Center for a New American Security

- Established in February 2007 by co-founders Dr. Kurt Campbell and Michèle Flournoy.
- 501(c)3 tax-exempt nonprofit organization.
- Research is independent and non-partisan.
- CNAS does not take institutional positions on policy issues.

Developing strong, pragmatic and principled national security and defense policies
CNAS Major Research Areas

- **Strategy & Statecraft**
- **20YY Warfare Initiative**
- **Military, Veterans and Society**
- **Technology & National Security**
- **Responsible Defense**

**Regions**

- **Asia**
- **Middle East**
- **Energy, Environment and Security**
Rapid advances in robotics, autonomy, networking and computer processing have the potential to spur a new war-fighting regime.

20YY is an ambitious multi-year initiative exploring future warfare concepts, policy, and strategy.

20YY aims to deliver practical, actionable recommendations to stakeholders today to help prepare for the future.
For Millennia, Projectile Weapons Were Unguided

Warfare with unguided munitions required **mass**

- Most projectiles *miss their targets* with increasing inaccuracy at range
- Rate-of-fire and density of barrage trumps range
- Success from fire superiority
- Collateral damage accepted as inevitable

Northwest Europe, 1914
**The Schlieffen Plan versus Plan XVII**
20th C. Saw Advent of Reconnaissance - Strike Battle Networks

- **Battle Network**
  - Sensor grid
  - Command-and-control grid
  - Effects grid

- **Precision-guided munitions**
  - Accuracy independent of range
  - If you can find it, you can kill it

- **New warfare regime**
  - Premium on intelligence
    - Finding vs. Hiding
  - Fire superiority -> Salvo density
    - Cost-exchange ratio: range, cost, quantity, and quality (Pk) tradeoff
  - Networking & Info management
  - Speed kills
  - Collateral damage less acceptable
Future Operating Environment Will Be More Contested, Transparent, & Lethal

- **Democratization of Violence**
  - Proliferation of guided munitions
  - Commercially-available technologies (UAVs, GPS-jamming, 3D printing)
  - “Open source” knowledge-enabled WMD (cyber, bio, robotics)

- **Democratization of Information**
  - Empowering the people
  - Radical transparency

- **Global “Megatrends”**
  - Diffusion of power
  - Urbanization, aging
  - Environmental scarcity, degradation
Untapped Potential in Unmanned & Autonomous Systems

1. Remove human from risk – Enables radically new operational concepts
2. Decouple mass from personnel
3. Opportunities to reduce cost:
   - Efficiencies through enhanced performance, endurance
   - Balance survivability with cost
   - Reduce manpower burden
   - Innovative, lower-cost approaches to same missions
4. Networked autonomy = speed
The *Reconnaissance-Strike Swarm*

- Envisioning a fully realized robotics warfighting regime
  - Persistent unmanned scouts
  - Stealthy, penetrating UxVs
  - Self-healing networks
  - Low-cost attritable UxVs
  - Manned-unmanned teaming
  - Swarming
  - Picket line defenses for ships
  - Unmanned “loyal wingmen”
  - Surface and undersea pods
  - Automated data management and machine cognition
20YY Research Agenda: New Concepts of Operation

• What are key trends in the security environment and disruptive technology?
  – What are state and non-state adversaries likely, and willing, to do?

• What new concepts of operation are needed?
  – Swarms to counter enemy air defenses, hunt mobile missiles
  – Electromagnetic spectrum dominance with autonomous jamming & decoys
  – The air-mobile swarm: ground maneuver warfare in the age of robotics
  – Undersea dominance through persistent unmanned underwater vehicles
  – Self-healing, resilient, intelligent networks
  – Hardening networks and systems against cyber attack
  – Human-machine cognition & big data

• What doctrine, training, and organization structures are required?

• What are key enablers, obstacles, or countermeasures?
  – Comms, energy, cyber, space, human performance enhancement, electric weapons
20YY Research Agenda: Policy & Strategy Challenges

• What are the strategic implications of the emerging warfighting regime?
  − Crisis stability and escalation dynamics in the age of robotics
  − Unmanned systems and War Powers, civ-mil relations
  − Implications for posture, partners and allies, and balance of power
  − Evolution of key domains – cyber, space, undersea

• What are appropriate policies and norms for emerging technologies – cyber, synthetic biology, robotics, space/counter-space, directed energy?

