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Future Strategic Issues/Future Warfare [Circa 2025]

- **Capabilities of the "Enemy After Next"**

  -Ongoing Worldwide Technological Revolutions

  -Economic Trends

- **Potential Nature of Farther Term Warfare**

The 'Bots, 'Borgs, '& Humans Welcome You to 2025 A.D.

THIS PRESENTATION BASED ON "FUTURES" WORK FOR/WITH

- USAF NWV
- USAF 2025
- National Research Council
- Army After Next
- ACOM Joint Futures
- SSG of the CNO
- Australian DOD
- NRO, DSB

- DARPA, SBCCOM
- DIA, AFSOC, EB, AU
- CIA, STIC, L-M, IDA
- APL, ONA, SEALS
- ONI, FBI, AWC/SSI
- NSAP, SOCOM, CNO
- MSIC, TRADOC, QDR
- NGIC, JWAC, NAIC
- JFCOM, TACOM
- SACLANT, OOTW

THIS PRESENTATION

- **Is meant to incite thought/ discussion**
- **Is based in all cases upon existing data/trends/analyses/technologies (e.g., NO PIXIE DUST)**
- **Provides in some cases a somewhat broader view of prospective developments and issues**
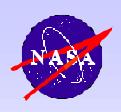
Utilization/Application of 2025+ Projections

- Inputs to Future Warfighting Concepts Development(s) (Enemy After Next & Blue)

- Inputs to New Procurement Decision (15+ years to Produce, 40+ years in Inventory

- "Heads Up" for Intel Community ("Watches and Warnings")

- Inputs to DOD R&D Planning

"Going In" Assumptions

- Politics can/does change "overnight" (e.g. Russia, Iran, Iraq, Pakistan, etc.), Potential CAPABILITIES is the future warfare issue, not Who but WHAT

Need to Plan "Differently"

- **WORLD is in the throes of triple/exponential (IT/Bio/Nano) Technological Revolutions**

- **Changes occurring at scales of months (instead of decades)**

- **Zeroth order potential effects upon Defense/Offense equipment/conops/threat**

"SPACESHIP EARTH"

The crew are:
- **Plundering the ship's supplies**
- **Tinkering with the temperature and life-support controls**
- **Still looking for the instruction manual**
- **Engaging in bloody skirmishes in every corner of the vessel**
- **Increasing the size of the crew by 2 million PER WEEK**

P. Creola

Humans Have "Taken Over" and Vastly Shortened "Evolution"

- **Of the Planet**
  - **Global Warming/Pollution/Deforestation**
  - **Huge "Public Work" (e.g. 3 Gorges Dam)**

- **Of the Human Species**
  - **Genomic Design and Repair**
  - **"Mind Children" (Moravec)**

- **Products/Life Forms**
  - **Cross Species Molecular Breeding**
  - **"Directed Evolution" (Maxygen etc.)**

CURRENTLY

- **Order of 70% of Worlds Research conducted outside of U.S. (to first order, a % of GDP, U.S. produces order of 18% of worlds GDP)**

- **Order of 70% of U.S. Research now "Commercial" (as opposed to Government sponsored)**

NanoTechnology Research

- **29% in Europe**

- **28% in Japan**

- **27% in U.S.**

- **16% "Other(s)"**

Technological Ages of Humankind

- **Hunter/Killer groups [Million BC~10K BC]**

- **Agriculture [10K BC~1800 AD]**

- **Industrial [1800~1950]**

- **IT [1950~2020]**

- **Bio/NANO [2020-?]**

- **Virtual**

- **Hunter-Gatherer - "Nature Provided"**
- **Agriculture - <u>Controlled</u> Nature (Plants/Animals)**
- **Industrial - <u>Mechanized</u> Agriculture**
- **IT/BIO/Nano - <u>Automating</u> Industry/Agriculture**
- **Virtual - <u>Robotization</u> of IT/Bio/Nano/Industry/Agriculture**

KEY "FUTURE TECHNOLOGIES"
(all highly synergistic/at the frontiers of the small, in a "feeding frenzy" off each other)

- **IT**
    - **Silicon/bio/optical/quantum/nano computing ("no end in sight," another 10^6 +)**
    - **(Virtual reality/holographic) immersive ubiquitous comms., hyperspectral sensors, "virtual presence"**
    - **Automatic/robotic "everything"**
    - **Huge cost reductions**
- **Bio**
    - **Life span doubling**
    - **Genetic engineering before birth**
    - **Plants irrigated by seawater (food, petro-chem feed stock, minerals, terraforming)**
- **Nano**
    - **Carbon nanotubes (600X strength-to-weight of steel)**
    - **"Assemblers"/"living factories"**
    - **Huge cost reductions**

Worldwide IT Revolution

- **Comms/Computing/Sensors/Electronics**
- **U.S. Commercial IT R&D ~ $100B/yr.**
- **Factor of 1 Million further improvement [Silicon,Molecular,Quantum,Bio,Optical]**
- **Beyond Human AI?**
- **Automatics/Robotics "in the large"**
- **Immersive multi-sensory VR/"Holodecks"**
- **Ubiquitous multi physics/hyperspectral sensors [land/sea/air/space]**
- **Micro/Nano sats/GNC/sensors,etc.**

[Worldwide] Impacts of Ongoing IT Revolution Upon Society

- **Tele-commuting**
- **Tele-shopping**
- **Tele-entertainment**
- **Tele-travel**
- **Tele-Education**
- **Tele-medicine**
- **Tele-commerce**
- **Tele-politics**
- **Tele-socialization**

IT Status

- **10E6 improvements in Computing since '59, 10E8 further possible next 30 years (10E3 provides "better than Human" capabilities)**

- **100 Million Telecommuters Worldwide NOW (expected to at least double in 15 years)**

- **India graduates three times more software engineers than the U.S., More software written in Bangalore than Southern CA**

- **IW effectively constitutes a 4th WMD**

SOME IT "PREDICTIONS"

- **Quantum computing initially available in 5 years**

- **15% of all power today is used by computers, will reach 60% by 2010**

- **Wearable/implantable (on-person) electronics--comms, computing, sensory augmentation, health monitoring, brain stimulation**

AI (AND BEYOND) COMPUTING

Human Brain Characteristics/Capabilities

- **100 billion neurons**

- **100 trillion connections**

- **200 calculations/second, (slow) speed of neural circuitry**

- **20 million billion calculations/second**

- **Excellent at (parallel-computing) pattern recognition, "poor" at sequential thinking**

- **Operates via "random tries"**

Machine Capabilities

- **Currently, 10,000 billion calculations/second; 100,000 billion by 2004**

- **By 2010, 20 million billion is available (by 2025, on a PC)**

- **By 2030, PC has collective computing power of a town full of human minds**

U.S. "HUMAN BRAIN PROJECT"

