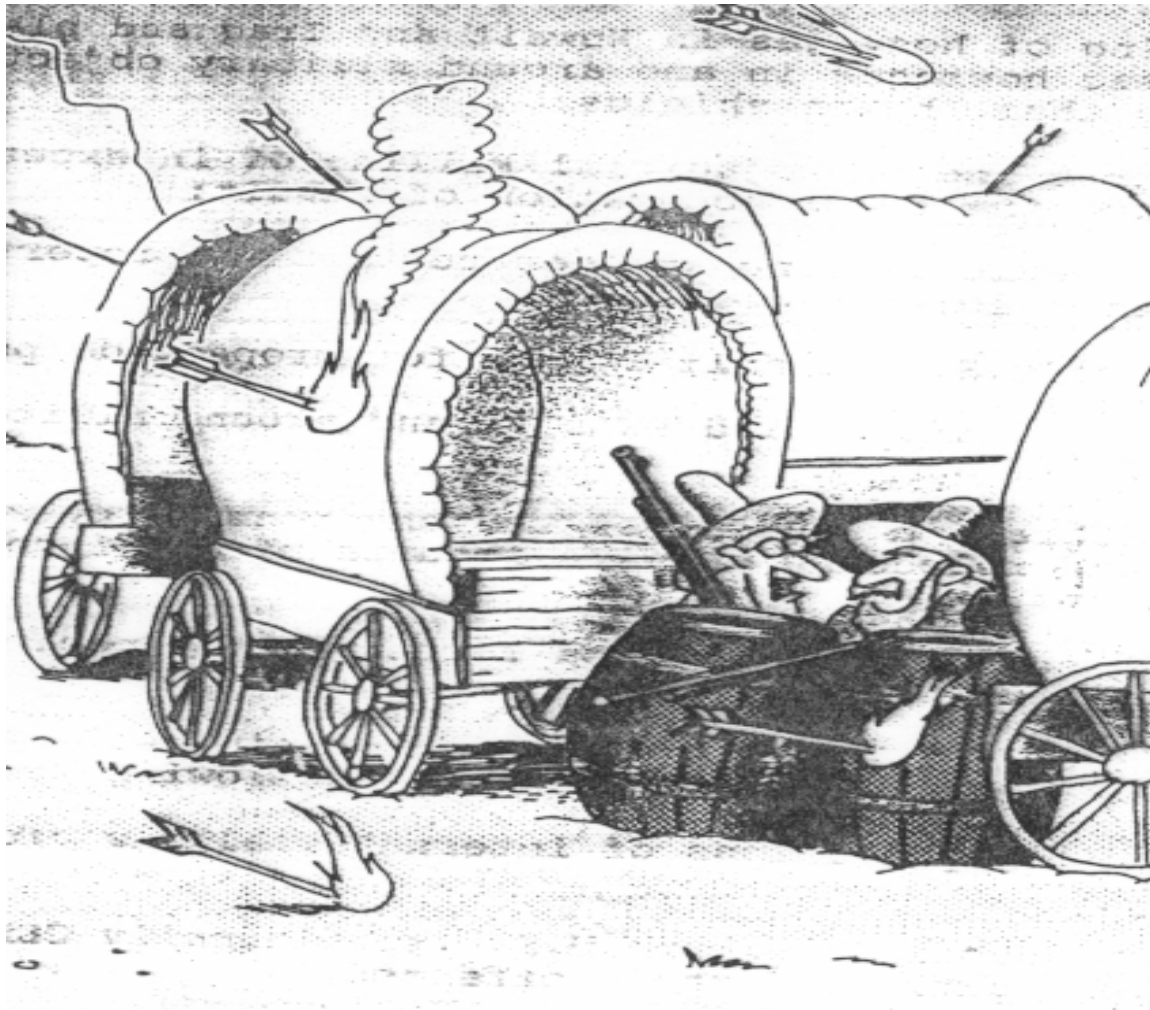




A Concept of Operations for Armed Autonomous Systems

*The difference between “Winning the War”
and “Winning the Peace.”*

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Hey, they're lighting their arrows...can they do that?

