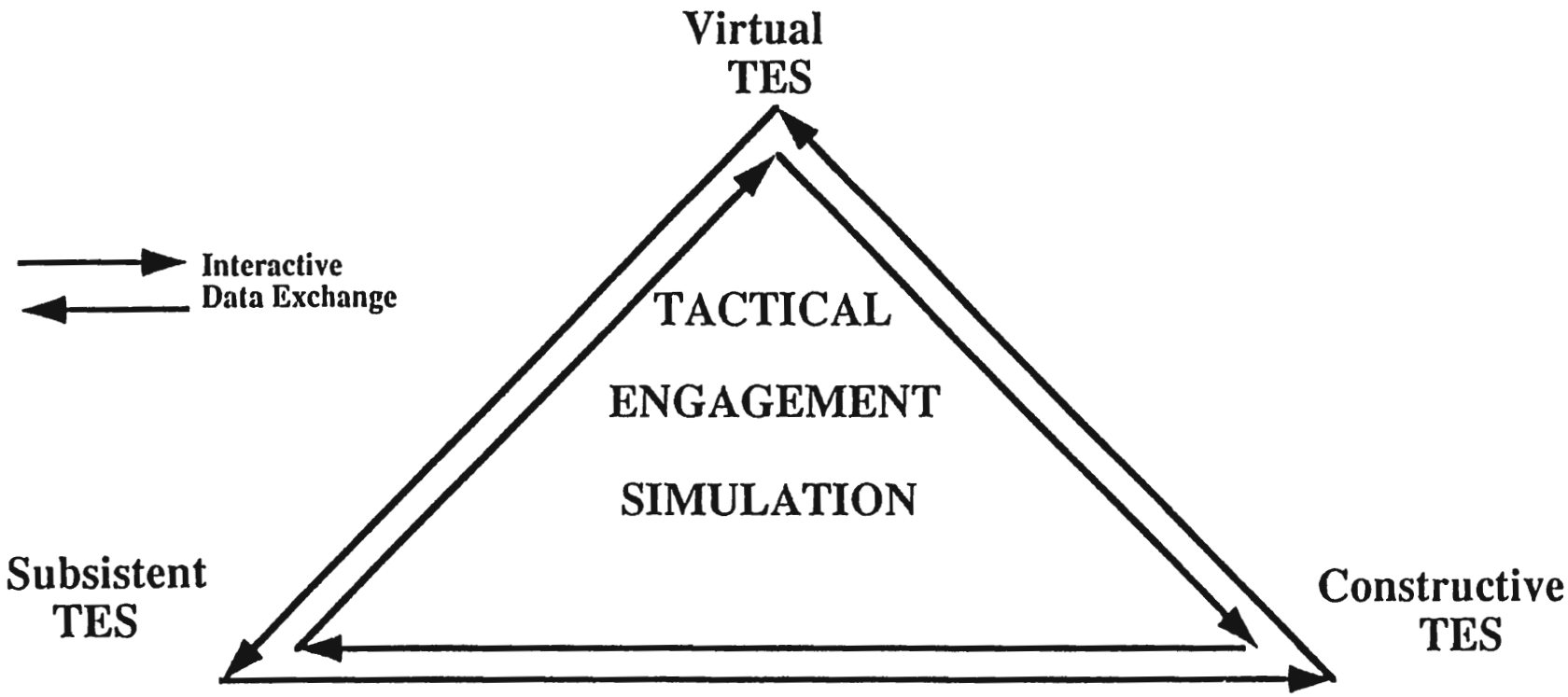
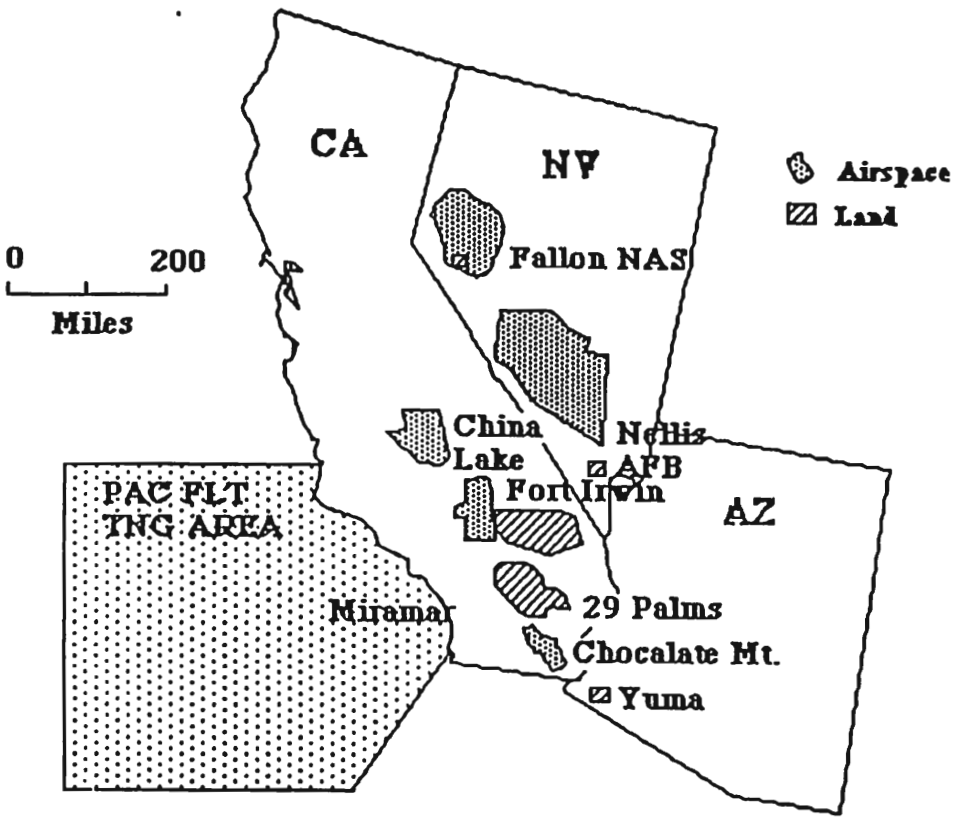
SYNTHETHIC ENVIRONMENTS:
A PARADIGM SHIFT FOR MODELS AND SIMULATIONS