- **Begun in early 90's, funded by 16 organizations across 5 agencies (NIH, NSF, DOD, NASA, DOE)**

- **AKA "Neuroinformatics" (intersection of neuroscience and informatics)**

- **"Exploding field;" 10,000 individual presentations at annual meeting of Society for Neuroscience (from molecular geneticists to cognitive psychologists)**

- **Determining detailed neuroanatomy of human brain ("digital brain atlas")**

- **Use of IT to study brain, use of brain info to aid IT/AI**

THE "IMAGINATION ENGINE"
aka "Creativity Machine,"
aka "Creative Agent"

- **Current AI "best bet," not a rule based/expert system**

- **GENERATES new ideas/concepts via starving a trained neural net of meaningful inputs, forcing it to "dream"/"cavitate," create new concepts, etc. An attendant neural net used to capture/record/evaluate and report on these "writings."**

"In this [Worldwide] economy our ability to create wealth is not bounded by physical limits/resources but by our ability to come up with new ideas"

[However,even "universal wealth" will not obviate the other causes of warfare which include Politics,"Face",Religion,

Megalomania and Territorial Disputes]

Global Problems/"Solutions"

- (Serious) Problems
  - Energy (2)
  - Water (2)
  - Food (2)
  - Land (2)
  - Population Growth (1)
  - Wealth Generation (1)
  - "Pollution/Warming" (2)

- "Killer Ap Solutions"
  - **(1)** Motivational/inexpensive Web-based Asynchronous "Distance Learning"
  - **(2)** Bio mass/food via seawater irrigation in current "wastelands"

Inexpensive Motivational Asynchronous Web-Based Distance Education Enables:

- **Demise of the U.S. "underclasses"**
- **Wealth Creation from enabled "Invention"**
- **Stabilization of World Population**
- **[Even More] Rapid Technology Diffusion**
- **Equalization of "Haves" and "Havenots"**
- **Altered Political/military outlooks Worldwide - I.E. Changes "Everything"**

Motivational learner/web-based asynchronous distance learning ~~allows~~ only method of providing requisite/improved educational

- – <u>BREADTH</u>
- – <u>DEPTH</u>
- – <u>QUALITY</u>
- – <u>RESPONSIVENESS</u> to shifting global economic warfare requirements/ accelerated increase in knowledge

At <u>orders of magnitude</u>

(1) reduced societal/individual cost

(2) increased convenience/accessibility

By ~ 2025, 40% of Private and 15% of Public Colleges and Universities are Expected to Close Due to Web-Based Competition

A Northern VA Business man recently donated ~ $100M to set up a FREE Ivy League Class On-Line University

The "Ultimate" Education Approach - Plug and Play

Direct Silicon (or other such) device connection to brain, (very rapid) uploads, Education in minutes instead of (many) years

Advantages of Shallow Sea/Desert Production of Biomass (Via Seawater Irrigation)

- **Closed CO2 Cycle (Obviates Global Warming)**
- **Food**
- **Petro-chemical feedstock**
  - **Materials/clothing, etc.**
  - **ENERGY (end reliance on Middle East)**
- **Terraforming, alter desertification etc.**
- **Preservation/Production of Fresh Water**
- **Rich Mineral source (Seawater)**
- **Utilization of "Wastelands" (Sahara, etc.)**

Probable Circa 2025 Societal Changes

- (Much) Increased Life Span (Bio)

- "Solution" to Energy/Water/"Warming" (Bio)

- (Far More) Global Distribution of Technology, Education, Economics, Wealth (IT)

- (Tremendous) Increases in Capability of Automatic/Robotic "Everythings" (IT/Bio/Nano)

  - Resulting in Reduced Tensions Associated with "Have/Have Nots" and Historical/Religious Issues

  - Also Resulting in (Greatly) Increased Individual destructive power (Bio, IW, etc.) and General Societal Disaffection WRT "Machines"

Major Emerging Law Enforcement "Issues"

- **Privacy (Ubiquitous micro/nano sensors)**
- **IT/Net Crime (wide spectrum)**
- **Bio Crime (binary pathogens, genetics)**
- **Protection of Human Electronic Implants**
- **Protection of CONUS (Beyond Terrorism)**
- **Societal Disaffection/Upheaval Caused by Rapid Technological Change(s) (Road/Air Rage, Psychosomatic Illnesses, Withdrawal)**

Of Particular Concern

Uncontrolled/Uncontrollable
SELF-REPLICATION
Of

- Brilliant Robots (IT)
- Nano-Replicators (Nano)
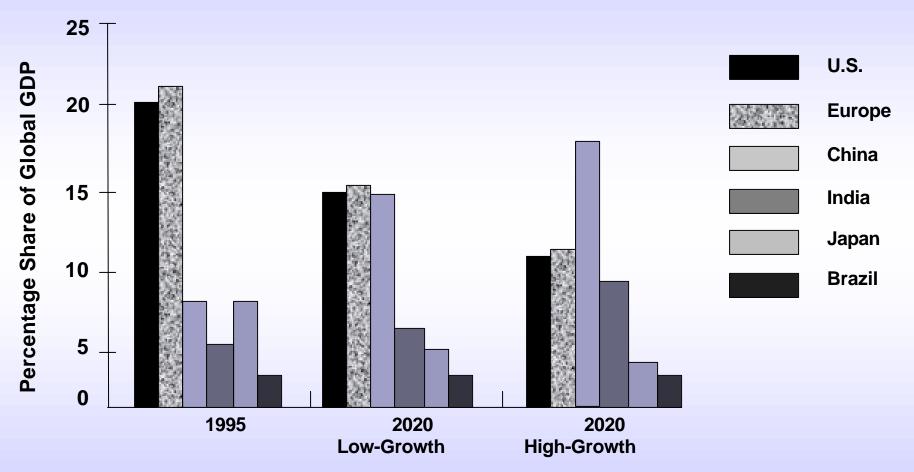## - Rampant Recombinant <u>Bio</u>

Current Competitive Landscape

- **U.S. produces only 18% of Worlds GDP**
- **~70% of Research conducted offshore**
- **$400B/yr trade deficit**
- **32 other nations devote a larger % of their GDP to Research**
- **5th in No of R&D personnel/labor unit**
- **3% savings rate vs. 30% in Asia**
- **13th out of 30 - Student Math/Science Scores**

AN EMERGING MULTIPOLAR ECONOMIC WORLD

Source: OCED, The World in 2020, p. 92

Bio Revolution Applications

- "Pharm Animals" [drugs, spare parts]
- Fast Growing plants on/near sea surface & sea water irrigated plants for biomass energy/closed CO_2 cycle
- Polymer growing plants
- Spider genes in goats allow spider silk spinning from goat milk for "Biosteel", 3.5X strength of aramid fibers for Armor
- Binary Bio-weaponry

