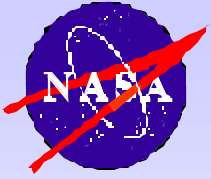


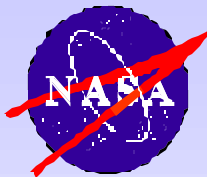
Dennis M. Bushnell  
Chief Scientist  
NASA Langley Research Center

# **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**

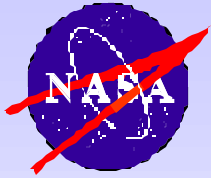


**The 'Bots, 'Borgs, ' & Humans  
Welcome You to  
2025 A.D.**



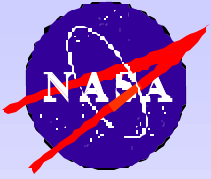
# **THIS PRESENTATION BASED ON “FUTURES” WORK FOR/WITH**

- **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**



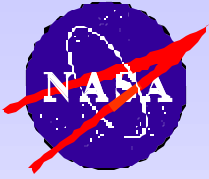
# **THIS PRESENTATION**

- **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**



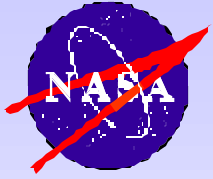
# Utilization/Application of 2025+ Projections

- 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



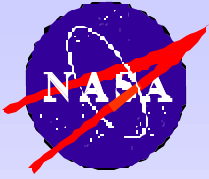
# “Going In” Assumptions

- 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**



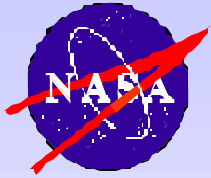
# **“SPACESHIP EARTH”**

## **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**

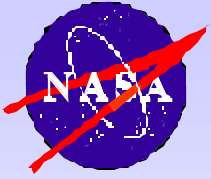
**P. Creola**





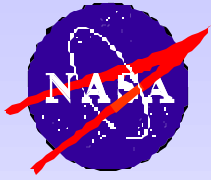
# Humans Have “Taken Over” and Vastly Shortened “Evolution”

- **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.)



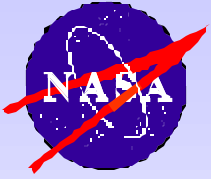
# CURRENTLY

- **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)**



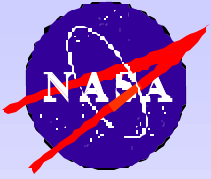
# NanoTechnology Research

- **29% in Europe**
- **28% in Japan**
- **27% in U.S.**
- **16% “Other(s)”**

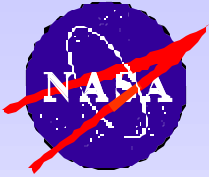


# Technological Ages of Humankind

- **Hunter/Killer groups [Million BC~10K BC]**
- **Agriculture [10K BC~1800 AD]**
- **Industrial [1800~1950]**
- **IT [1950~2020]**
- **Bio/NANO [2020-?]**
- **Virtual**



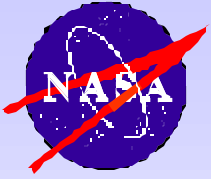
- **Hunter-Gatherer - “Nature Provided”**
- **Agriculture - Controlled Nature  
(Plants/Animals)**
- **Industrial - Mechanized Agriculture**
- **IT/BIO/Nano - Automating  
Industry/Agriculture**
- **Virtual - Robotization of  
IT/Bio/Nano/Industry/Agriculture**



## KEY “FUTURE TECHNOLOGIES”

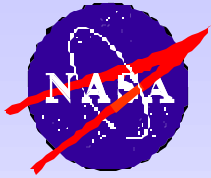
*(all highly synergistic/at the frontiers of the small,  
in a “feeding frenzy” off each other)*

- **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

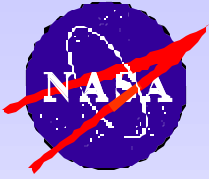
- **Comms/Computing/Sensors/Electronics**
- **U.S. Commercial IT R&D ~ \$100B/yr.**
- **Factor of 1 Million further improvement [Silicon,Molecular,Quantum,Bio,Optical]**
- **Beyond Human AI?**
- **Automatics/Robotics “in the large”**
- **Immersive multi-sensory VR/”Holodecks”**
- **Ubiquitous multi physics/hyperspectral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



# [Worldwide] Impacts of Ongoing IT Revolution Upon Society

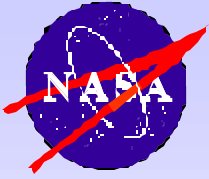
- **Tele-commuting**
- **Tele-shopping**
- **Tele-entertainment**
- **Tele-travel**
- **Tele-Education**
- **Tele-medicine**
- **Tele-commerce**
- **Tele-politics**
- **Tele-socialization**





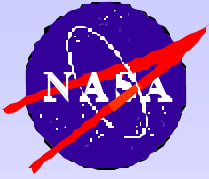
# IT Status

- **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**



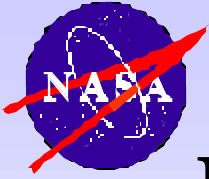
# AI (AND BEYOND) COMPUTING

## 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”**

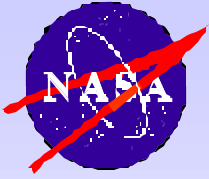
## Machine Capabilities

- **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**



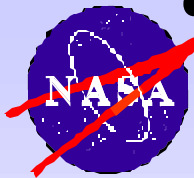
# U.S. “HUMAN BRAIN PROJECT”

- **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**



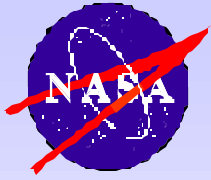
# THE “IMAGINATION ENGINE” *aka “Creativity Machine,”* *aka “Creative Agent”*

- **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.”**



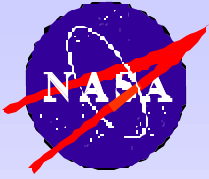
**“In this [Worldwide] economy our ability to create wealth is not bounded by physical limits/resources but by our ability to come up with new ideas”**

**[However, even “universal wealth” will not obviate the other causes of warfare which include Politics, “Face”, Religion, Megalomania and Territorial Disputes]**