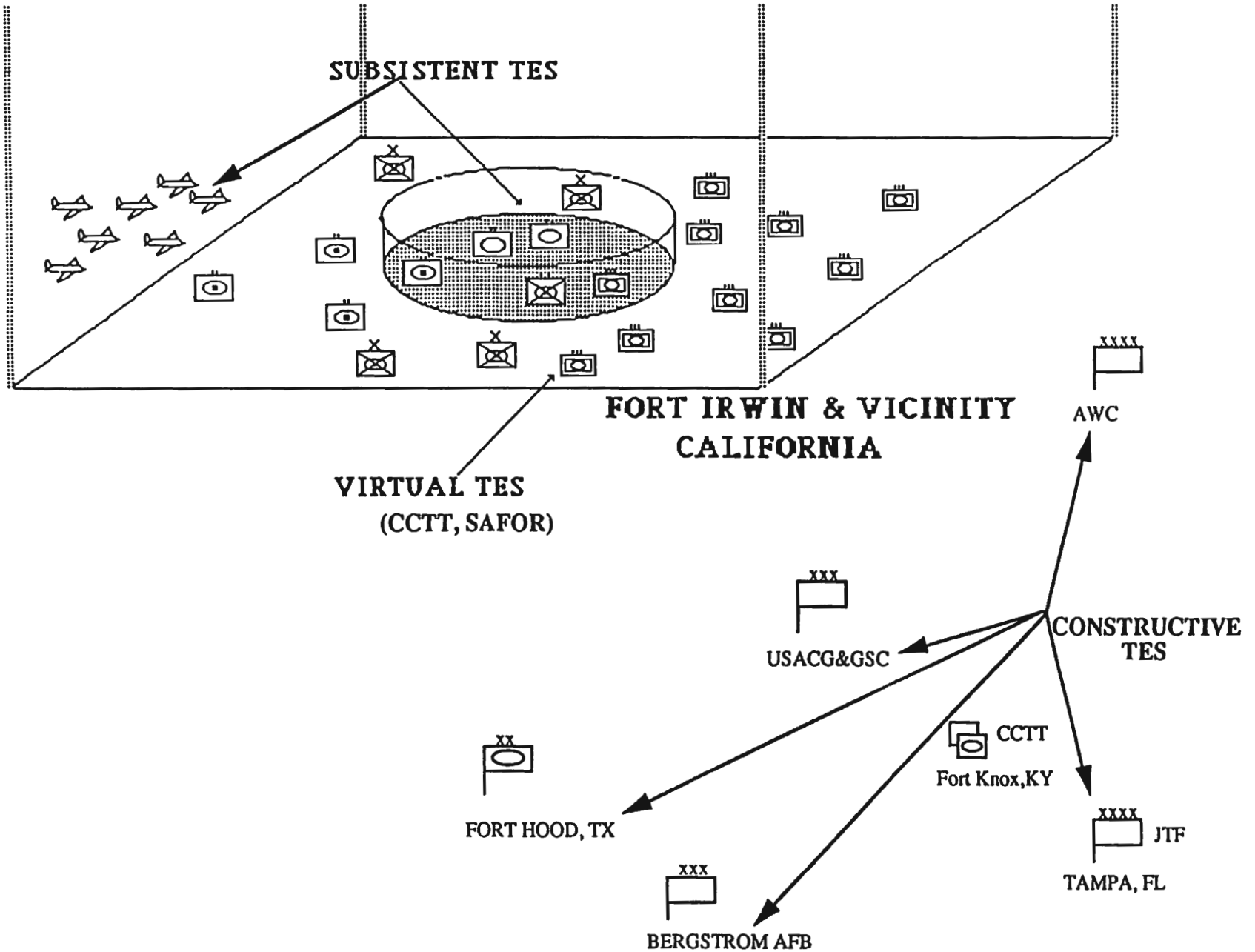
A MAJOR Δ IN COST-EFFECTIVENESS
OVER CONVENTIONAL SIMULATIONS

Military Field Exercises | Military Field Experiments | Map Exercises | War Games | Computer Simulations | Analytical Models

TES SITES IN THE SW USA



SEAMLESS SIMULATION



CONVENTIONAL SIMULATION
FOR
OPERATIONS, ACQUISITION, AND TRAINING

Military Field Exercises	Military Field Experiments	Map Exercises	War Games	Computer Simulations	Analytical Models