Examples
Confluence of IT/Bio/Nano

- **Brain of a sea lampry inserted/connected to body of a robotic fish (an initial cyborg)**

- **"Chew-Chew" - a flesh/plant eating robot that hunts/bio-digests "natural foods" to "live off the land"**

Carbon Nanotubes

- **C1,000,000, Buckminister Fullerine Carbon**

- **100X strength, 1/6 weight of steel**

- **8X better Armor**

- **Low energy Molecular/Petaflop Computing (10^{-4} En. Usage)**

- **Ultra Capacitor/High Temperature SC**

Revolutionary Power Generation/Storage Opportunities

- **Ultracapacitors**
- **Adv. Fuel Cells (e.g. Lithium/water/air)**
- **HEDM (e.g. Solid H2, Isomers, anti-matter, etc.**
- **Adv. PV (50%?)**
- **Room Temperature SC/SMES**

- **C-Nanotube storage of H2 (non-cryo)?**
- **Offshore Methane Hydrate**
- **Black light power?**
- **LENR**
- **ZPE**

Free Form Fabrication

- **Powder/Wire Metallurgy using robotic magnetically steered electron beams to create accreting local melts - GROW instead of CUT**

- **No fasteners, no strong backs for fasteners**

- **Nearly infinite fatigue life, excellent metallurgy**

- **(Repairable) metals at lower weight than far more expensive composites**

Aluminum/Vortex Combustor

- **Micro powdered Aluminum fed into a vortex combustor "burns" SEAWATER**

- **Provides AIP with high energy density/efficiency for:**

   -inexpensive SS with "near SSN" perf.

   -Transoceanic UUV's

- **Would allow "Enemy After Next" to AFFORDABLY Threaten CONUS via Multitudinous in-shore short-time-of-flight "popups"**

(Sample) New(er) Sensors

- **Lidar w/ 50% efficiency via S-C optical Amplifiers, Also Fempto-second Lasers**
- **Molec./Bio Sensors**
- **Nanotags**
- **Smart Card Sensors**
- **Sensors implanted during Manuf./Servicing**
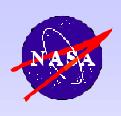- **Nano IR (10E-6 Sensitivity)**
- **Smart Dust**

Some Sensor "Swarms"

- **SMART DUST**
  - **Cubic mm or less**
  - **Combined sensors, comms and power supply**
  - **Floats in air currents**

- **NANOTAGS**
  - **Placed on everything/everywhere**
  - **Identification and Status Info**

- **Co-opted INSECTS**

Some "Explosive" Smart Dust Opportunities

- **Optimal Positioning of Explosive Dust - Dust/Air Explosives**

- **Formation of "Explosive Lenses"**

- **Infiltration of Deeply Buried/other such targets**

Micro Dust Weaponry

A Mechanical Analog to Bio, Micron sized mechanized "dust" which is distributed as an aerosol and inhaled into the lungs. Dust mechanically bores into lung tissue and executes various "Pathological Missions."

A Wholly "New" class of Weaponry which is legal.

"Givens" (Now-to-"Soon")

- **Gb data transfer rates, optical comms**

- **Petaflop + computing**

- **Exceptional AI (from Bioinfomatics, biomimetics)**

- **Wonderous/Ubiquitous land/sea/air/space multiphysics/hyperspectral sensor swarms (military/commercial/scientific)**

- **Survival requires dispersion/size reduction and concealment**

- **Robotic/swarm technologies primarily commercial/endemic worldwide**

(Agreed Upon) Assumptions, Combat in 2025

- **Proliferation of TBM's, IT, Precision strike/targeting, ubiquitous micro sensors, camo/spoofing, robotics, bio/chem munitions**

- **Logistic assets highly vulnerable in or out of theater**

- **In and near theater ports/airfields possibly unusable**

- **Beam weapons increasingly prevalent**

Cruise Missiles (Current Status)

- **Range/payload similar to TBM at fraction of the cost and far greater accuracy**

- **75,000 in inventory of 75 countries, 130 different versions produced in 19 countries (10 "exporting" countries)**

- **German V-1 cruise killed 5,000; injured 40,000**

- **LO, launchable "anywhere/from anything," highly maneuverable**

- **"Then Year" costs potentially reduced to 10K - 25K**

- **Warhead(s) de jour/de hour (HE/carbon fibers/EMP/sub munitions/CNB/volumetric)**

Cruise Missiles (Potential Outlook)

- **Any RPV/UAV (or UUV) is a potential "cruise missile" (50 countries have UAV's!)**

- **Low cost and "ready availability" of requisite technology/components essentially ensure the "Enemy after Next" will have/inventory/ field "<u>hordes</u>" of <u>very capable</u>/easily concealed/very difficult (and expensive) to counter/accurate cruise "missiles" with a potential "devil's brew" of warheads.**

"Volumetric" Weaponry

[Alternatives to HE]

- **EMP**
- **Info/Net/Psy warfare**
- **Miniature brilliant sensor/mine combo's**
- **Fuel/air & dust/air/Thermobarics**
- **RF**
- **Chem/bio Antifunctionals/antifauna**
- **Isomers, Strained Bond Energy Release, etc.**
- **Carbon fibers and "Blades," Acoustics etc.**

Antipersonnel MW/RF Weaponry

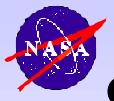- **Heating [High Power Requirements(s)]**

- **Surface Effects**

- **Brain Interactions [Low Frequency Modulation]**

EFFECTS OF LOW POWER MICROWAVES (U.S. ARMY, SRI, WALTER REED)

- **Behavioral performance decrements**

- **Seizures**

- **Gross alteration in brain function**

- **30% to 100% increases in brain blood flow**

- **Lethality**
  - **Interactions between low power (microwatts per sq. cm./.4 to 3 GHz) MW and brain function**

Often "Fingerprintless" Bio Archipelago

- **Bacteriological**
- **Viruses**
- **Prions**
- **Parasites**
- **Fungi**
- **Carcinogens**
- **Toxins**
- **Hormones/Regulators**

- **Fatal-to-disabling**
- **Short-to-long time scales**
- **Anti-flora/fauna/functional**
- **Direct and (undetectable) Binary**
- **Natural, Genomic**
- **Bio-Hacking**