This is all about what is, and isn't, allowed under the Law of Armed Conflict (LOAC)

From the beginning of human history, man has been targeting his enemies with his weapons



Civil War dead



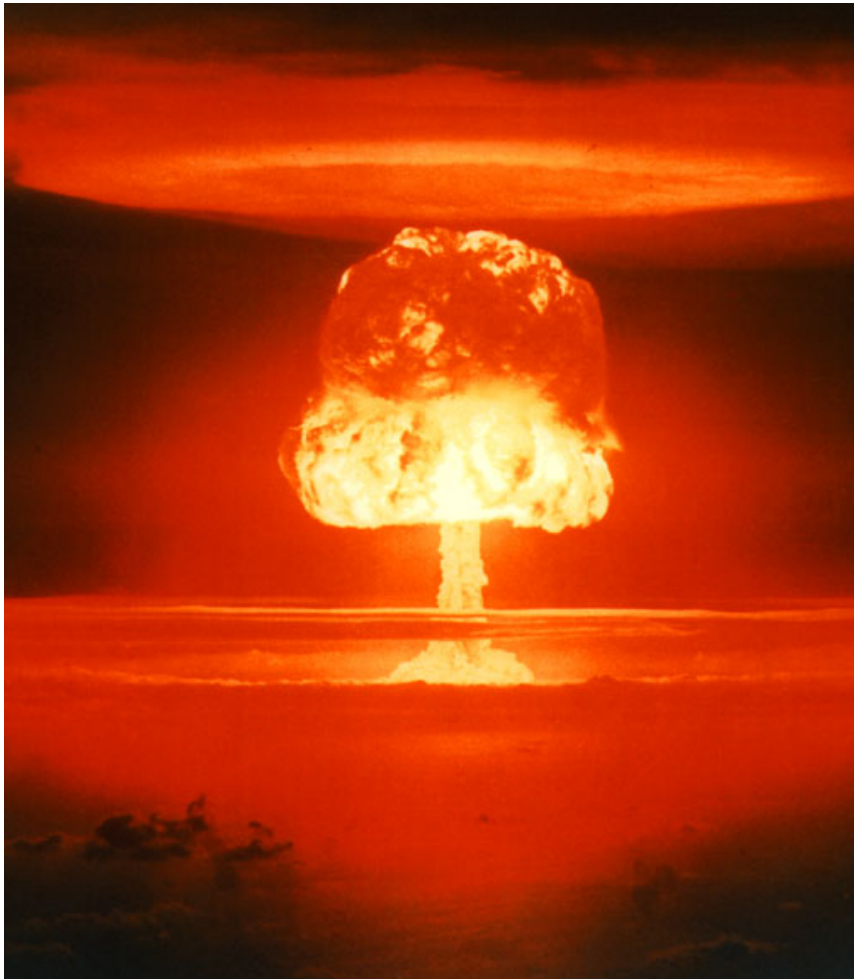
WWII Battle of the Bulge



Remembering the dead from Iraqi Freedom

How many millions have died, or been injured?

Under the Napoleonic Theory of War (everything is fair game), we have opted for the “bigger bang,” causing potential for incidental injury to civilians and collateral damage to civilian property to increase.



An atomic blast



The atomic dome in Hiroshima, located directly under Ground Zero.

Safety of innocent civilians wasn't the greatest concern.

Lessons from WWII: Destruction beyond that necessary to accomplish the military objective can prolong the war, and can make securing a lasting peace more difficult.



WWII bomb damage in the German city of Dresden



German civilians in Halberstad following 8 APR 1945 bombing



TV brought the Vietnam war to the nation's living rooms, put a human "face" on the war and contributed to civil and political unrest at home



Siege at Khe Sanh – 500lb bombs falling on NVA trenches



Vietnam War protest in Washington, D.C.