# Global Problems/“Solutions”

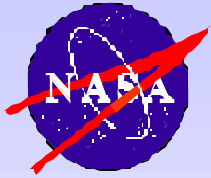
- (Serious) Problems
  - Energy (2)
  - Water (2)
  - Food (2)
  - Land (2)
  - Population Growth (1)
  - Wealth Generation (1)
  - “Pollution/Warming” (2)
- “Killer Ap Solutions”
  - (1) Motivational/inexpensive Web-based Asynchronous “Distance Learning”
  - (2) Bio mass/food via seawater irrigation 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”**



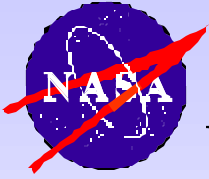


Motivational learner/web-based asynchronous distance learning ~~allows~~ only method of providing requisite/improved educational

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

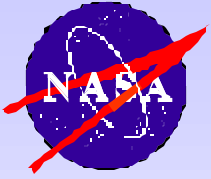
At orders of magnitude

- (1) reduced societal/individual cost
- (2) increased convenience/accessibility



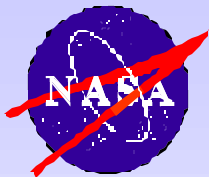
By ~ 2025, 40% of Private and  
15% of Public Colleges and  
Universities are Expected to  
Close Due to Web-Based  
Competition

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



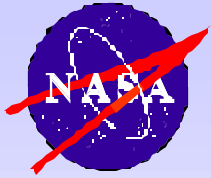
# **The “Ultimate” Education Approach - Plug and Play**

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



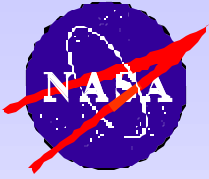
# **Advantages of Shallow Sea/Desert Production of Biomass (Via Seawater Irrigation)**

- **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.)**



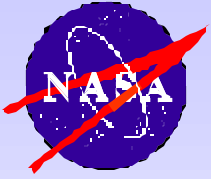
# Probable Circa 2025 Societal Changes

- (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)**



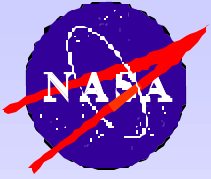
# **Of Particular Concern**

**Uncontrolled/Uncontrollable**

**SELF-REPLICATION**

**Of**

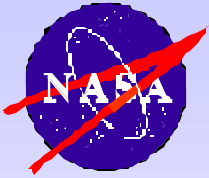
- Brilliant Robots (IT)**
- Nano-Replicators (Nano)**
- Rampant Recombinant Bio**