Some Interesting "Then Year" BW Possibilities

- **Aflatoxin - ("natural," parts-per-billion, carcinogen)**

- **Airborne varieties of Ebola, Lassa, etc.**

- **Binary agents distributed via imported products (Vitamins, Clothing, Food)**

- **Genomicaly (individual/societal) targeted pathogens**

- **Long term/fingerprintless campaign (as opposed to "shock and awe" BW)**

An (Existing Bio Calmative - VEE (Venezuelan Equine Encephalitis)

- **Ideal Incap. BW Agent**
- **Weaponized by U.S. & USSR in 50's/60's**
- **Easily transmitted via Aerosol**
- **Highly infectious, Low Fatality Rate**
- **1 to 5 day incubation, 3 week recovery**
- **Tested on Humans (Operation Whitecoat)**
- **No Treatment Available**

Frontiers of
(Rapidly Growing/Genomic/Insitu)
"Bio on the Battlefield"

- **Sustainment:**
  - **Food**
  - **Water (soil/air/purif.)**
  - **Energy (HC, H2, PV)**
  - **Meds/"Health"**
  - **Computing, Clothing**

GREATLY REDUCES "LOGISTICS TAIL" & ENHANCES CAPABILITIES

- **Lethality**
  - **Capabilities Enhancement**
  - **Armor**
  - **Concealment (living camo)**
  - **Sensors, FOF ID**
  - **Bio-weaponry (anti-personnel/functional, bio virus into bio computer)**
  - **Explosives (e.g. N2 fixation, grow overnite)**

What is Apparently "Legal"

- **Microwave/RF Anti-Functional and Anti-Personnel Weaponry**

- **Chemical Anti-Functional Weaponry**

- **Chemical "Psychological Effects" via Sensory Organs Weaponry (e.g. smell)**

- **Chemical Personnel Incapacitation Weaponry ["Non-Warfare" (e.g. Hostage/Terrorism) only]**

- **PSYWAR**

- **Acoustic Weaponry**

- **Mechanical Micro Dust**

(FUTURE) NON-NUCLEAR EXPLOSIVES FOR "VOLUMETRIC"/ WEAPONS OF "MASS EFFECT"

- **Metastable interstitial composite (MIC/Cubanes)**
  - **Order of 6 x TNT**
- **Fuel-air/dust-air explosives**
  - **Order of 15 x TNT**
- **Strain-bond energy release (SBER)**
  - **Order of 100 x TNT**
- **Hafnium (metastable) isomers**
  - **Order of 1,000 to 100,000 x TNT**
- **Atomic boron, carbon, hydrogen**

High Energy Density Materials (HEDM)
(Power, Explosives, Propellants)

- **Tetrahedral N (Isp $\longrightarrow$ 600+ sec)**
- **Atomic Born, C, H (Isp $\longrightarrow$ 600+ sec)**
- **Metastable He (Isp $\longrightarrow$ 1500 sec)**
- **Metallic Hz (Isp $\longrightarrow$ 2000 sec)**
- **ISOMERS ($\longrightarrow 10^5$ x TNT)**
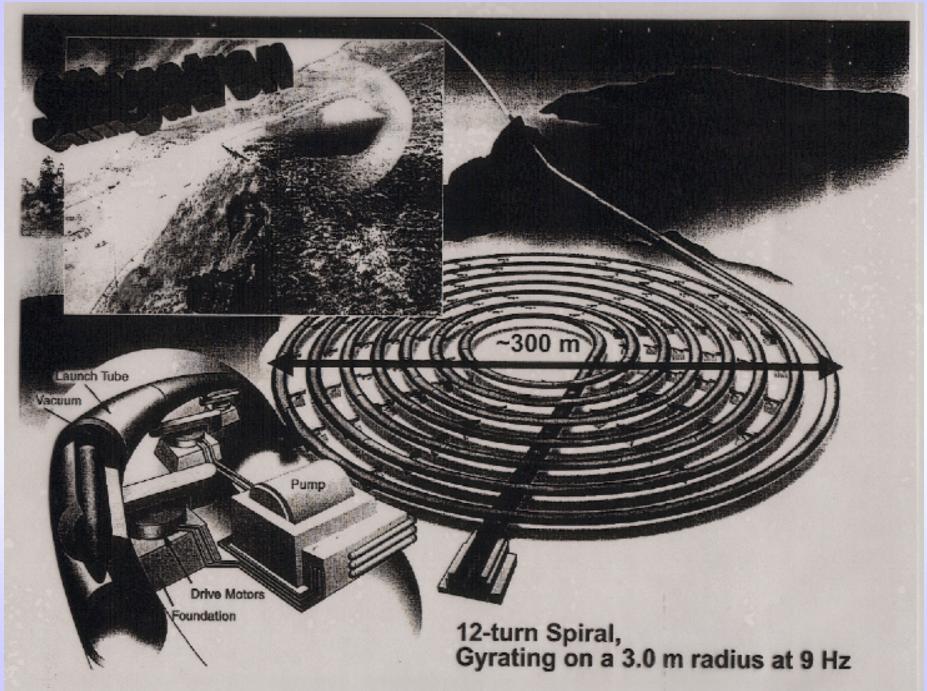- **Anti-matter, LENR's**

Transoceanic UAV's

- **Current Capability - ('98 - 29 lbs, 2000 mi., 1.5 gals. Fuel; '01 - Transpac, 5000 mi.**

- **Provides Capability for Undetectable Ultra-inexpensive Swarms Against CONUS**

- **Interesting (Precision) "Payloads"**
  - **ISR**
  - **Smart Dust/Explosive**
  - **Target/explode Hazmat Trucks, Chem. Plants, Oil Storage/Refineries, etc.**
  - **Bio Dispensers (Anti-People, Things, Plants)**
  - **IW/EMP**
  - **Brilliant/Miniature sensor/Mine Combos**
  - **CNT's (Power Lines, "Wire Blade")**

Blast Wave Accelerator

- **Global Precision Strike "On the Cheap"**

- **No barrel, ~200 ft. notched rails, sequentially detonated Distributed HE**

- **Mach 21 or less as desired, up to 3000 lb**

- **Base anywhere, ~$200/lb of projectile**

- **Excellent stealth [no plume], affordability, ferocity, reaction time, survivability, recallability, effectiveness**

- **Being worked at Aberdeen and NASA MSFC for lofting of Fuel and Nanosats**

Launch Tube
Vacuum
Pump
Drive Motors
Foundation

~300 m

**12-turn Spiral,
Gyrating on a 3.0 m radius at 9 Hz**

"Slingatron" for Global Precision Strike

- **10Kg projectiles, up to thousands/minute**

- **Global, or less, range**

- **$20M/device, 80m diameter**

- **Mechanical "on-the-ground" propulsion via Gyrating Spiral Guide Tube (a multiple "hula hoop"**

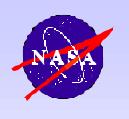- **"Poor Mans" Global Precision Strike/"Takedown Weapon"**

Then Year Targeting/ Connectivity etc.