"The Wall"



Despite man's history of violence, there have long been restrictions on the use of force during war. Today, *treaties* as well as the *Law of Armed Conflict or LOAC* regulate the use of force during armed conflict.



- Now, all weapons and weapon systems, from small arms and ammunition to cruise missiles are subjected to a legal review to ensure compliance with the Law of Armed Conflict (LOAC) and applicable treaties.
- Additionally, once declared legal, the employment of these weapons may be further controlled by *Rules of Engagement* and the *Discriminate Use of Force*



Legal Review of Weapons

- DoD policy requires that a legal review be conducted of all weapons and weapon systems acquired to meet a military requirement of the US.
- Primarily this review requires an analysis of three factors:
 - (1) whether the weapon causes suffering that is needless, superfluous, or disproportionate to the military advantage reasonably expected from the use of the weapon. It cannot be declared unlawful merely because it may cause severe suffering or injury;
 - (2) whether the weapon is capable of being controlled so as to be directed against a lawful target, (i.e., it can *discriminate* between lawful and unlawful targets);
 - (3) whether there is a specific treaty provision or domestic law prohibiting the weapon's acquisition or use.
- These three factors are analyzed in relation to the weapon's intended method of employment, not in relation to any possible use, as any lawful weapon can be used illegally.

With regard to Armed Autonomous Systems, the critical issue is the ability for the weapon to discriminate a legal target

Rules of Engagement Defined

- Directives issued by competent authority which delineate the circumstances and limitations under which U.S. forces will initiate and/or continue combat engagement with other forces encountered.

Joint Pub 1-02

- ROE are based on the LOAC as well as political and military factors and can be utilized to guide the military use of force during a particular operation.



ROE can restrict the employment of certain weapons depending on the tactical, strategic or political situation.



Discriminate Use of Force (DUF)

- “Our concept of DUF strongly aligns with much of the current thinking about effects-based operations (EBO). The coming of age of these concepts is influenced both by *opportunity* and *need*.
- DUF brings new concepts for collaboration and massing of effects, which are joint in character and integrated among joint force echelons and components. It is enabled by new weapons; improved intelligence, surveillance, and reconnaissance; shared situation understanding; improved individual and collaborative training; greater agility; smaller footprints; and other emerging capabilities of the U.S. military that allow more timely and precise use of force than heretofore possible.
- *The need* is driven by the nature of current military campaigns. A striking feature of these campaigns is the tension among multiple strategic and operational objectives: cause regime change, destroy a terrorist organization, decapitate leadership, but preserve infrastructure, don’t wage war on a people, do hold an international coalition together, etc.”

“Report of the Defense Science Board Task Force on Discriminate Use of Force,” JUL 2003

Driven by new technology yielding better discrimination,
which leads to demand for even better technology



The Issue

- Using today's paradigm of warfare, there is a requirement to maintain an operator in the "weapons release"-loop to avoid the possibility of accidentally killing someone.
- An operator is effectively "welded" to each armed unmanned system for this purpose.
- This is a "performance- and cost-killer" when considering the employment of large numbers of armed unmanned systems

How can we effectively employ armed unmanned systems, while avoiding this problem?

Target Discrimination: How do you tell the difference?



Between a cruise ship...



Between people who are just mad at you...



...and a war ship?



...and a determined enemy?

What we want to avoid...



**This is your worst nightmare!
It is a safety issue concerning the innocents of war.**



A Proposed Concept of Operations (CONOPS) for Autonomous Use of Weapons

- **Let the machines target other machines**
 - Specifically, let's design our armed unmanned systems to automatically ID, target, and neutralize or destroy the weapons used by our enemies – not the people using the weapons.
 - This gives us the possibility of disarming a threat force without the need for killing them.
 - We can equip our machines with non-lethal technologies for the purpose of convincing the enemy to abandon their weapons prior to our machines destroying the weapons, and lethal weapons to kill their weapons.
- **Let men target men**
 - In those instances where we find it necessary to target the human (i.e. to disable the command structure), the armed unmanned systems can be remotely controllable by human operators who are “in-the-weapons-control-loop”
- **Provide a “Dial-a-Level” of autonomy to switch from one to the other mode.**