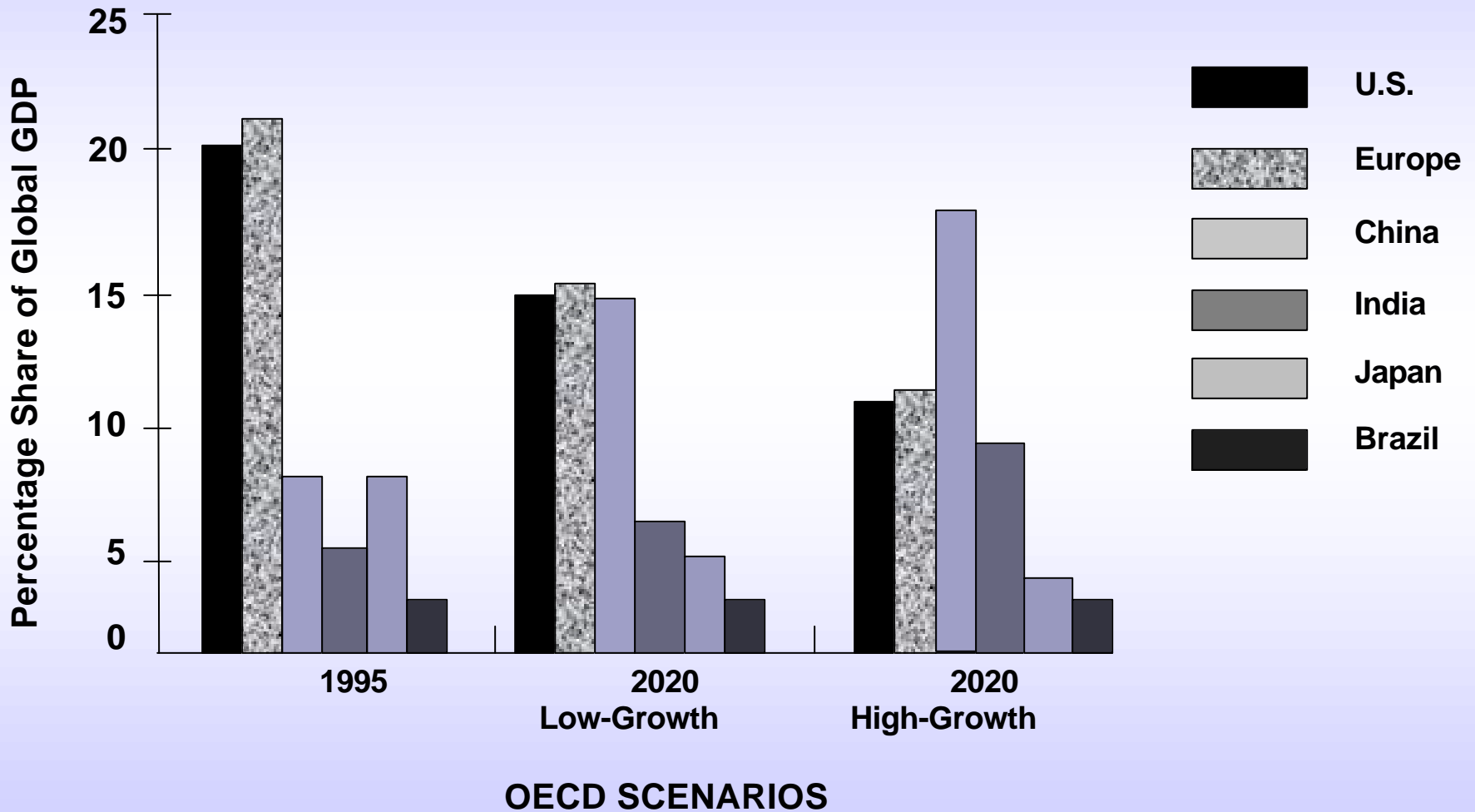
# Current Competitive Landscape

- **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**

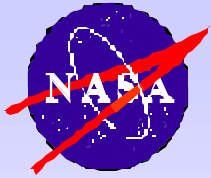




# AN EMERGING MULTIPOLAR ECONOMIC WORLD

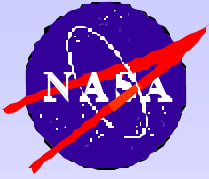


Source: OCED, *The World in 2020*, p. 92



# **Bio Revolution Applications**

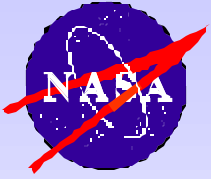
- **“Pharm Animals” [drugs, spare parts]**
- **Fast Growing plants on/near sea surface & sea water irrigated plants for biomass energy/closed CO2 cycle**
- **Polymer growing plants**
- **Spider genes in goats allow spider silk spinning from goat milk for “Biosteel”, 3.5X strength of aramid fibers for Armor**
- **Binary Bio-weaponry**



# Examples

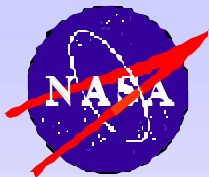
## Confluence of IT/Bio/Nano

- **Brain of a sea lamprey 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”**



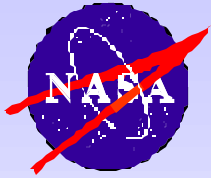
# Carbon Nanotubes

- **C1,000,000, Buckminster Fullerene 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**



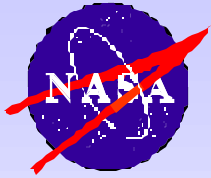
# Revolutionary Power Generation/Storage Opportunities

- **Ultracapacitors**
- **Adv. Fuel Cells (e.g. Lithium/water/air)**
- **HEDM (e.g. Solid H<sub>2</sub>, Isomers, anti-matter, etc.**
- **Adv. PV (50%?)**
- **Room Temperature SC/SMES**
- **C-Nanotube storage of H<sub>2</sub> (non-cryo)?**
- **Offshore Methane Hydrate**
- **Black light power?**
- **LENR**
- **ZPE**



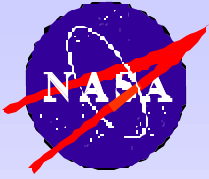
# Free Form Fabrication

- **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**

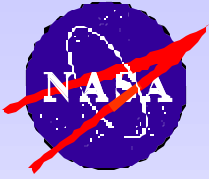
- **Micro powdered Aluminum fed into a vortex combustor “burns” SEAWATER**
- **Provides AIP with high energy density/efficiency for:**
  - inexpensive SS with “near SSN” perf.**
  - Transoceanic UUV’s**
- **Would allow “Enemy After Next” to AFFORDABLY Threaten CONUS via Multitudinous in-shore short-time-of-flight “popups”**



# **(Sample) New(er) Sensors**

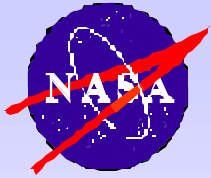
- **Lidar w/ 50% efficiency via S-C optical Amplifiers, Also Fempto-second Lasers**
- **Molec./Bio Sensors**
- **Nanotags**
- **Smart Card Sensors**
- **Sensors implanted during Manuf./Servicing**
- **Nano IR (10E-6 Sensitivity)**
- **Smart Dust**





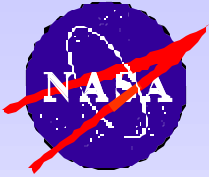
# Some Sensor “Swarms”

- **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

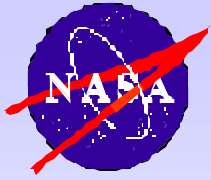
- **Optimal Positioning of Explosive Dust -  
Dust/Air Explosives**
- **Formation of “Explosive Lenses”**
- **Infiltration of Deeply Buried/other such  
targets**



# Micro Dust Weaponry

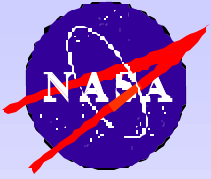
**A Mechanical Analog to Bio, Micron sized mechanized “dust” which is distributed as an aerosol and inhaled into the lungs. Dust mechanically bores into lung tissue and executes various “Pathological Missions.”**

**A Wholly “New” class of Weaponry which is legal.**



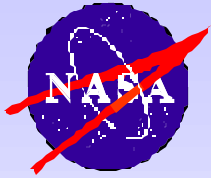
# **“Givens” (Now-to-“Soon”)**

- **Gb data transfer rates, optical comms**
- **Petaflop + computing**
- **Exceptional AI (from Bioinformatics, 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**



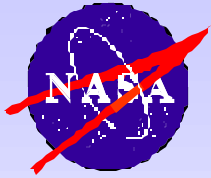
# (Agreed Upon) Assumptions, Combat in 2025

- 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**



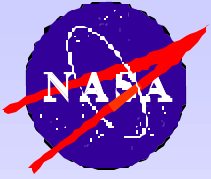
# Cruise Missiles (Current Status)

- **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 “hordes” of very capable/easily concealed/very difficult (and expensive) to counter/accurate cruise “missiles” with a potential “devil’s brew” of warheads.**

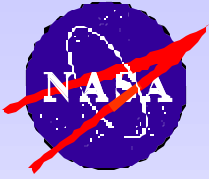


# “Volumetric” Weaponry

[Alternatives to HE]

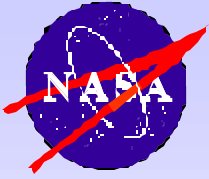
- **EMP**
- **Info/Net/Psy warfare**
- **Miniature brilliant sensor/mine combo’s**
- **Fuel/air & dust/air/Thermobarics**
- **RF**
- **Chem/bio Antifunctionals/antifauna**
- **Isomers, Strained Bond Energy Release, etc.**
- **Carbon fibers and “Blades,” Acoustics etc.**





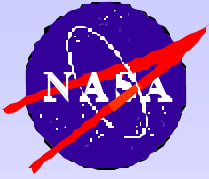
# Antipersonnel MW/RF Weaponry

- **Heating [High Power Requirements(s)]**
- **Surface Effects**
- **Brain Interactions [Low Frequency Modulation]**