- **<u>MILITARY</u> overheads/systems**

- **Ubiquitous <u>COMMERCIAL</u> overheads/systems**

- **<u>SCIENTIFIC</u> overheads/systems**

  IN the context of:

    - Inexp. Reconstitution via micro/nano sats

    - Optical comms /GPS etc.

    - Ubiquitous inexp. UAV/HALE adjuncts

EXAMPLE: POTENTIAL "COMPETITOR" MILITARY (SURVELIANCE/INTELLIGENCE/TARGETING/DAMAGE ASSESSMENT) UTILIZATION OF INTERNATIONAL SCIENTIFIC "GLOBAL CHANGE" PROGRAMS/ASSETS

- Extensive/increasing <u>international</u> assets (land-based, ship, aircraft (conventional/HALE), spacecraft) dedicated to <u>measuring</u>, on a <u>global scale</u>, <u>details</u> of land, atmospheric, ice, ocean, biota status/"dynamics" (to understand total Earth "system" and effects of humans on the global environment)

- Extensive/magnificent/often redundant <u>wide coverage</u> and <u>detailed</u> instrumentation suite(s) (imaging radars/SARS/LIDARS/radar altimeters/laser altimeters/radiometers/scatterometers/spectrometers/IR sensors/ magnetomiters/etc.

- Terrabites+ of data archived/readily/publicably available increasingly in near real time

- Sample measurements include: OH, O_3, HCI, NO, NO_2, $N_2 O$, CO, CH_2 , HNO_3 , CO_2, $H_2 O$, aerosols, wind speed/vector/profile(s), vegetation type, temperature profile(s), humidity profile(s), soil moisture/composition, snow cover/depth/moisture content, cloud/surface reflectance, sea ice type/coverage/temperature, ocean temperature(s)/sediments/topography/salinity/currents, magnetic field(s), surface emissivities/reflectance, leaf area index, land topography/use/temperature/cover, ice sheet elevation/topography gravity field/gradients, fires extension/temperature, 3-D cloud distributions/temperatures/ice content, pressure distribution(s), ocean wave heights/period(s)/direction(s)
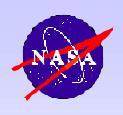
Then Year, Global Targeting Capabilities are a Given - Major Issue is "Legs"/Range for Increasingly Miniaturized Affordable Payloads/Systems

- **Range Enhancement Approaches:**
  - **Airbreathing or "water breathing," to first order doubles range**
  - **Initial boost for cruise (ala Blast Wave Acceleror)**
  - **HEDM Fuels [Atomic Boron, Carbon, Isomers, etc.)**
  - **Drag Reduction (Wave/Friction/Drag-due-to-lift, Increased Dia.)**
  - **Hypersonic Maneuvering Boost-Glide**

Summary - Major Influences of IT/Bio/Nano Upon Future Warfare

- **Ubiquitous miniaturized/networked multi physics,hyperspectral sensors**

- **Robotics/Automatics "in the large"**

- **Long range precision strike/targeting**

- **Info/net Warfare**

- **Mini/micro/nano Sats, Cruise, UAV's**

- **Binary Bio Weaponry**

- **Miniature/ubiquitous "smart mines"**

Increasingly Critical Human Limitations/Downsides

- **Large**
- **Heavy**
- **Tender**
- **Slow (Pysically, Mentally)**
- **Require Huge Logistic Train(s)**
  i.e. <u>Humans have rapidly decreasing-to-negative "Value Added"</u>

ROBOTICS "IN THE LARGE"
(saves lives, enhances affordability, redefines risk/threat environment, enhances effectiveness)

"Unattended"

- **Munitions**
- **Sensors**
- **Platforms**
  - **Air (UAV's)**
  - **Sea (UUV's)**
  - **Land (UGV's)**

- **Logistics**
- **Spoofing/obscurants**
- **RSTA (including NBC)**
- **Defense (across the board including counter recon/ambush)**
- **Offense**
  - **Obstacle breaching**
  - **"The Shooter" (especially Mout)**
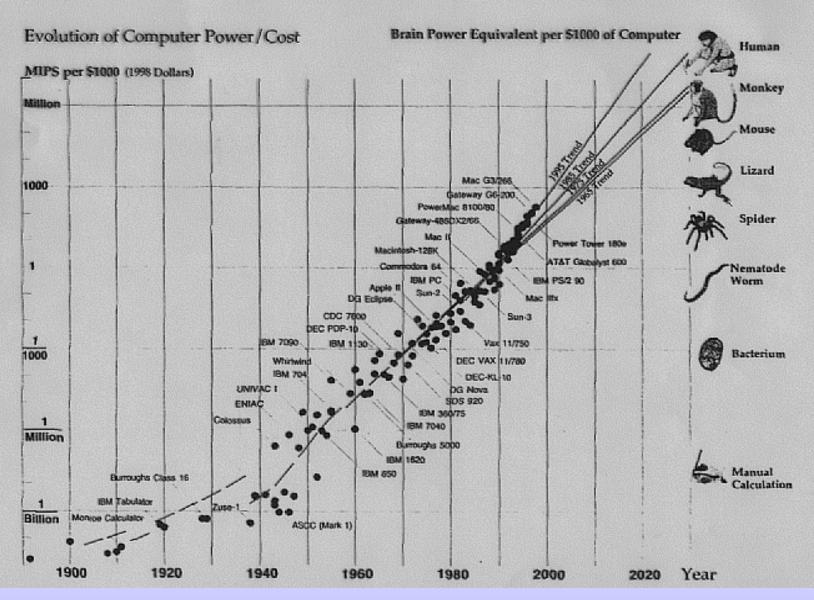 - **Mine Clearing**

Emerging Characteristics
of Robotic Systems
(Enabled by Ongoing IT Revolutions-Comms/Sensors/Computation/Miniaturization

- **From expert systems toward AI and <u>beyond</u>**
- **Much more reactive than humans, greatly increased tempo**
- **Greatly improved hyperspectral sensors/data fusion**
- **Greatly improved accuracy and lethality**
- **Greatly improved affordability/miniaturization**
- **Redefines "risk," minimal casualties, salutes CNN syndrome**
- **Greatly reduced logistics**

Robotic Intelligence

- **Two "flavors**
    - **Traditional AI - Rule Based**
    - **Experiential - Behavior Based (Neural Nets/other "Soft Computing"**
- **Combination of these is current "best bet" (per Moravec) to produce artificial/cyber "life" which will possibly-to-probably be sentient but will not be anthropomorphic**

Evolution of Computer Power/Cost

Brain Power Equivalent per $1000 of Computer

MIPS per $1000 (1998 Dollars)