This CONOPS may overcome some of the political objections and legal ramifications of the use of Armed Autonomous Systems



Valid Targets from a Legal Standpoint

People

Things

	Not a Military Objective	Valid Military Objective
Not a Military Objective	Can't Target	Target People
Valid Military Objective	Target Things	Target All

“We can target objects when they are military objectives and we can target people when they are military objectives. If people or property isn't a military objective, we don't target it. It might be destroyed as collateral damage, but we don't target it. Thus in many situations, we could target the individual holding the gun and/or the gun and legally there's no difference.” – MAJ R. Craig Burton, USAF, Judge Advocate General's Legal Center and School



Target Subset for Autonomous Systems

People

	Not a Military Objective	Valid Military Objective
Not a Military Objective	Can't Target	Won't Target
Valid Military Objective	Target Things	Target Things, but Not People

Things

For autonomous systems, we are purposefully restricting the target set.



Legal Precedence Established

- TOMAHAWK Anti-Ship Missile
 - Passive Identification/Direction-Finding Equipment
- CAPTOR Mine
 - “Mousetrap that chases the mouse”
- AEGIS Ships
 - “Auto-Special” Engagement Mode
- Close-In Weapon System
 - Automatic Cruise Missile Defense
- Patriot Missile System
 - Automated air defense

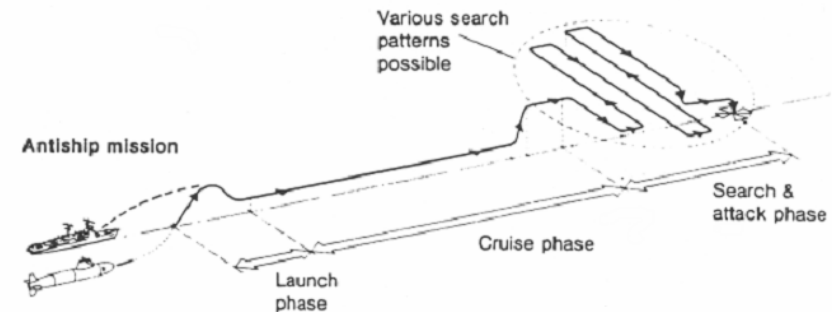
Each of these directly targets either the bow, or the arrow, but not the archer. People may still die, but as a secondary consequence of going after the weapon of war.

Tomahawk Anti-Ship Missile

1983 to about 1992



PI/DE Capability



From "The Commander's Handbook on the Law of Naval Operations," NWP 1-14M

9.9 OVER-THE-HORIZON WEAPONS SYSTEMS

Missiles and projectiles with over-the-horizon or beyond-visual-range capabilities are lawful, provided they are equipped with sensors, or are employed in conjunction with external sources of targeting data, that are sufficient to ensure effective target discrimination.

The missile is launched in the general direction of the target and at some distance from the expected target position, it enters a serpentine flight pattern to search for it using both passive radar to scan enemy emissions and active radar to lock on a detected target.

