Headquarters U.S. Air Force

Integrity - Service - Excellence

Rapid Prototyping: Leapfrogging into Military Utility

Mr. Randy Walden

Air Force Rapid Capabilities Office (SAF/RCO)

9th Annual NDIA Science & Engineering Technology Conference

16 April 2008

Rapid Prototyping Needed

- **Asymmetric threat has a very short timeline for change**
  - **COTS timeline available to threats**
  - **WWW used by threat**
- **DoD Acquisition has relatively long timeline**
  - **Limited access to COTS**
  - **Budget process is multi-year**
- **Complex systems stress definition of requirements/architecture**
  - **Requirement trade-offs delay system**
  - **Only as fast as slowest element**

SAF/RCO Rapid Prototyping

Objectives

- **Rapidly develop new capabilities to counter the increasing pace of threat evolution**
- **Improve acquisition process; facilitate faster transition of S&T to warfighter**
- **Realistic definition of requirements & architectures for complex problems; prototype to innovate**

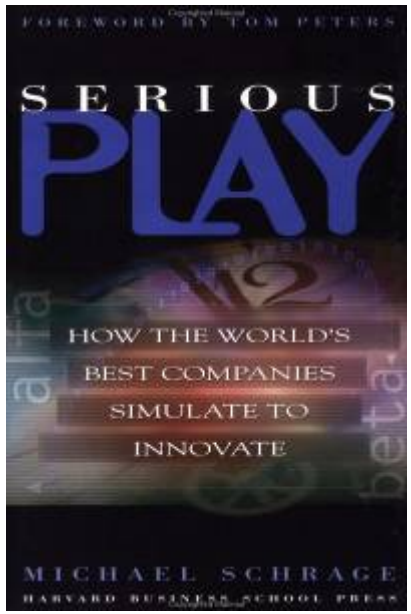
Enablers

- **Mindset: acceptance of 80% solution**
- **Team: leadership support, warfighter involvement, "A-team" executing**
- **Investments for the future: open architectures, etc.**
- **Experience: practice to improve**