COST ←

OPERATIONAL REALISM ←

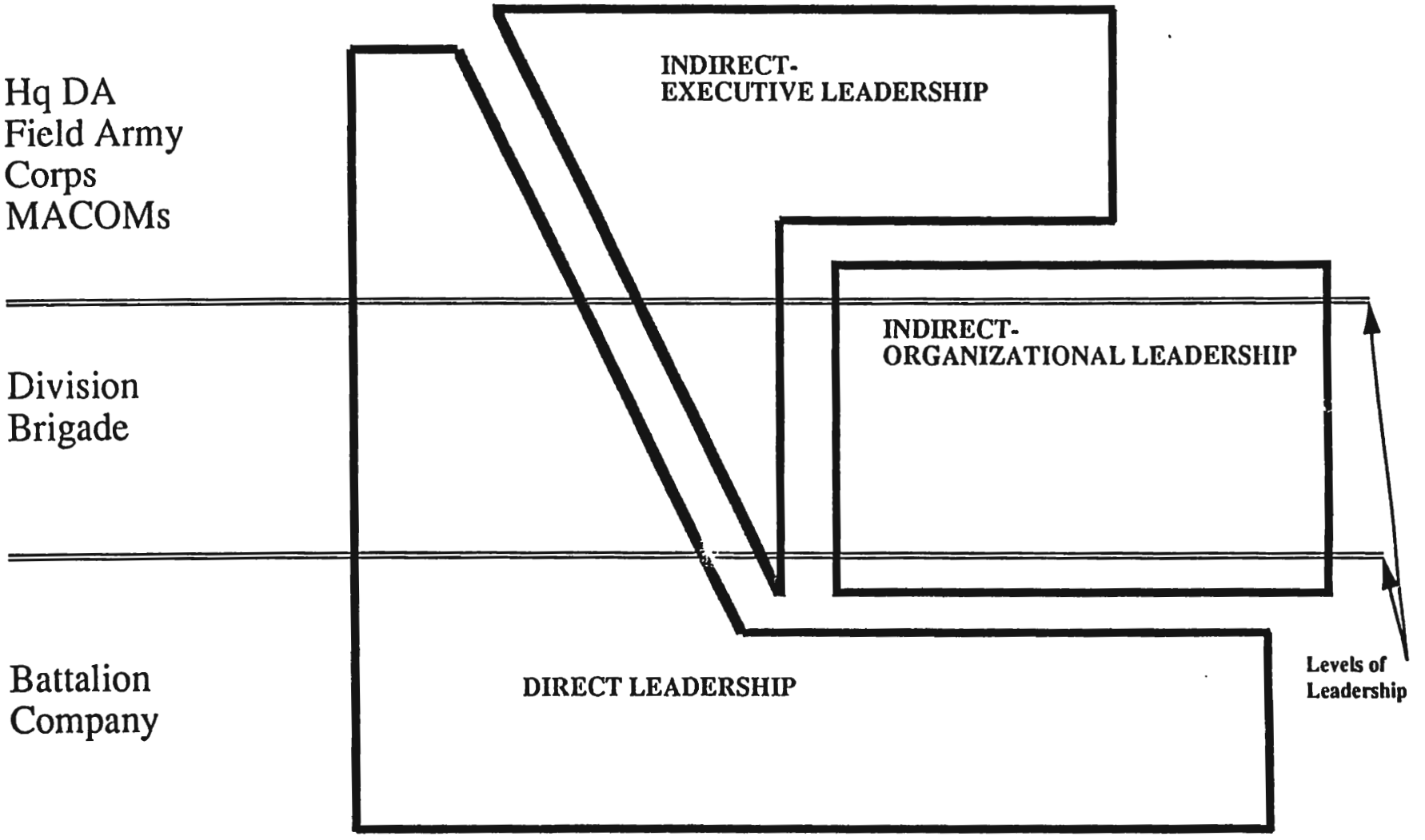
ABSTRACTION →

CONVENIENCE AND ACCESSIBILITY →