Million

1000

1

$\frac{1}{1000}$

$\frac{1}{Million}$

$\frac{1}{Billion}$

1995 Trend
1985 Trend
1975 Trend
1965 Trend

Human
Monkey
Mouse
Lizard
Spider
Nematode Worm
Bacterium
Manual Calculation

Mac G3/266
Gateway G6-200
PowerMac 8100/80
Gateway-486DX2/66
Mac II
Macintosh-128K
Commodore 64
IBM PC
Sun-2
Apple II
DG Eclipse
CDC 7600
DEC PDP-10
IBM 7090
IBM 1130
Whirlwind
IBM 704
UNIVAC I
ENIAC
Colossus
Power Tower 180e
AT&T Globalyst 600
IBM PS/2 90
Mac IIfx
Sun-3
Vax 11/750
DEC VAX 11/780
DEC-KL-10
DG Nova
SDS 920
IBM 360/75
IBM 7040
Burroughs 5000
IBM 1620
IBM 650
Burroughs Class 16
IBM Tabulator
Zuse-1
Monroe Calculator
ASCC (Mark 1)

1900   1920   1940   1960   1980   2000   2020   Year

WHAT IS <u>BEYOND ROBOTIC SYSTEMS</u> (SENSORS/PLATFORMS/WEAPONS/ MUNITIONS)

- Robotic/automatic ⟶ autonomous warfare?
  - Computer capability will exist (beyond terra flop) to do "AI" (or better?), required connectivity is a "given"
  - Competitor capabilities /tempo sidelines the innate inadequacies of human interactions/education/conscious decision <u>timelines</u>
  - Little-to-no "troops" ⟶ "Acme warfare Ltd."
  - Flat hierarchy ⟶ demise of "main in the chair?"
  - High level/"soft sciences" human aspects "<u>boundary conditions</u>"
    - Sociological/"humanitarian"
    - Political
    - Environmental
    - Religious
    - Psychological
    - Economics
    - Etc.

Extent/scale, projected effects/ Damage(s), personnel attrition (general-to-specific)

"Non-Explosive Warfare"

- **IW/IO**
- **PSYWAR "In-the-Large"**
- **Anti-Functionals**
  - **MW**
  - **Chem**
  - **Bio**
  - **Micro-Mechanical**
- **Anti-Personnel MW/RF, Micro-Mechanical**

"Natural Warfare"

- **Sensors:**

  – **Utilize insitu plants/animals/insects as sensor platforms/instruments to indicate presence/movement/characteristics**

- **Weapons/Munitions:**

  – **Utilize animals (e.g. urban rats)/insects as "delivery systems"/munitions ("feeding," swarming, biting, poisoning)**

  – **Utilize insitu explosive/destructive capability (e.g. offshore Methane Hydrate, Dams, etc.)**

Characteristics - Future/Emerging Sensors/Munitions/Weapons/Platforms

- **Inexpensive**
- **Numerous-to-Hordes/Clouds/Swarms**
- **Small/light/ubiquitous**
- **Readily Available (Largely Comm. Tech.)**
- **Long Range**
- **"Volumetric" or "Precise"**
- **Both "Explosive" and "Non-Explosive"**
- **Smart-to-Brilliant**

Potential Future "Orders of Magnitude" Increases in Overall Weapon Effectiveness/Availability at Orders of Magnitude Reduced Cost(s)

- **Bio/Chem/Molec./Nano Computing - (E6)**
- **Ubiquitous Optical Comms - (E4)**
- **Micro/Nano/Ubiquitous Sensors - (E4)**
- **BioWeaponry - (EN)**
- **Co-operative Swarms of Cheap/Small Weapons/Sensors - (E4)**
- **Volumetric Weaponry - (E4)**
- **Cyber/Artificial Life (Beyond AI) - (E?)**

Major (Anti-U.S.) Asymmetries

- **Long increasingly vulnerable logistics chain**
- **Long, "undefendable" coastline (esp. against underwater threats)**
- **Sensitivity to casualties (greatly enhanced by the "CNN syndrome")**
- **Vulnerabilities to "terrorism" (esp. IT, bio)**
- **Increasing over reliance upon vulnerable "overhead" assets**

Potential En-route Logistic Vulnerabilities

Logistic surface ships and aircraft are non-LO and undefended, could be targeted and attrited inside the continental shelf by:

-"Eggs" [subsurface floating encapsulated missiles implanted by freighters/SS/air]

-SS [torps/missiles/subsam]

-Transoceanic UUV's, UAV's, USV's

-Blast wave accelerator

-Cruise, TBM's

-MINES

Fundamental Problem With Future U.S. Power Projection

- "EAN" can have "country sized magazines" filled with hordes of inexpensive Precision strike "Munitions" - Area Denial

- U.S. Forces run out of "bullets" and die

  [Beam weapons not panacea, inexpensive workarounds available]

- Deep Water Subs with large loadout/"swimin" weaponry only survivable "Close-in" platform

Sampling of TBM/Cruise Missile "Penaids" (Derived from Extensive Worldwide ICBM/IRBM RV Cold War Defensive/Offensive Studies Over Some Three Decades

- **Decoys (anti-sensor)**

- **Ablative/subliming coatings (thermal [laser/mw] protection)**

- **Fluid injection (laser protection)**

- **Wake modification(s) (anti-sensor)**

- **Electronic/optical "shielding" (MW protection)**

- **RAM/RAS/shaping (anti-sensor)**

e.g., current efforts involving beam weapons (laser, MW) "kills" of undefended"/"unpenaided" "dumb" incoming NOT REALISTIC

Potential "Workarounds" for Beam Weapon Effects on Missile Sensors/Comms

- **Off board sensors (networked, everywhere, on everything)**
- **Optical Comms**
- **Optical/fluidic Computing**
- **Optical GPS**

Example 'Then Year" Direct Conus Attack Capabilities

[~80% of CONUS population/infrastructure within ~ 50 Miles of a "coastline"]

- **Inexp. Transoceanic UUV's/UAV's/Cruise**
- **Inexp. Blast Wave Accelerators**
- **Inexp. Info/Net/Psywar**
- **Inexp. Inshore AIP SS [mines/torps/SLCM]**
- **Inexp. Binary Bio into Food Supply**
- **Inexp. Semi-submerged Missile "eggs"**
- **Inexp. 'Trojan Horse" "civilian" systems**

[Above in addition to ICBM/TBM]

"Unconventional" Nuc Delivery

- **Sink a ship offshore, detonate to produce Tidal Waves with Radioactive spume**