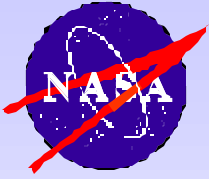
# **EFFECTS OF LOW POWER MICROWAVES (U.S. ARMY, SRI, WALTER REED)**

- **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**



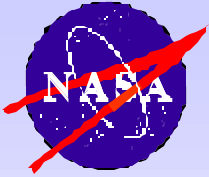
# Often “Fingerprintless” Bio Archipelago

- Bacteriological
- Viruses
- Prions
- Parasites
- Fungi
- Carcinogens
- Toxins
- Hormones/Regulators
- Fatal-to-disabling
- Short-to-long time scales
- Anti-flora/fauna/functional
- Direct and (undetactable) Binary
- Natural, Genomic
- Bio-Hacking



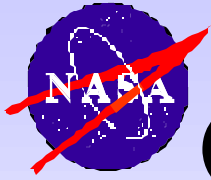
# Some Interesting “Then Year” BW Possibilities

- **Aflatoxin - (“natural,” parts-per-billion, carcinogen)**
- **Airborne varieties of Ebola, Lassa, etc.**
- **Binary agents distributed via imported products (Vitamins, Clothing, Food)**
- **Genomically (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”

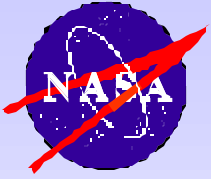
- **Sustainment:**

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

**GREATLY REDUCES**  
**“LOGISTICS TAIL” &**  
**ENHANCES CAPABILITIES**

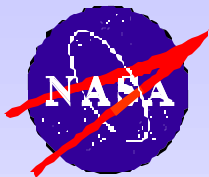
- **Lethality**

- **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”

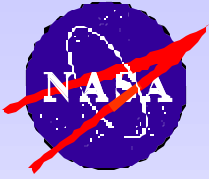
- **Microwave/RF Anti-Functional and Anti-Personnel Weaponry**
- **Chemical Anti-Functional Weaponry**
- **Chemical “Psychological Effects” via Sensory Organs Weaponry (e.g. smell)**
- **Chemical Personnel Incapacitation Weaponry [“Non-Warfare” (e.g. Hostage/Terrorism) only]**
- **PSYWAR**
- **Acoustic Weaponry**
- **Mechanical Micro Dust**



# **(FUTURE) NON-NUCLEAR EXPLOSIVES FOR “VOLUMETRIC”/ WEAPONS OF “MASS EFFECT”**

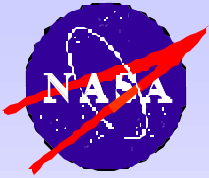
- **Metastable interstitial composite (MIC/Cubanes)**
  - **Order of 6 x TNT**
- **Fuel-air/dust-air explosives**
  - **Order of 15 x TNT**
- **Strain-bond energy release (SBER)**
  - **Order of 100 x TNT**
- **Hafnium (metastable) isomers**
  - **Order of 1,000 to 100,000 x TNT**
- **Atomic boron, carbon,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





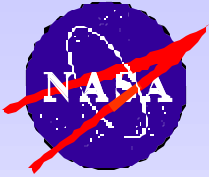
# High Energy Density Materials (HEDM) (Power, Explosives, Propellants)