“Rapid Prototyping” in Commercial Industry

A tool for rapid design & manufacturing …

A way to rapidly get products to market …



A way to innovate …

Not a new idea; approaches well established in commercial industry

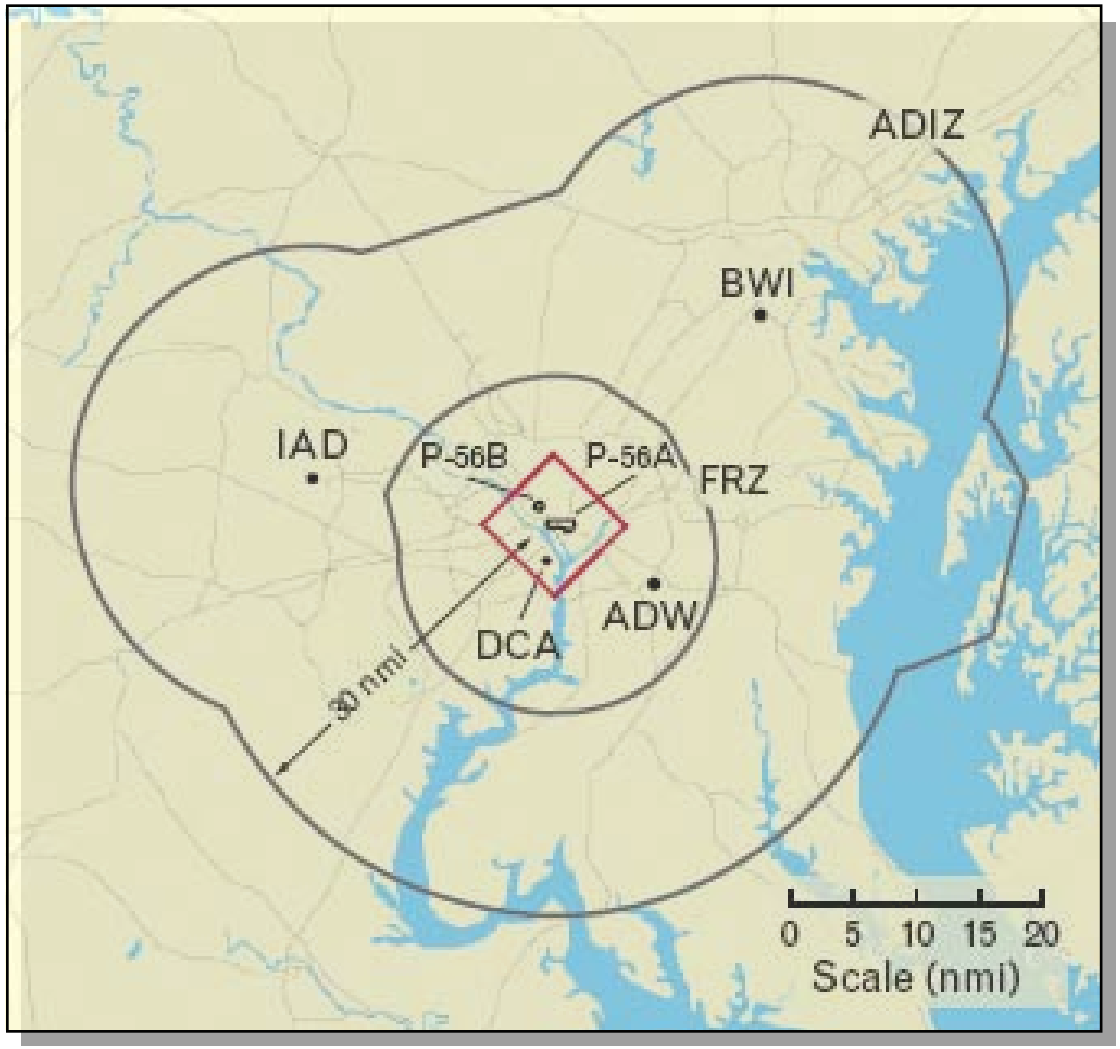
Outline

- Motivation / Objectives
- Air Force Rapid Capabilities Office
- Rapid Prototyping
  - Rapid capability development examples
  - Enablers to rapid development
  - Prototyping to innovate
- Summary

Air Force Rapid Capabilities Office

- Established April 2003
- Mission: Expedite development and fielding of select DoD systems
  - Leveraging defense wide technology development efforts and existing operational capabilities
- Reports directly to Board of Directors
  - SecAF, CSAF, SAF/AQ, and USD(AT&L) chairs
  - Responds to Combat Air Force (CAF) and Combatant Command (COCOM) requirements
- Rapid Prototyping Example: National Capital Region (NCR) IADS
  - Enhanced Regional Situational Awareness (ERSA)
  - Norwegian Advanced SAM System (NASAMS)