• How do we reform our institutions to be better postured to adapt and thrive in an era of rapid, disruptive change?
  − How do we develop shorter-term acquisitions and requirements processes?
  − How do we avoid “next-gen-itis”? How should we invest in disruptive technology?
  − Where are bureaucracy and culture obstacles to innovation?
  − How do we foster a willingness to experiment and take risks?
20YY Action Agenda: Build a Community of Interest & Action

• CNAS will work with partners to build an enduring community of interest – and of action – around the 20YY research agenda:
  – Invitation-only research meetings
  – Public events
  – Senior policymaker & industry engagement
  – A venue for publication and debate

• Success for 20YY Warfare Initiative: Over the next three years
  – Demonstrably influence DOD strategy and budget
  – Build a community of interest
  – Develop next generation of strategists
Shaping the Debate (Jan-March)

Publications

Time to Get Ready for War in the Robotic Age, *Defense One*, January


Presentations

ISR Task Force

Joint IED Defeat Organization

CNO Rapid Innovation Cell

NATO Multinational Capability Development: Autonomous Systems Focus Area

Chatham House London: Autonomous Military Technologies Conference

ICRC: Experts Meeting on Autonomous Weapon Systems

January CNAS report
Shaping the Debate (April-June)

Publications

These Are Not the Drones You’re Looking For: Why the Navy’s betting on the wrong airplane for future wars, Foreign Policy, April

Congress’s Chance to Fix Aircraft Carrier Drones, Defense One, May

CTRL-ALT-DEL: Resetting America’s Military, Foreign Policy, May/June print edition

Presentations

UN Convention on Certain Conventional Weapons: Lethal Autonomous Weapons Experts Meeting

U.S. Navy for the 21st Century discussion, hosted by RealClearDefense

NATO Defence College: War in the Robotics Age

British Embassy Science & Technology Conference

IEEE Robotics Conference: Ethical Autonomy

May CNAS report
Building the Community of Interest

- Since January, three workshops plus one Hill engagement with diverse government, corporate, and think tank participation

- Talks and engagements with DoD offices, robotics companies, academia, and international audiences
Upcoming Annual Conference
Next Wednesday, June 11th

• 20YY will be featured at the CNAS Annual Conference on **June 11th**
  – 9:00a–5:30p at the Willard Hotel @ 1401 Penn NW
  – Keynote speakers Susan Rice & Paul Ryan
  – 20YY talk will focus on operational uses of robotics

• To register, visit
We are currently looking to expand the consortium of 20YY sponsors.

If you are interested in learning more about opportunities to partner with the 20YY Warfare Initiative, please contact me at pscharre@cnas.org.
The Coming Swarm

- Unmanned systems currently limited to niche roles
- In the future, will revolutionize warfare
- Today’s forces fight as a network
- A fully roboticized force will fight as a swarm

Winner of the robotics revolution will not be who develops this technology first or even who has the best technology, but who figures out how best to use it
Untapped Potential in Unmanned & Autonomous Systems

• Robots have two key attributes:
  • Unmanned
  • Autonomous

• These can lead to tremendous advantages on the battlefield
  • Cost savings
  • *Operational advantages*
The Benefits of Unmanned Systems

• Improved performance, such as increased range, endurance, persistence, speed, stealth or maneuverability, or reduced size

• Increased ability to take risk with the platform
The Benefits of Autonomous Systems

Autonomy is the ability of a machine to perform a task without human input. Benefits can include:

• Increased safety and reliability
• Improved reaction time and performance
• Reduced personnel burden, with operational advantages or cost savings
• The ability to continue operations in communications-degraded or -denied environments
Limitations, Enablers, and Obstacles

- Unmanned systems depend on some combination of communications links and autonomy

- Power is often a limiting factor for extreme endurance

- Bureaucracy and culture can be obstacles to innovation
Potential Cost Savings of Unmanned and Autonomous Systems

• Reduced platform requirements can lead to direct cost savings in platform design
• Greater endurance can save costs by reducing the required number of platforms
• Remote operations can reduce personnel costs by not requiring deployed personnel
• Multivehicle control can reduce personnel costs
• Autonomy can reduce training costs
• Automated information processing can reduce personnel costs
The *Reconnaissance-Strike Swarm*

- Operational advantages over reconnaissance-strike networks
  - Greater range and persistence
  - More daring concepts of operation
  - Greater mass on the battlefield
  - Improved coordination and intelligence
  - Faster speed
Greater Range and Persistence

The first virtue in a soldier is endurance of fatigue; courage is only the second virtue.