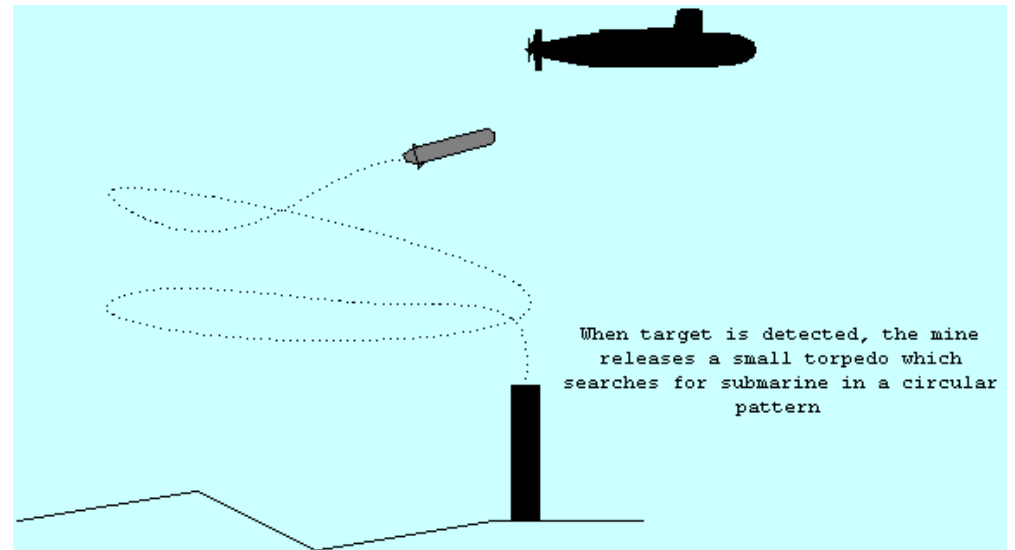


CAPTOR Mine System 1979- 2000



The mousetrap that chases the mouse

CAPTOR acoustically detects submarines while ignoring surface ships. Upon detection of a target, the mine launches an acoustic homing Torpedo Mk 46 Mod 6.





AEGIS Auto-Special Doctrine 1973-Present



AEGIS Auto-Special Doctrine allows “hands-off” engagement of AAW threats completely from initial detection to kill assessment, and the decision to re-engage, if necessary.