- **Transcontinental UAV's, UUV's (nano, AI)**

- **Ballons with GPS sport 'chutes**

- **Ganged Micro Rockets (ala MIT)**

- **Trojan Horse Everything (ships, boats, planes, cars, trucks, packages, cargo, containers)**
  - **Targeted "Effects" include Tidal Waves, EMP, Earthquakes, Radiation, Blast**

(Civilian) IW Examples/CONUS

- **(National) Banking System Computers**
  - **3 sites/nodes - HE/EMP/IW/C/B (attack buildings, power, software, hardware)**
  - **Interruptions in National/International Payments system irrecoverable**

- **Railroads**
  - **4 sites, attack options as above**
  - **All freight cars networked, "everyone" on "just in time," no reserves/stockpiles**
  - **Takes down Auto Industry, power grid, chicken farms, all movements of "War Materials," ETC!!!**

The Revolutionary Size/Capability/Cost Warfighting Spiral

1   **Commercial electronics/GNC/Comms/Sensors (Much smaller/cheaper/better - Allows:**

2   **IO and "Precision" - Reduces Reqd. munition size and Numbers much-Leads to:**

3   **Small/Light/Deadly/Inexpensive Munitions -**

4   **Which Reduces requisite Platform size/cost -**

5   **Which is reduced still further by (also enabled) "Automatics/Robotics" - Uninhabited**

6   **Combined with Much lighter/cheaper Revol. Materials/Fabrication for structure and energetics (propul./warhead) - Yields "Cheap Warfare"**

And Then There Is NANO ...

Future Warfare "On The Cheap"

- **Info/net warfare**
- **Binary bio [anti-functional/fauna]**
- **Non-lethals**
- **Miniature brilliant sensor-mines**
- **Micro/Nano Sats**
- **LO/Long leg/precision UUV's/UAV's/Cruise**
- **Inexp./Superb/survivability ISR/comms**
- **Blast wave accelerator**

"Then Year" "Peer Competitors"

Peer Competitor no longer defined by "megatonnage" of obsolescent Industrial age steel and aluminum Artifacts. The Drastically reduced entry investment enabled by "Warfare on the Cheap" ensures almost any nation or sizable organization can be a very worrisome Military "peer."

SOME INTERESTING POSSIBILITIES

- **Surreptitious nano "tagging" (with MW interrogation) of "everything/everyone" (imprinted during manufacture/maintenance etc.)**

- **Detonation of offshore seabed methane hydrate deposits to produce tactical/strategic level tidal waves against littoral regions**

- **Demise of "stealth" via ubiquitous multi-static, multi-physics sensors operated on "take-a-vote"**

"Anti-Access"

- **MINES**
- **Hordes/Swarms (country-sized/dispersed magazines) of small/inexpensive/brilliant cruise/UAVs, micro rockets, BWA/slingatron projectiles, UUVs (e.g. RPGs on jet skis)**
- **Tyvek nets**
- **Attrite/"take out"/threaten APODS/SPODS**
- **EMP, IW/IO**
- **TBM/Cruise/HPM/Lasers**
- **"The Sensor Web"**

Counters to U.S. "Information Dominance"

- **EMP ("conventional," Isomers/other HEDM, Nuc.)**

- **Jammers "in the Large"**

- **"Fry" (MW, Lasers), "Blowup"**

- **Anti-Sensor (various, include D&D)**

- **"Software" (subvert/deception/decimation/Trojan Horse/viruses/etc., other IO/IW)**

- **"Chaos" (Excite circuit nonlinearitys)**

- **PSYWAR**

Counter U.S. Logistics

- **Take out pre-positioned everything**

- **Ubiquitous nano inexpensive multiphysics, hyperspectral land/sea/air/space military, scientific, commercial sensors; Nano tags (aka "The Sensor Web")**

- **Target/attrite logistic air/sea lift over continental shelf via Brilliant mines, cruise, UAVs, UUVs, TBMs, Micro missiles, prepositioned semi-submerged missile "eggs," AI/vortex SS weaponry (include Subsam), BWA, slingatron, Automatic MANPADS in CONUS (via Blast/EMP etc.)**

- **Small number of military ports/airfields in CONUS; C-17/5/141, Ro-Ro/other ships, trains inside CONUS are non LO, undefended**

Anti-U.S. RMA "Strategies/Tactics"

- **Threaten Bio to force "suit-up"/degrade effectiveness**
- **Keep forces beyond range of short-legged fighters**
- **Attrite JSTARS/AWACS/ABL/Missile "cows" etc. platforms**
- **Miniaturize/Disperse EVERYTHING - no large/massed/ interesting targets**
- **Use "Hard to Degrade"/Jam optical Comms/GPS**
- **Operate out of cities/International Commercial Entities**
- **Degrade U.S. Info Dominance**
- **Machine Intell. "automatic warfare," (much) tighter OUDA loop (faster than Human ops)**

Exploit "CNN Syndrome"

- **Sink Carrier(s) via "swarm attacks"**
- **Capture/torture Americans in living color on prime time**
- **"Terror" attacks within CONUS (binary bio, critical infrastructure "takedown," IO/IW, EMP, RF against Brain, etc.)**
- **Serious "Psywar" (collateral damage exploitation, etc.)**

The Key Technologies

- **Free form/"point of use" fabrication**

- **Beyond silicon computing (quantum, optical, bio, nano, molec.**

- **Optical comms/nav**

- **Nano sensors/tags/materials/bots/GNC**

- **HEDM explosives and propellants (NANO POWDERS, CUBANES, SBER, ISOMERS, LENR, THERMOBARICS, F-S LASERS/4TH GEN NUCS)**

- **Anti-personnel/material (Binary) Bio, MW**

- **Robotics/Machine Intelligence**

- **Miniaturized/brilliant/lightweight/low-power/inexpensive swarms of <u>everything</u> (SATS, weapons, robots, sensors, mines, etc.)**

Fundamental Military Issues/Metrics

- **<u>Affordability</u>** ["Warfare on the Cheap"]

- **<u>Survivability</u>** ["Can see everything, Anything you can see you can kill"]

- **<u>Effectiveness</u>** [Lethality of Precision and Volumetric weaponry]

   I.E. Simultaneous ongoing Revolutions in all three of the major Warfare Metrics

Given the Superb/Ubiquitous World Wide Sensor Suites and Precision Strike Capabilities "Then Year" the Following <u>WILL NOT BE SURVIVABLE</u>

- **APODS/SPODS**

- **Runways**

- **Surface Ships**

- **Manned (logistic/combat) Aircraft**

- **Manned (logistic/combat) Ground Vehicles**

<u>**Due to their size & (multi-physics) signatures**</u>

CONCERNING (CURRENT) FARTHER TERM (U.S.) DEFENSE "STRATEGIC STUDIES"