National Capital Region Airspace



ADIZ – Air Defense Identification Zone

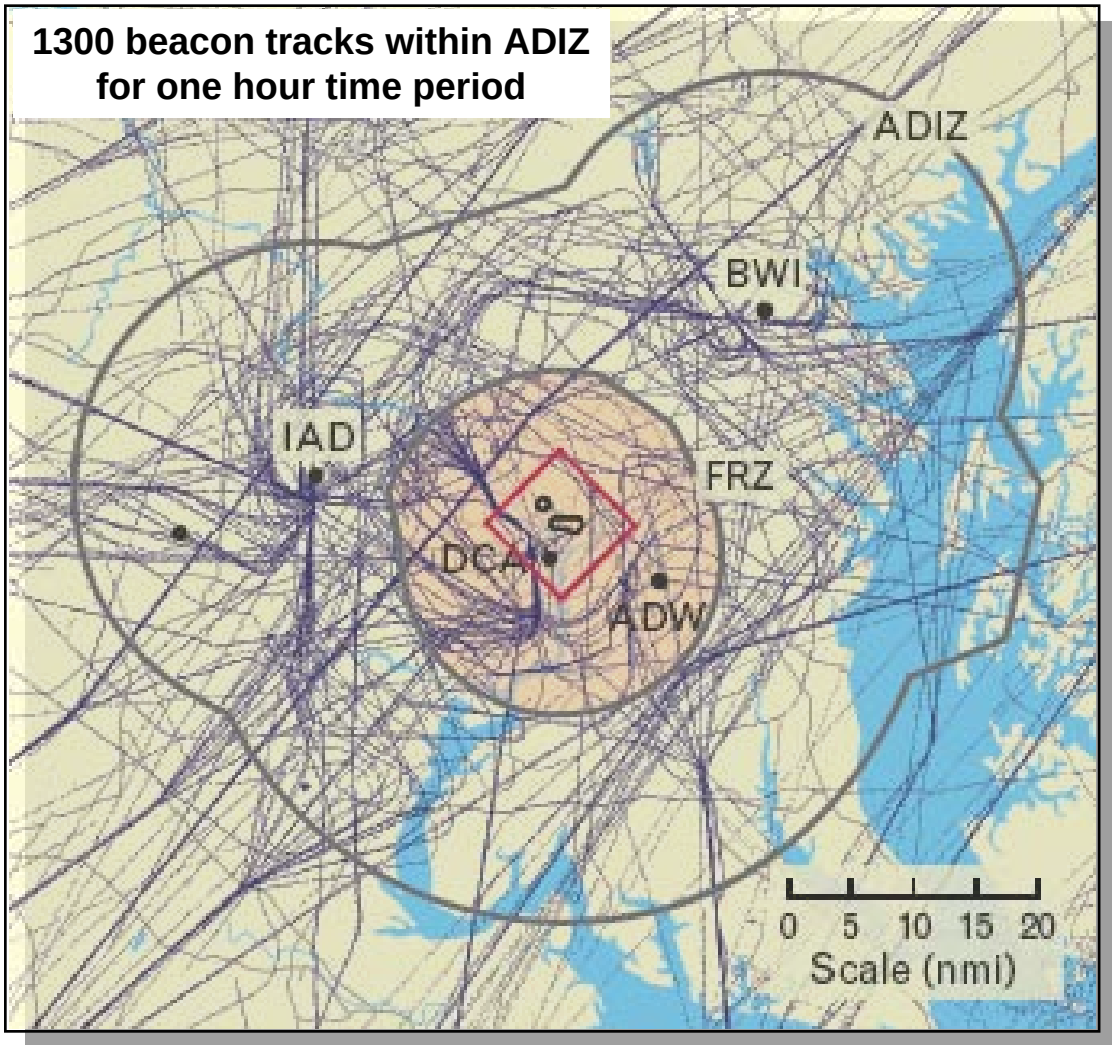
FRZ – Flight-Restricted Zone

IAD – Dulles International Airport

DCA – Reagan National Airport

ADW – Andrews Air Force Base

National Capital Region Airspace



ADIZ – Air Defense Identification Zone

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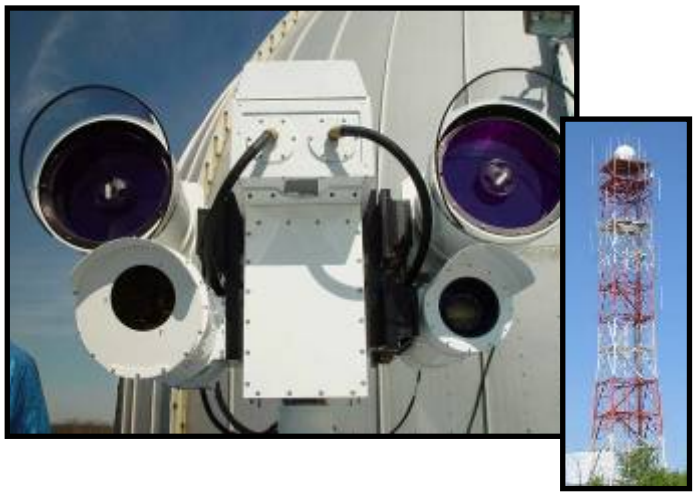
RCO Rapid Developments

Enhanced Regional Situational Awareness (ERSA)



- Integrated air defense system for National Capital Region (NCR) in 2 years
- Operational for Jan 2005 Presidential Inauguration
- Developed and Fielded
  - Tower Mounted Radars
  - Aircraft ID
  - Visual Warning