After J.G. Taylor ORSA

DECISION-MAKING BY ECHELON

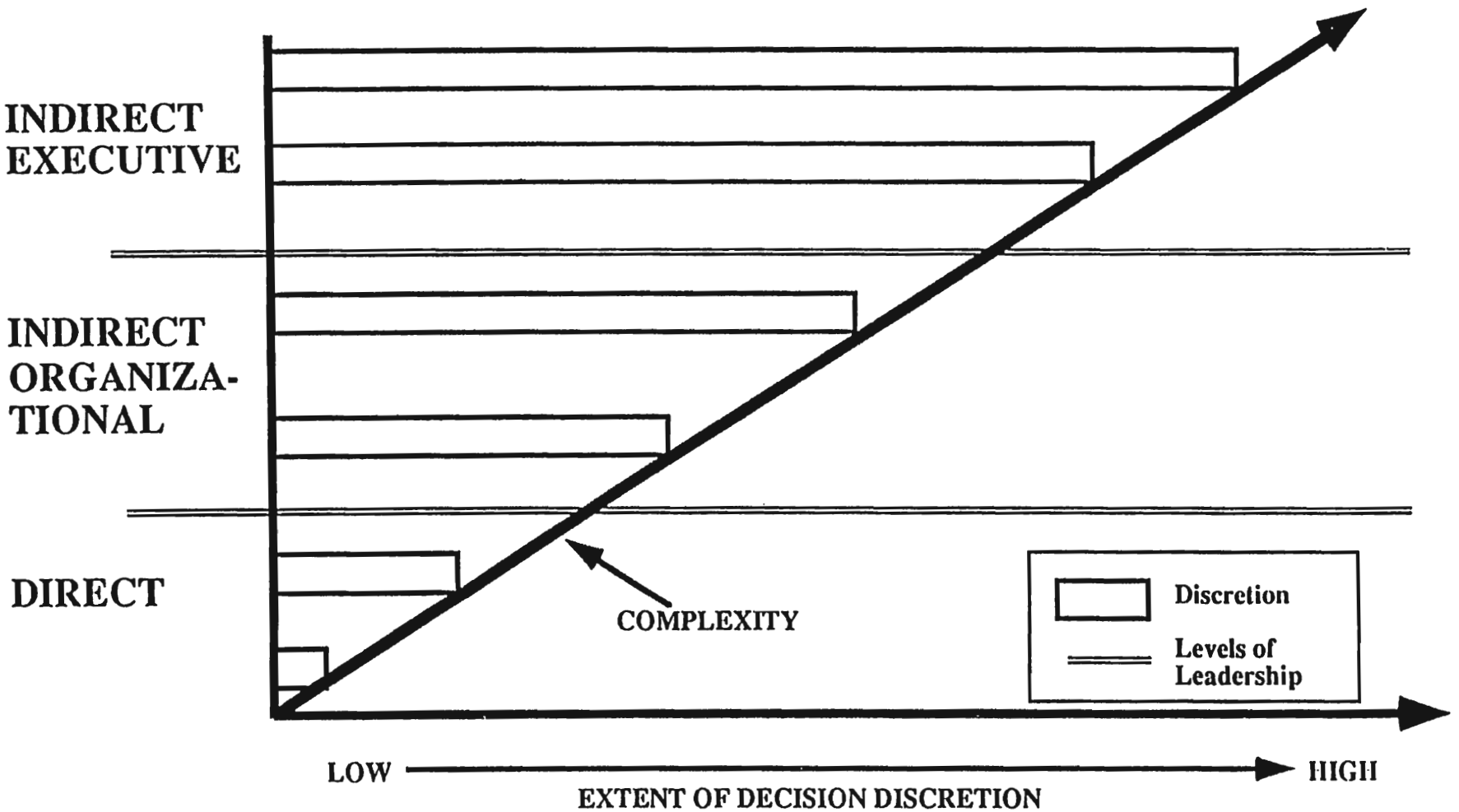
PER DA PAMPHLET 600-80 "Executive Leadership"