- **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**



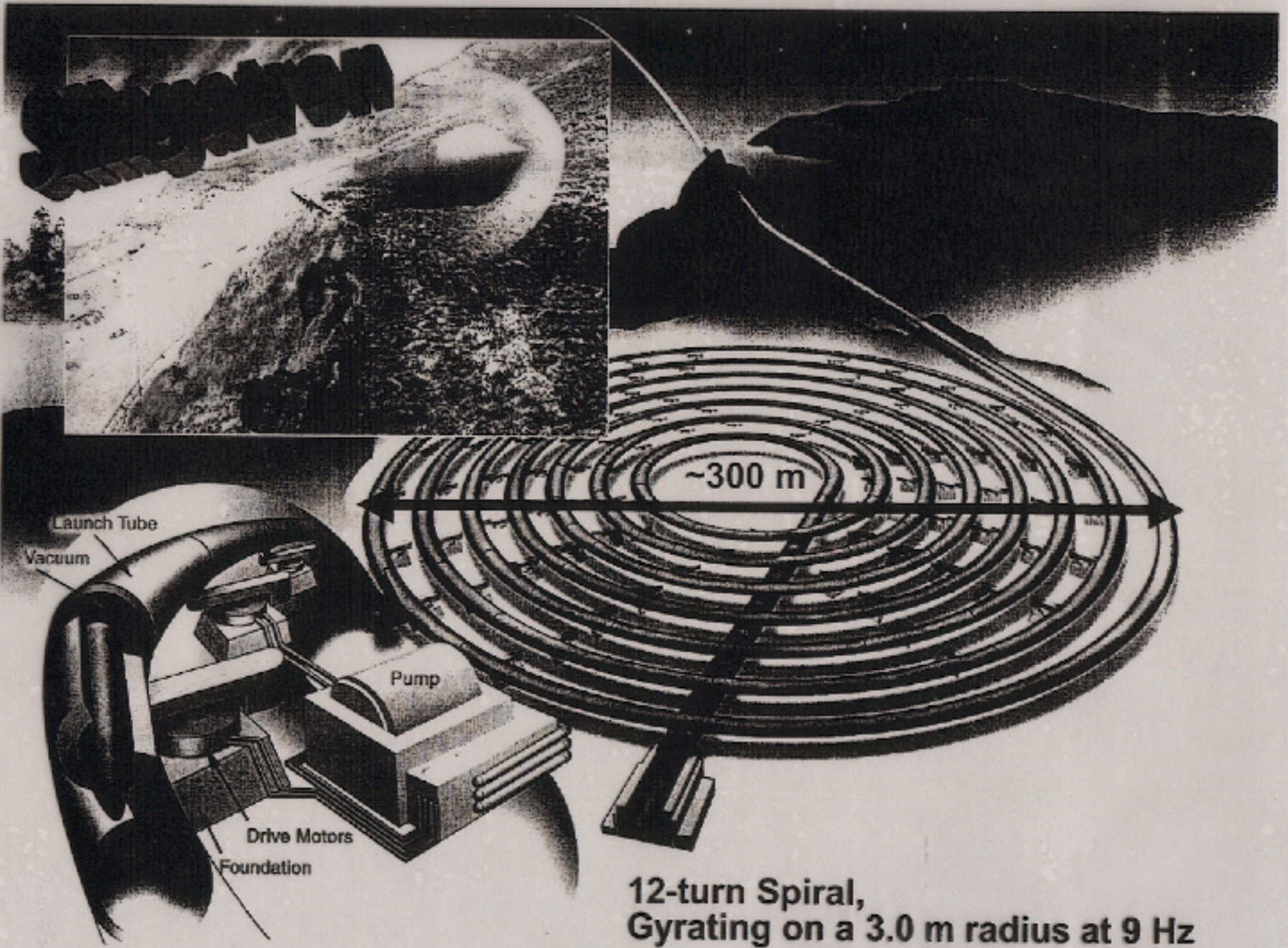
# Transoceanic UAV's

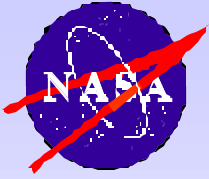
- **Current Capability - ('98 - 29 lbs, 2000 mi., 1.5 gals. Fuel; '01 - Transpac, 5000 mi.**
- **Provides Capability for Undetectable Ultra-inexpensive Swarms Against CONUS**
- **Interesting (Precision) "Payloads"**
  - **ISR**
  - **Smart Dust/Explosive**
  - **Target/explode Hazmat Trucks, Chem. Plants, 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**

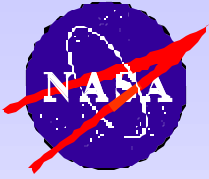
- **Global Precision Strike “On the Cheap”**
- **No barrel, ~200 ft. notched rails, sequentially detonated Distributed HE**
- **Mach 21 or less as desired, up to 3000 lb**
- **Base anywhere, ~\$200/lb of projectile**
- **Excellent stealth [no plume], affordability, ferocity, reaction time, survivability, recallability, effectiveness**
- **Being worked at Aberdeen and NASA MSFC for lofting of Fuel and Nanosats**





# **“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”**

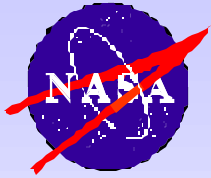


# Then Year Targeting/ Connectivity etc.

- **MILITARY overheads/systems**
- **Ubiquitous COMMERCIAL overheads/systems**
- **SCIENTIFIC overheads/systems**

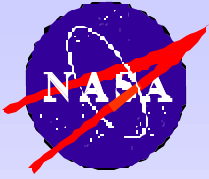
**IN the context of:**

- **Inexp. Reconstitution via micro/nano sats**
- **Optical comms /GPS etc.**
- **Ubiquitous inexp. UAV/HALE adjuncts**



**EXAMPLE: POTENTIAL “COMPETITOR” MILITARY  
(SURVEILLANCE/INTELLIGENCE/TARGETING/DAMAGE ASSESSMENT)  
UTILIZATION OF INTERNATIONAL SCIENTIFIC “GLOBAL CHANGE”  
PROGRAMS/ASSETS**

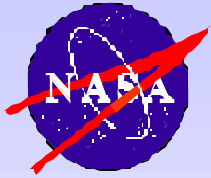
- Extensive/increasing international assets (land-based, ship, aircraft (conventional/HALE), spacecraft) dedicated to measuring, on a global scale, details of land, atmospheric, ice, ocean, biota status/“dynamics” (to understand total Earth “system” and effects of humans on the global environment)
- Extensive/magnificent/often redundant wide coverage and detailed instrumentation suite(s) (imaging radars/SARS/LIDARS/radar altimeters/laser altimeters/radiometers/scatterometers/spectrometers/IR sensors/ magnetometers/etc.
- Terrabites+ of data archived/readily/publicably available increasingly in near real time
- Sample measurements include: OH, O<sub>3</sub>, HCl, NO, NO<sub>2</sub>, N<sub>2</sub> O, CO, CH<sub>2</sub>, HNO<sub>3</sub>, CO<sub>2</sub>, H<sub>2</sub> 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**

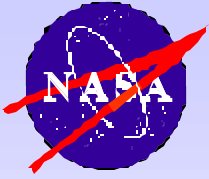
- **Range Enhancement Approaches:**
  - **Airbreathing or “water breathing,” to first order doubles range**
  - **Initial boost for cruise (ala Blast Wave Acceleror)**
  - **HEDM Fuels [Atomic Boron, Carbon, Isomers, etc.)**
  - **Drag Reduction (Wave/Friction/Drag-due-to-lift, Increased Dia.)**
  -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





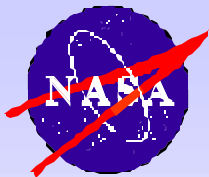
# **Summary - Major Influences of IT/Bio/Nano Upon Future Warfare**

- **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 (Physically, Mentally)**
- **Require Huge Logistic Train(s)**  
**i.e. Humans have rapidly decreasing-to-negative “Value Added”**



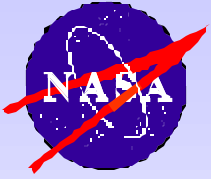
# ROBOTICS “IN THE LARGE”

*(saves lives, enhances affordability,  
redefines risk/threat environment,  
enhances effectiveness)*

## “Unattended”

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

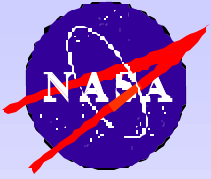
- Logistics
- Spoofing/obscurants
- RSTA (including NBC)
- Defense (across the board including counter recon/ambush)
- Offense
  - Obstacle breaching
  - “The Shooter” (especially Mout)
  - Mine Clearing



# Emerging Characteristics of Robotic Systems

(Enabled by Ongoing IT Revolutions-  
Comms/Sensors/Computation/Miniaturization)

- From expert systems toward **AI and beyond**
- 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