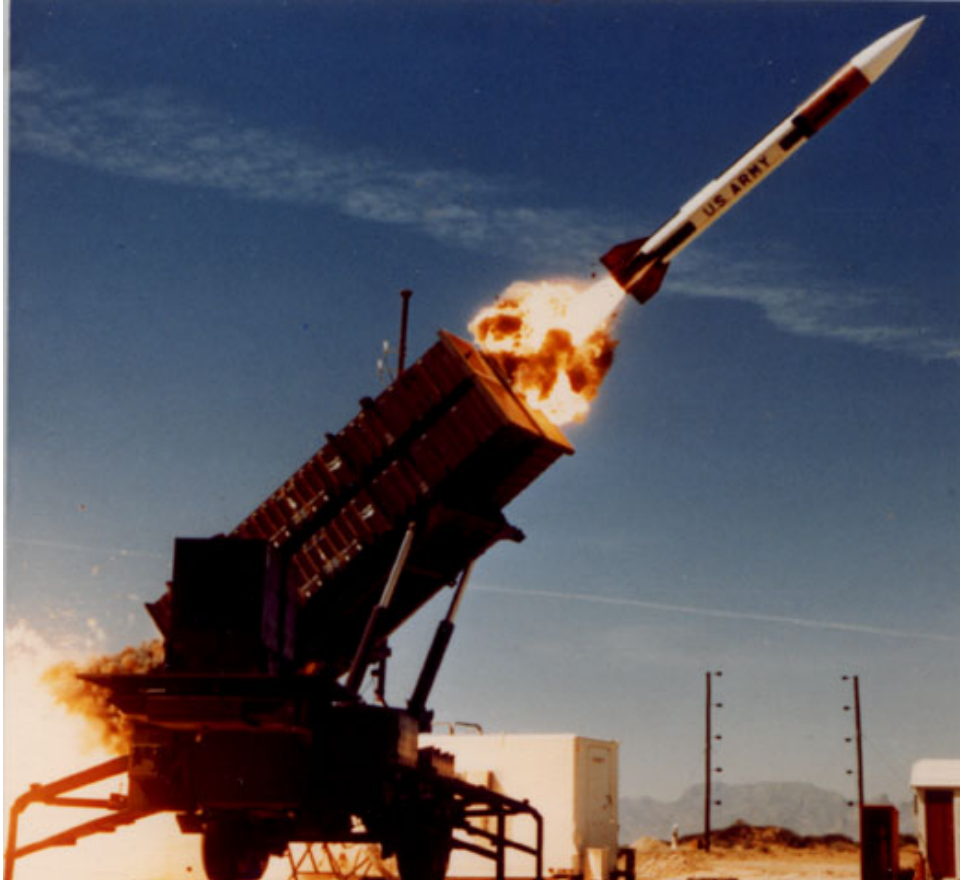


Close-In Weapon System 1980- Present



The MK 15 Phalanx Close-In Weapons System is a fast-reaction, rapid-fire 20-millimeter gun system that provides US Navy ships with a terminal defense against anti-ship missiles that have penetrated other fleet defenses. Designed to engage anti-ship cruise missiles and fixed-wing aircraft at short range, Phalanx automatically engages functions usually performed by separate, independent systems such as search, detection, threat evaluation, acquisition, track, firing, target destruction, kill assessment and cease fire.

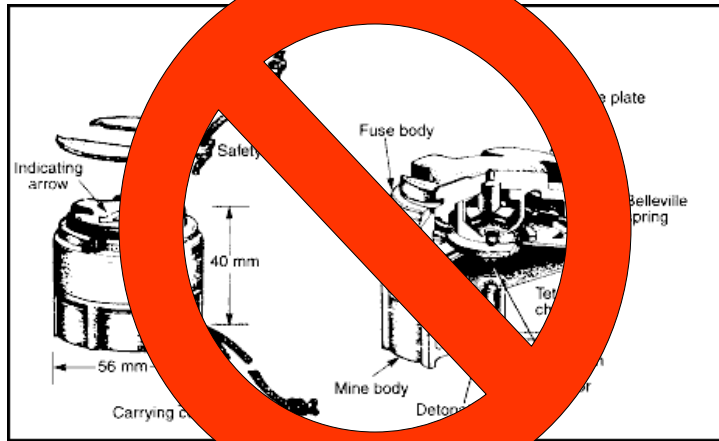
Patriot Missile System 1984- Present



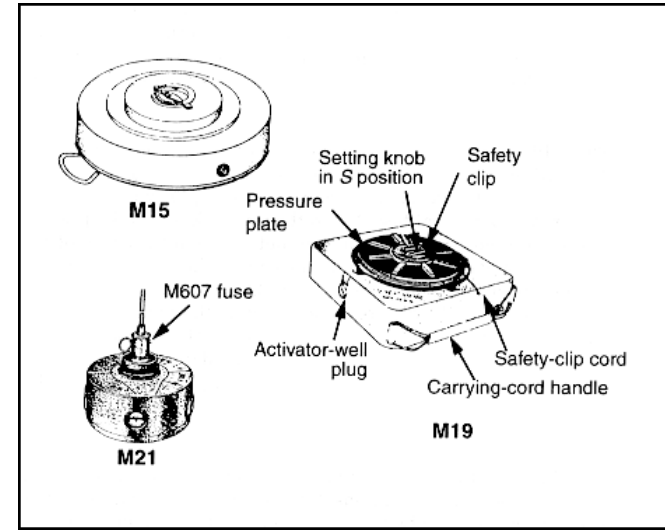
“An incoming missile could be 50 miles (80.5 kilometers) away when the Patriot's radar locks onto it. At that distance, the incoming missile would not even be visible to a human being, much less identifiable. It is even possible for the Patriot missile system to operate in a completely automatic mode with no human intervention at all. An incoming missile flying at Mach 5 is traveling approximately one mile every second. There just isn't a lot of time to react and respond once the missile is detected, making automatic detection and launching an important feature.”

<http://science.howstuffworks.com/patriot-missile.htm>

A Relevant Dichotomy



Anti-Personnel Landmines



Anti-Tank Landmines

There is a huge international debate over the continuing use of Anti-Personnel Landmines, with most of the world abandoning their use. The single essential of the problem is the fact that conventional Anti-Personnel Landmines are designed to persist, remaining lethal for decades after they are emplaced. This then becomes a long-term issue for civilian populations living in the areas that were mined. There is not the same level of debate over the use of Anti-Tank Landmines.