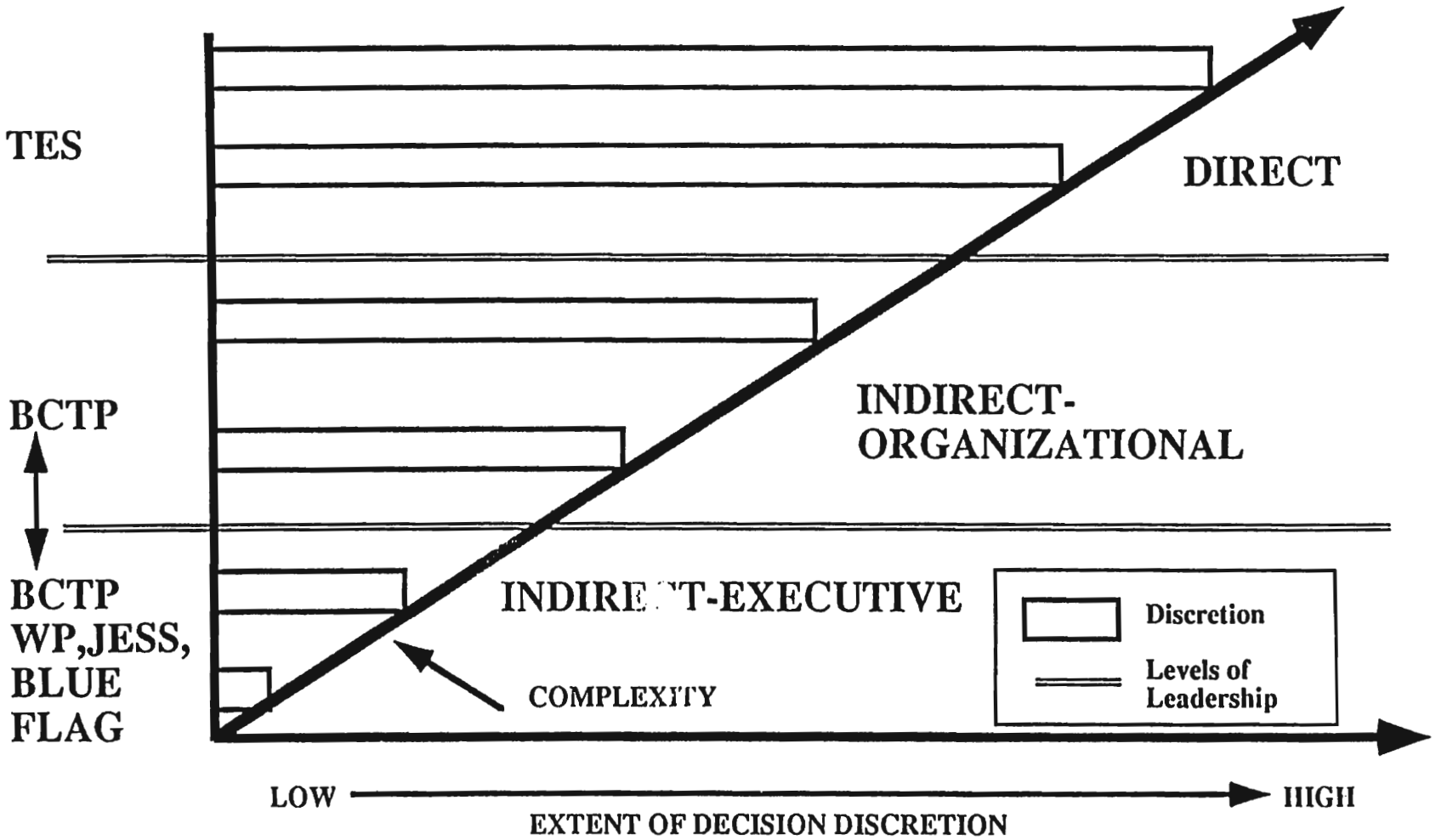
THE LEADERSHIP SYSTEM (Fig. 1)

SCOPE OF DECISION-MAKING BY ECHELON

(DA Pam 600-80, fig. 8, p. 34)



SCOPE OF DECISION-MAKING BY TRAINING TECHNIQUE



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  - --Instrument tactical engagement simulation (TES)
    - *Virtual TES, e.g., CCTT
    - *Subsistent TES, e.g., CTC
    - *Constructive TES, e.g., JANUS (A)/NTC
  - --Enhance anthropogenic fidelity of battle simulations (BSim)

- Ergo, that technology can:
  - --Serve RDT&E by refining requirements, and verifying man-machine interfaces early in development
  - --Extend military medicine via virtual combat casualty care
  - --Provide common instrumentation for SWUSA "Theater"
  - --Instrument TES anywhere
  - --Support introduction of robots integral to land combat units
  - --Serve as C3I, IFF for Airland Battle