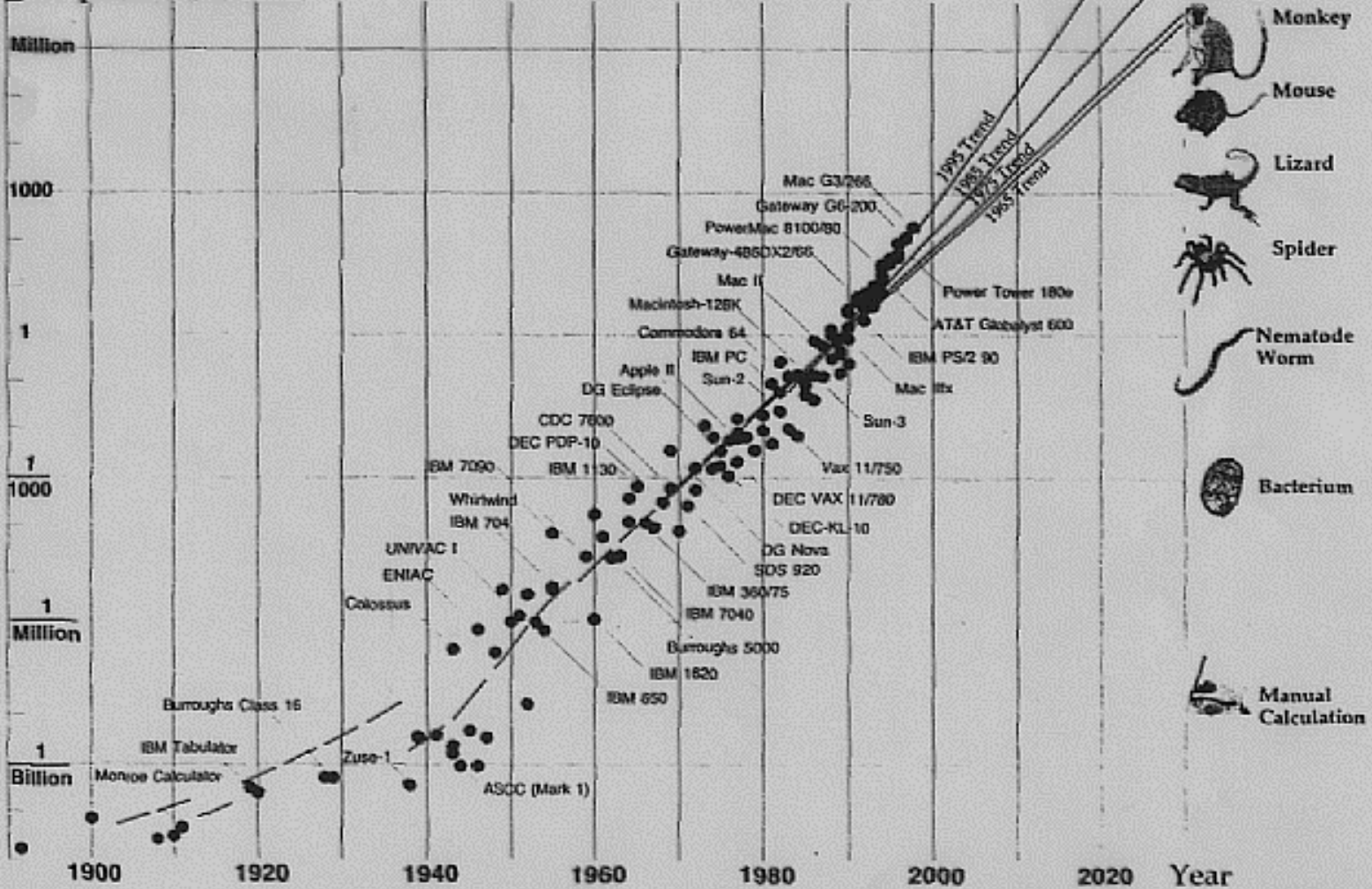
# Robotic Intelligence

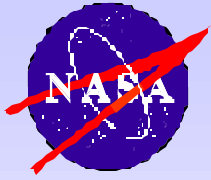
- **Two “flavors”**
  - **Traditional AI - Rule Based**
  - **Experiential - Behavior Based (Neural Nets/other “Soft Computing”)**
- **Combination of these is current “best bet” (per Moravec) to produce artificial/cyber “life” which will possibly-to-probably be sentient but will not be anthropomorphic**

# Evolution of Computer Power/Cost

## Brain Power Equivalent per \$1000 of Computer

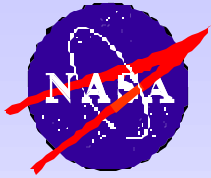
MIPS per \$1000 (1998 Dollars)





# WHAT IS BEYOND ROBOTIC SYSTEMS (SENSORS/PLATFORMS/WEAPONS/ MUNITIONS)

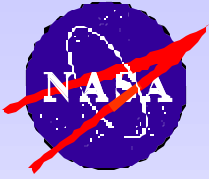
- Robotic/automatic → autonomous warfare?
    - Computer capability will exist (beyond terra flop) to do “AI” (or better?), required connectivity is a “given”
    - Competitor capabilities /tempo sidelines the innate inadequacies of human interactions/education/conscious decision timelines
    - Little-to-no “troops” → “Acme warfare Ltd.”
    - Flat hierarchy → demise of “main in the chair?”
    - High level/”soft sciences” human aspects “boundary conditions”
      - Sociological/”humanitarian”
      - Political
      - Environmental
      - Religious
      - Psychological
      - Economics
      - Etc.
- Extent/scale, projected effects/  
Damage(s), personnel attrition  
(general-to-specific)*



# “Non-Explosive Warfare”

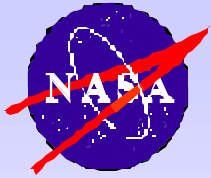
- **IW/IO**
- **PSYWAR “In-the-Large”**
- **Anti-Functionals**
  - **MW**
  - **Chem**
  - **Bio**
  - **Micro-Mechanical**
- **Anti-Personnel MW/RF, Micro-Mechanical**





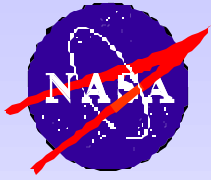
# “Natural Warfare”

- **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.)