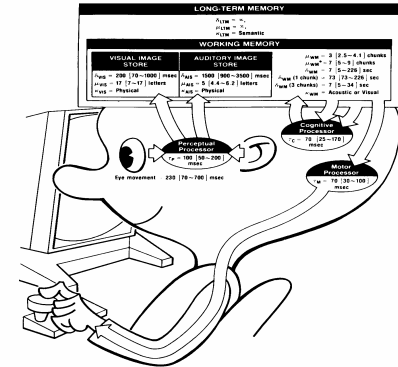
This highlights the issue of targeting the archer, as opposed to his bow, or arrow.



CONOPS-Enabling Technologies



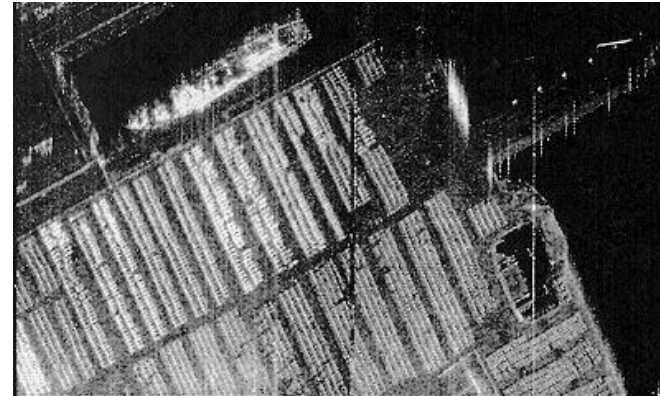
- Sensors
- Artificial Intelligence
- Communications
- Protection
- Stabilized weapons
- Data recording





Sensors

- “DC to Daylight”
 - Broad spectrum coverage
 - Detect the presence of weapons
- Radar
 - Imaging
 - Robust
 - Enable target discrimination
 - Distributed Imaging Radar Technology (DIRT)
- Optical
 - IR
 - Low Light Level
 - “All-weather” capability
- Other
 - ?
- No single “Silver Bullet” sensor
 - Likely will need a combination of sensors