– Napoleon Bonaparte

• Long-range, precision-strike anti-access weapons are pushing U.S. power projection assets further away, placing a premium on range

• Because of longer endurance, uninhabited systems can operate from greater range and enable persistent reach inside anti-access areas
Unrefueled combat radii of various carrier-based aircraft

Ranges shown are approximate. Actual combat radius will depend on specific aircraft configuration, including payload and external fuel tanks.
Greater Range and Persistence – continued

- Sea-based loitering surveillance and strike for expeditionary operations
- Maritime domain awareness for early detection of threats
- High-altitude long-endurance pseudolites for airborne communications and navigation relay
- Long-endurance aircraft for forward missile defense
- Loitering uninhabited aircraft for persistent defensive counter-air
- Sea surface and undersea vehicles enable persistent undersea surveillance
- Exoskeletons: “wearable robotics” to strengthen and protect infantry troops
More Daring Concepts of Operation

Uninhabited systems can enable new, more daring concepts of operation without placing human lives at risk

- Countermine operations
- Expendable scouts
- Decoys, deception and defense
- Stand-in jamming and electronic attack

- Suppression and destruction of enemy air defenses
- Small-boat interdiction
- Casualty evacuation
- Clandestine reconnaissance and sabotage

Who dares, wins.
– British Special Air Service
In the 1970s, U.S. adopted a deliberate “offset strategy” to offset Soviet quantitative superiority in conventional arms with U.S. qualitative superiority

- Precision-guided munitions coupled with advanced sensors and networks allowed a smaller force to decisively defeat a numerically superior foe who had unguided munitions
- Gulf War casualty ratio ran 30-to-1

*Quantity as a quality all of its own.*

– Apocryphally attributed to Joseph Stalin
Proliferation of precision-guided munitions is shifting the calculus:

- Large numbers of low-cost unmanned vehicles could bring mass back to the fight
- Operating with mission-level autonomy and multi-vehicle control, combat power could be decoupled from personnel

*Cost-exchange ratio* and *salvo density* become key factors
Increased Mass on the Battlefield – continued

Advantages of large numbers of unmanned vehicles:

• Combat power can be *disaggregated*, giving the enemy more targets, forcing the adversary to expend more munitions.

• Platform survivability is replaced with a concept of *swarm resiliency*. Individual platforms need not be survivable if there are sufficient numbers of them such that the whole is resilient against attack.

• Mass allows the *graceful degradation* of combat power as individual platforms are attrited, as opposed to a sharp loss in combat power if a single, more exquisite platform is lost.

• Salvos can *saturate enemy defenses*. Most defenses can only handle so many threats at one time.
Improved Coordination and Intelligence

The battlefield is a scene of constant chaos. The winner will be the one who controls that chaos, both his own and the enemies.

– Napoleon Bonaparte

A large number of uncoordinated unmanned systems is not a swarm; it is a deluge.

A *swarm* consists of disparate but coordinating elements that combine to form a coherent whole

- A wolf *pack* is different than a group of wolves
Improved Coordination and Intelligence – *continued*

Many examples of swarming in nature

- Foraging, building, collective intelligence

Robotic swarms being developed in research laboratories
Cooperative, autonomous behavior can have many benefits:

- Coordinated attack and defense
- Self-healing networks
- Distributed sensing and collective intelligence

Early stages of research:

- How do simple rules give rise to collective behavior
- How do you control a swarm?
- How do you protect against hacking?
Faster Speed

Humans still superior to machine intelligence in many ways, but machines excel at *speed*.

Automation should shorten decision cycles, but ...

Could be strong pressures to take human “out of loop” in order to accelerate the pace of warfare.

Could automated/autonomous weapons be:

Legal? Ethical? Safe?

Even purely defensive automation could run the risk of accidental war. Strategic stability a serious concern.
Result: A Revolution in Warfare

If these advantages are realized, then a fully roboticized force would have significant advantages over today’s reconnaissance-strike networks

- Greater range and persistence
- More daring concepts of operation
- Greater mass on the battlefield
- Improved coordination and intelligence
- Faster speed

Result will be the reconnaissance-strike swarm
For More Information, Visit CNAS 20YY Warfare Initiative

20YY: Preparing for War in the Robotic Age

Robotics on the Battlefield Part I: Range, Persistence and Daring