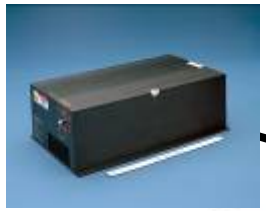
Norwegian Advanced Surface to Air Missile System (NASAMS)

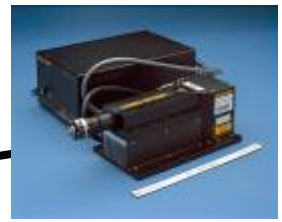
- Developed & integrated system into NCR IADS
- 9 months from Chairman JCS tasking to IOC

Rapid Prototyping
Visual Warning System (VWS)

HPD
HIGH POWER DEVICES, INC.

Red Light



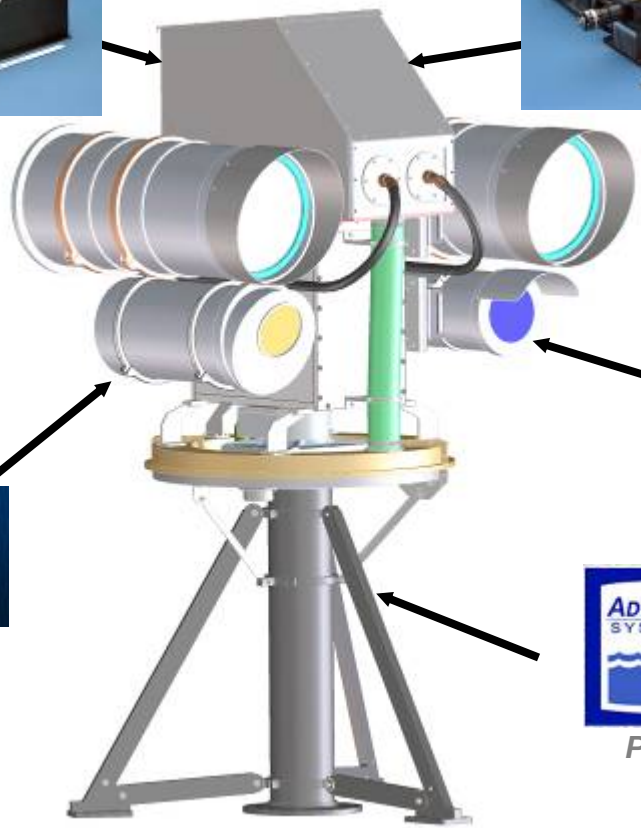


CVI Melles Griot

Green Light

CELESTRON

Telescope & Optics



HITACHI
Inspire the Next

Visible Camera

L3 communications

Infrared Camera

ADVANCED EO SYSTEMS, INC.
PVP

Pedestal

Visual Warning System developed by rapidly integrating COTS to create a new capability

Visual Warning System (VWS)

- Provide visual warning to errant pilots entering NCR airspace
- Eye safe system at aperture and beyond
- Precision pointing at single aircraft
- Special Flight Advisory has been published on meaning of lights
- Operational on 21 May 2005

• Warning Sequence with translucent covers on

• Nighttime aircraft view from 3 nm, 28 Jan 05

NORAD uses the Visible Warning System
U. S. Capitol, 12 March 2008

AIR SAFETY

Small Plane Enters Restricted Space

2nd Incident in a Week Prompts Calls to Refine Evacuation Process at Capitol

By Mary Beth Sheridan
Washington Post Staff Writer
Thursday, March 13, 2008; Page B06

A small plane penetrated restricted air space and flew within six miles of the U.S. Capitol yesterday before being intercepted without incident, officials said.