Imaging Radar



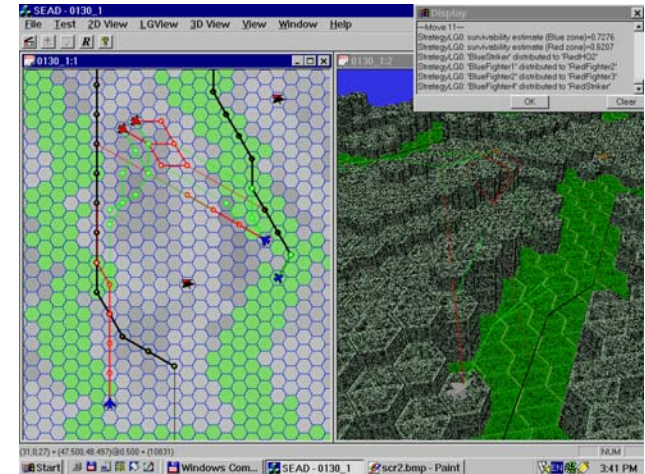
Night Vision



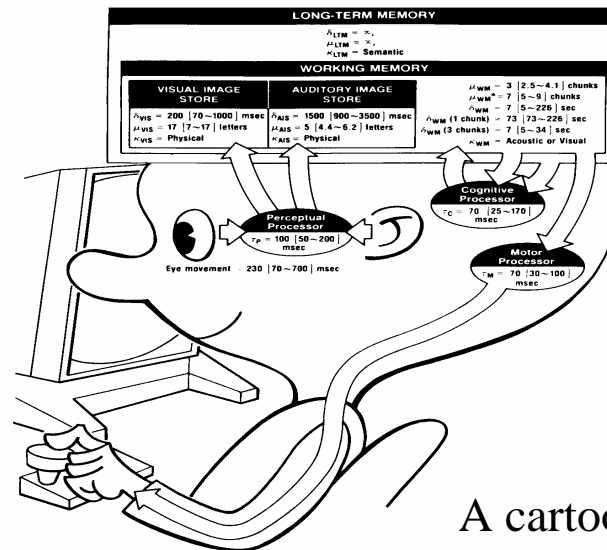
IR Image

Artificial Intelligence

- Situational Awareness
 - Sensor fusion
- Efficient battlefield search for weapons
- ID weapons as weapons
 - Automatic Target Recognition
 - Share information about new weapons with others
- Communicate to enemy that his weapon is being targeted
 - Give him the opportunity to abandon his weapon
- “Dial-a-Level” of autonomy
- Select correct weapon(s) for use
- Target/track enemy weapons
- Engage enemy weapons
- Swarm behavior
 - Self-coordinating



Linguistic Geometry



A cartoon for AI



Communications

- Provide Common Relevant Operational Picture (CROP) input to the Command Structure
- Local coordinating communications among other unmanned systems
- “Skip echelon” capability
- Secure
 - LPI/LPD
 - Encryption
- High bandwidth
 - HDTV
- Communicate with the enemy



Long-Range Acoustic Device



Navy Combat Information Center

Protection

- Expect to draw fire
 - Remember, we will be using COTS gear
 - Be prepared for it
- Armor
 - Passive (i.e. Kevlar)
 - Active (i.e explosive)
- Use redundant & dispersed components
- Active defenses
 - Take out the source of incoming fire
 - Hostile intent is already established
 - Kill the source
 - Take out the incoming fire itself
 - Wolfpack Electronic Attack System
 - FCLAS counter-RPG system
 - Self-repairing materials



Ye olde armor



FCLAS counter-RPG System



Wolfpack Electronic Attack System



Stabilized Weapons

- Shoot faster and straighter than a human
- Target the enemy's weapons
- Stay inside the enemy's OODA loop
- Non-lethals needed to separate human from his weapons
 - Active Denial technology
- Lethals needed to destroy weapons
 - Lethal to weapons
 - Traditional lethals
 - Guns
 - Missiles
 - Unconventional lethals
 - Directed Energy Weapons



Ship-mounted stabilized guns



Active Denial ACTD



Data Recording

- What happens if the enemy spoofs our armed unmanned systems, and causes them to kill when they shouldn't?
 - Political support can disappear virtually instantaneously
- Law enforcement departments equip today's police cruisers with video cameras and recorders to provide evidence of what happens during routine traffic stops.
- Need to record, and download, sensor data from our unmanned systems leading up to, and encompassing, engagements so that we have a record of any attempts at spoofing.
- Supplies direct evidence of enemy guilt



From a police video of a traffic stop



Summary

- Unfettered death and destruction (particularly of civilians and civilian property), can impair the restoration of a lasting peace. Real-time media coverage has brought the destruction of war to the “living room” and has added to the political reactions and a possible perception of excessive civilian casualties.
- This has driven strong adherence to LOAC considerations for *all* weapons. The LOAC has evolved to prevent needless death and destruction and most nations now utilize ROE as further measure to control the use of force.
- The use of armed unmanned systems offers us the opportunity to break this centuries-old paradigm of warfare, if we design them to target an enemy’s weapons instead of the people who are employing them. Legal precedent has been set.
- An enemy would then have a choice of abandoning his weapon and living, or continue using it, and dying.
- The widespread utilization of armed fully autonomous unmanned systems will be impossible, from cost and performance standpoints, without it.
- The development of a number of technologies would help to support such a CONOPS:
 - Sensors
 - Artificial Intelligence
 - Communications
 - Protection
 - Stabilized weapons
 - Data recording

Let the machines target machines – not people

A Parting Shot