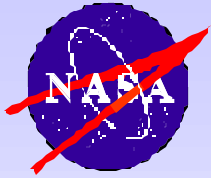
# **Characteristics - Future/Emerging Sensors/Munitions/Weapons/Platforms**

- **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**



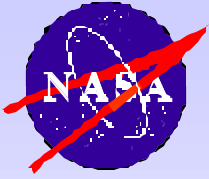
# **Potential Future “Orders of Magnitude” Increases in Overall Weapon Effectiveness/Availability at Orders of Magnitude Reduced Cost(s)**

- **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

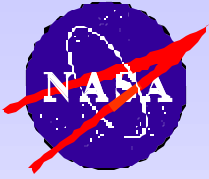
- **Long increasingly vulnerable logistics chain**
- **Long, “undefendable” coastline (esp. against underwater threats)**
- **Sensitivity to casualties (greatly enhanced by the “CNN syndrome”)**
- **Vulnerabilities to “terrorism” (esp. IT, bio)**
- **Increasing over reliance upon vulnerable “overhead”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



# Potential En-route Logistic Vulnerabilities

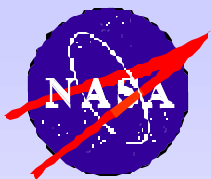
Logistic surface ships and aircraft are non-LO and undefended, could be targeted and attrited inside the continental shelf by:

- “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**

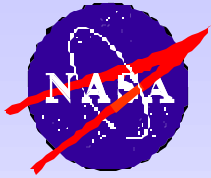
- **“EAN” can have “country sized magazines” filled with hordes of inexpensive Precision strike “Munitions” - Area Denial**
- **U.S. Forces run out of “bullets” and die [Beam weapons not panacea, inexpensive workarounds available]**
- **Deep Water Subs with large loadout/“swimin” weaponry only survivable “Close-in” platform**



# Sampling of TBM/Cruise Missile “Pen aids” (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)

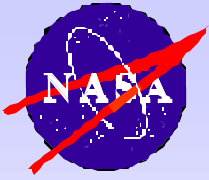
*e.g., current efforts involving beam weapons (laser, MW)  
“kills” of undefended”/“unpenaided” “dumb” incoming  
NOT REALISTIC*



# Potential “Workarounds” for Beam Weapon Effects on Missile Sensors/Comms

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



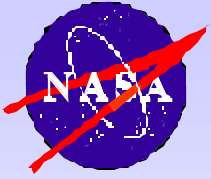


# Example ‘Then Year’ Direct Conus Attack Capabilities

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

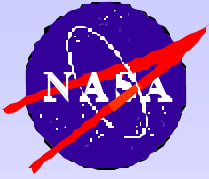
- Inexp. Transoceanic UUV’s/UAV’s/Cruise
- Inexp. Blast Wave Accelerators
- Inexp. Info/Net/Psywar
- Inexp. Inshore AIP SS [mines/torps/SLCM]
- **Inexp. Binary Bio into Food Supply**
- Inexp. Semi-submerged Missile “eggs”
- **Inexp. ‘Trojan Horse’ “civilian” systems**

[Above in addition to ICBM/TBM]



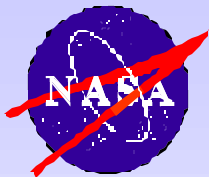
# **“Unconventional” Nuc Delivery**

- **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**



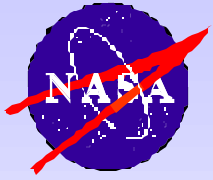
# (Civilian) IW Examples/CONUS

- (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!!!

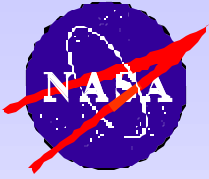


# **The Revolutionary Size/Capability/Cost Warfighting Spiral**

- 1 Commercial electronics/GNC/Comms/Sensors (Much smaller/cheaper/better - Allows:**
- 2 IO and “Precision” - Reduces Req’d. 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”**



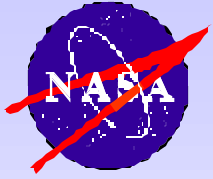
**And Then There Is NANO ...**



# Future Warfare

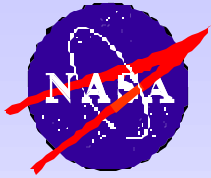
## “On The Cheap”

- **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”**

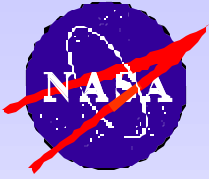
**Peer Competitor no longer defined by “megatonnage” of obsolescent Industrial age steel and aluminum **Artifacts**. The Drastically reduced entry investment enabled by “Warfare on the Cheap” ensures almost any nation or sizable organization can be a very worrisome Military “peer.”**



## **SOME INTERESTING POSSIBILITIES**

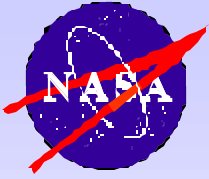
- **Surreptitious nano “tagging” (with MW interrogation) of “everything/everyone” (imprinted during manufacture/maintenance etc.)**
- **Detonation of offshore seabed methane hydrate deposits to produce tactical/strategic level tidal waves against littoral regions**
- **Demise of “stealth” via ubiquitous multi-static, multi-physics sensors operated on “take-a-vote”**





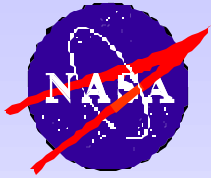
# “Anti-Access”

- **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”**



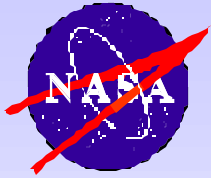
# Counters to U.S. “Information Dominance”

- **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 nonlinearities)**
- **PSYWAR**



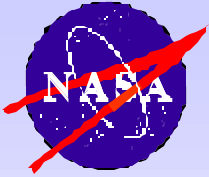
# Counter U.S. Logistics

- **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**



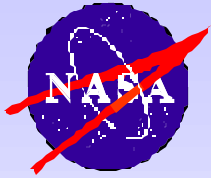
# **Anti-U.S. RMA “Strategies/Tactics”**

- **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)**



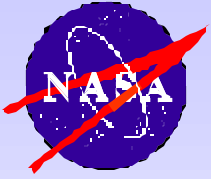
# Exploit “CNN Syndrome”