- **Almost wholly dedicated to/concentrated on <u>offensive</u> operations (DOO?)**
  - **Across the board (Army, Navy, Air Force, Marines, OSD)**
- **(Apparent) wholly inadequate consideration of defense**
  - **Defense of Conus, especially from short time of flight inshore undersea attack**
  - **Defense of the offensive forces [especially in terms of the "enemy after next" capabilities definitization and response(s) thereto]**
  - **Defense of the logistics assets, especially "out of theater"**

Typical Scenario - "Takedown" of U.S. by 10 People and <$10M

- **Binary Bio [via (imported Vitamins/Clothing, etc., food supply(s)]**

- **Terror Bio (e.g. Aflatoxin)**

- **IW ("usual" plus physical against key nodes such as Railroads - take down the economy)**

- **Selective anti-personnel RF/MW (Towers)**

- **Water Supply Contamination via Intercontinental UAV's**

Accompanied by SERIOUS "PSYWAR"

Trends Summary

- **Tele-everything**
- **U.S. just "one of the crowd" economically**
- **"Warfare on the cheap," many potential "peers"**
- **Warfare Increasingly Robotic**
- **Survivable/Affordable power projection via deep water subs and Blast Wave Accelerators**
- **CONUS and Logistics Defense increasingly worrisome**

FROM U.S. COMMISSION ON NATIONAL SECURITY/21ST CENTURY

- **It will soon be possible to connect human brain cells to silicon chips**

- **Due to IT technology we will witness the "death of distance"**

- **More than 2/3rds of the satellites are foreign owned**

- **Large scale missile attacks will be able to overwhelm defensive systems**

- **Development of genetically engineered pathogens that will thwart our bio detection/defense measures/cycles**

"Circa 2025"

- **Machines as creative/"smart" as humans "Robotics" the "norm"**

- **Zeroth order "warstopper" - Binary bio into nation's agric./food distrib. system (every home/fox hole)**

- **Next level of concern: Ubiquitous/Cheap micro-to-nano EVERYTHING (sensors, munitions, weapons swarms/hordes)**

- **Battlefield attrition/CNN syndrome forces U.S. Army to look/act like SOCOM**

(Suggested) Major U.S. Future (2025) Warfare Issues

- **CONUS Defense (Requirement(s) for, potential approaches)**

- **Logistics Defense/Protection (in/out of theater)**

- **Survivability/Effectiveness of U.S. Forces on/near the "Killing Ground" in an era of affordable ubiquitous multiphysics hyperspectral sensors, precision strike, volumetric weaponry, "swarms" and hardened munitions**
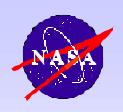
- **"Non-explosive Warfare" (psywar, biowar IT/net war, "anti-operability war," Beam weaponry including RF, Spoofing/Cammo**
- **Robotic Warfare "in the large"/better than human AI/"Cyber life"**
- **Alternative Power Projection Approaches (e.g. Deep Water depth/death sphere, blast wave accelerator, etc.)**

Future "Power Projection"?

- **Humans "hold" instead of "take" ground (go in after "Sanitization")**

- **Sanitization via:**
  - **IW/Psywar**
  - **Global Reach "Guns" (BWA/Slingatron)**
  - **Deep water/large loadout Subs w/"swimins"**
  - **"Robotic Everything" w/Volumetric weaponry, non-explosive warfare**
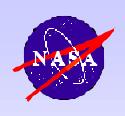
Future(s) of SOF

- **Becomes THE (only survivable) HUMAN Strike Force (Army/Marines forced to become "SOF-Like")**

- **Increasingly The "Overseas FBI" to counter the increasingly capable (IO/Bio WMD) & horrific destructive power of INDIVIDUALS and Groups**

- **Ops involve increasingly difficult-to-deal-with omni-present/omni-physics sensor/ID suites, Few-to-No exploitable Interstices for Covert/Clandestine "work" - THE Challenge**

Future "Warfare"

- **"Defense" against the "then year" multitudinous conventional and unconventional delivery methods for volumetric and precision munitions is essentially neither doable nor affordable.**

- **Suggested National Defense Approaches:**
  - **Work Technology, Intel, Diplomacy, SOCOM for detection/interdiction/deflection of the "pre-delivery" phases (causes of war, motivational and decision processes, design and construction, test)**
  - **Work and ADVERTISE a REALLY EFFECTIVE RETRIBUTION to deter delivery (ala MAD)**

Changing Nature of Warfare

Hunter/ Gatherer	*Hunting Grounds*	*Tribal Bands*	*Hand Held/ Thrown*
Agricultural	*Farm Lands*	*Prof. Armies*	*Hand Held/ Thrown*
Industrial	*Natural Resources*	*Mass Levee*	*Mech./Chem.*
IT/Bio/Nano	*Societal Disruption*	*Everyone*	*IT/Bio'Bots*

RMA Planning "Shortfalls" (NPS)

- **"Indications of the innovative paths adversaries might take or how they might adapt technologies from the civilian world"
(Being worked in the "Technical War Games")**

- **"The path from todays systems and capabilities to those hypothesized for the future (2020+)"**

What is needed is a "Then Year" (~2030) Serious/Holistic Vision of Warfare Changes Resulting from the On-going IT/Bio/Nano/Virtual Technological Revolutions

- Such does not exist, "bumper sticker" attempts extant.

- All are agreed, warfare will become increasingly robotic and probably more affordable, swarms of sensors/shooters are a given.

- A longer term "Vision" of these changes would enable "mapping" from the present, NOT AT ALL CLEAR HOW TO "Get There From Here" as do not know where "there" is!

"**War between mass armies weighed down with baroque equipment has become a third world sport. The advanced world, too vulnerable to survive a war of attrition or mass destruction, must learn to conduct its affairs by the Rapier--by the threat or use of small specialized forces exploiting high tempo and strategic surprise**"

R. E. Simpkin, "Race to the Swift: 1985

In the second half of the 1900's Nuclear/Bio Warfare was "Unthinkable"
In the first half of the 2000's "conventional" warfare may become so deadly/effective as to become "Unthinkable" ("Killer Aps" available to mitigate the "Causes of War")

Approaches to Countering Group/Individual Deployment of IO/Bio WMD

PREVENTION -

- Universal inexpensive Web based educ.

- Biomass via sea water irrigation

DISCOVERY -

- All Source Intel/Fusion/AI Analysis

PREEMPTION/RETRIBUTION -

- SOF (Foreign)

(Usual) Reactions to this Presentation

- **Is in the "Too Hard Box"**

- **Not being done yet by anyone, therefore, will not be done**

- **They would not do that**

- **We have to Hope they would not do that**

- **Why go there, cannot defend against it**

- **Some Disbelief, but agreement there is too much there to disregard**