- 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

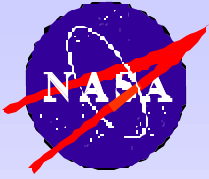
- **Free form/“point of use” fabrication**
- **Beyond silicon computing (quantum, optical, bio, nano, molec.**
- **Optical comms/nav**
- **Nano sensors/tags/materials/bots/GNC**
- **HEDM explosives and propellants (NANO POWDERS, CUBANES, SBER, ISOMERS, LENR, THERMOBARICS, F-S LASERS/4TH GEN NUCS)**
- **Anti-personnel/material (Binary) Bio, MW**
- **Robotics/Machine Intelligence**
- **Miniaturized/brilliant/lightweight/low-power/inexpensive swarms of everything (SATS, weapons, robots, sensors, mines, etc.)**



# Fundamental Military Issues/Metrics

- Affordability [“Warfare on the Cheap”]
- Survivability [“Can see everything,  
Anything you can see you can kill”]
- Effectiveness [Lethality of Precision and  
Volumetric weaponry]

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

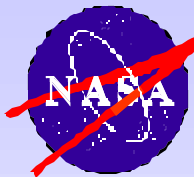


**Given the Superb/Ubiquitous World  
Wide Sensor Suites and Precision  
Strike Capabilities “Then Year” the  
Following WILL NOT BE SURVIVABLE**

- **APODS/SPODS**
- **Runways**
- **Surface Ships**
- **Manned (logistic/combat) Aircraft**
- **Manned (logistic/combat) Ground Vehicles**

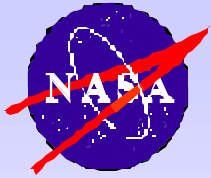
**Due to their size & (multi-physics)  
signatures**





# CONCERNING (CURRENT) FARTHER TERM (U.S.) DEFENSE “STRATEGIC STUDIES”

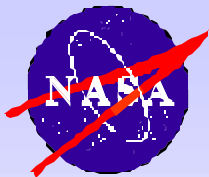
- **Almost wholly dedicated to/concentrated on offensive operations (DOO?)**
  - **Across the board (Army, Navy, Air Force, Marines, OSD)**
- **(Apparent) wholly inadequate consideration of defense**
  - **Defense of Conus, especially from short time of flight inshore undersea attack**
  - **Defense 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**

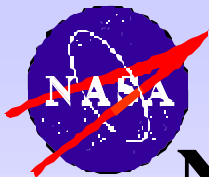
- **Binary Bio [via (imported Vitamins/Clothing, etc., food supply(s))]**
- **Terror Bio (e.g. Aflatoxin)**
- **IW (“usual” plus physical against key nodes such as Railroads - take down the economy)**
- **Selective anti-personnel RF/MW (Towers)**
- **Water Supply Contamination via Intercontinental UAV’s**

**Accompanied by SERIOUS “PSYWAR”**



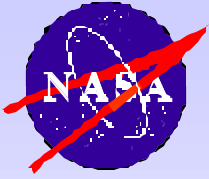
# Trends Summary

- **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**



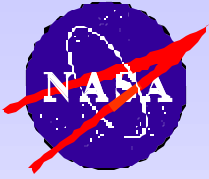
# **FROM U.S. COMMISSION ON NATIONAL SECURITY/21ST CENTURY**

- 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**



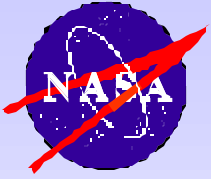
# “Circa 2025”

- **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**

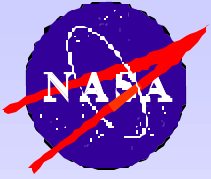


# **(Suggested) Major U.S. Future (2025) Warfare Issues**

- **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**



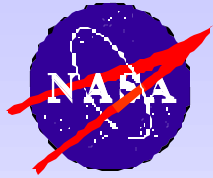
- **“Non-explosive Warfare” (psywar, biowar IT/net war, “anti-operability war,” Beam weaponry including RF, Spoofing/Cammo**
- **Robotic Warfare “in the large”/better than human AI/“Cyber life”**
- **Alternative Power Projection Approaches (e.g. Deep Water depth/death sphere, blast wave accelerator, etc.)**



# Future “Power Projection”?

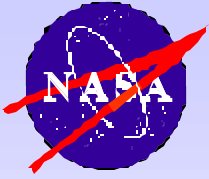
- **Humans “hold” instead of “take” ground (go in after “Sanitization”)**
- **Sanitization via:**
  - **IW/Psywar**
  - **Global Reach “Guns” (BWA/Slingatron)**
  - **Deep water/large loadout Subs w/“swimins”**
  - **“Robotic Everything” w/Volumetric weaponry, non-explosive warfare**





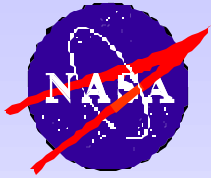
# Future(s) of SOF

- **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 omnipresent/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*

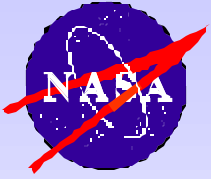
*Mech./Chen.*

**IT/Bio/Nano**

*Social  
Disruption*

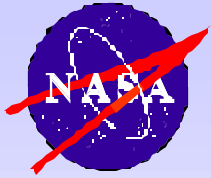
*Everyone*

*IT/Bio/Bots*



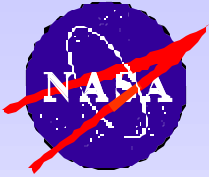
# **RMA Planning “Shortfalls” (NPS)**

- **“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 today’s systems and capabilities to those hypothesized for the future (2020+)”**



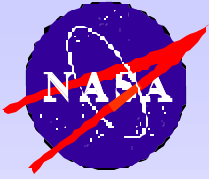
**What is needed is a “Then Year” (~2030)  
Serious/Holistic Vision of Warfare Changes  
Resulting from the On-going  
IT/Bio/Nano/Virtual Technological Revolutions**

- 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!



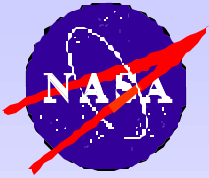
**“War between mass armies weighed down with baroque equipment has become a third world sport. The advanced world, too vulnerable to survive a war of attrition or mass destruction, must learn to conduct its affairs by the Rapier--by the threat or use of small specialized forces exploiting high tempo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

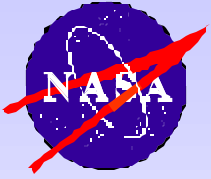
## DISCOVERY -

- 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**