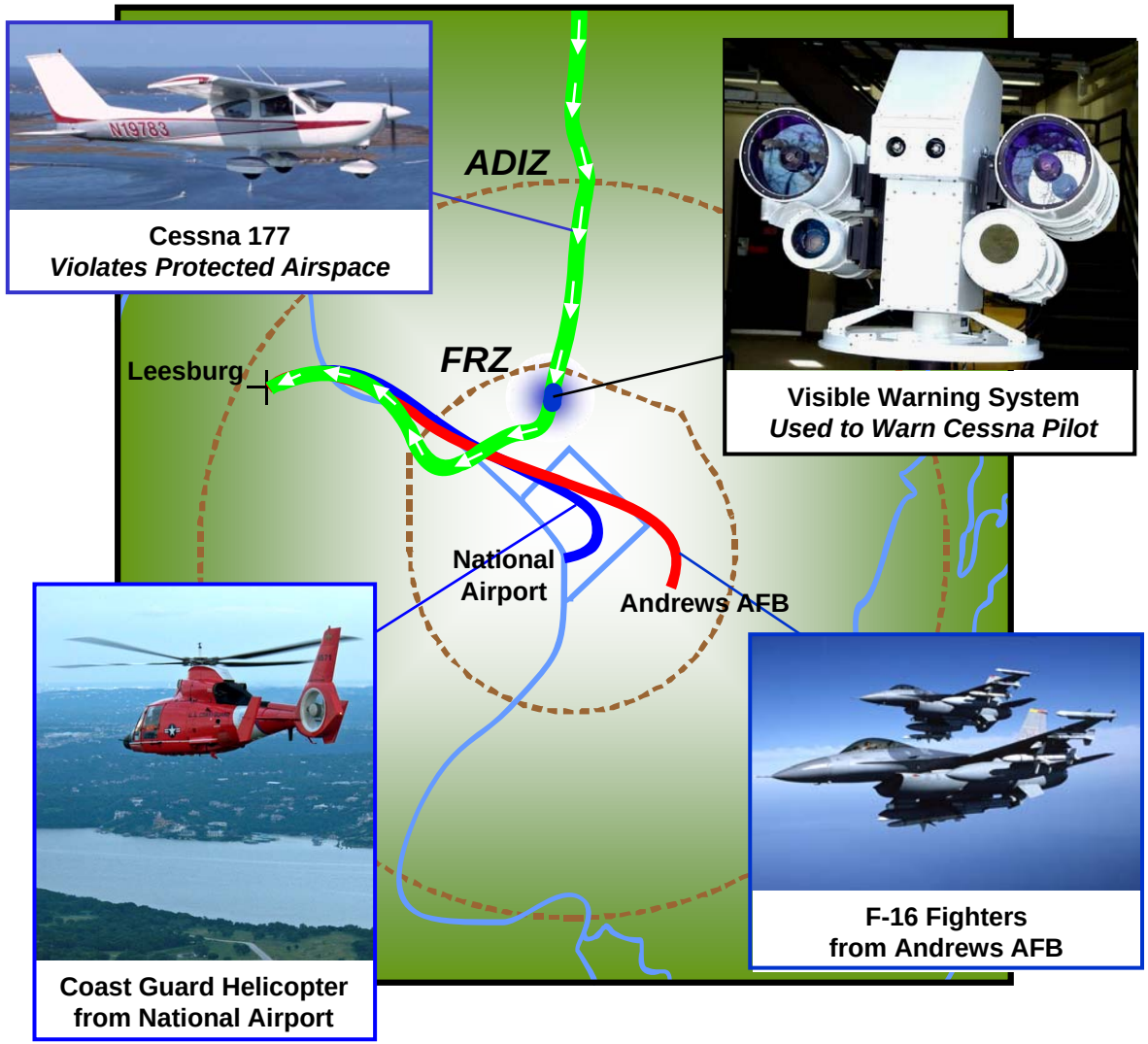
A NORAD spokesman cites the use of the Visible Warning System

When air-traffic controllers couldn't reach the pilot by radio, military personnel on the ground aimed red and green warning lights at the cockpit, said Maj. Brian Martin, a spokesman for the North American Aerospace Defense Command, or NORAD. That prompted the pilot to veer west, Martin said.

Two F-16 jets from Andrews Air Force Base and a Coast Guard helicopter escorted the plane to Leesburg airport, where the pilot was questioned by the Secret Service and the FAA, officials said. He was not considered a threat, they said.

12 March 2008 Events

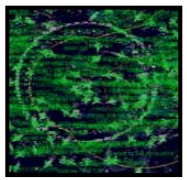
- A Cessna 177 crosses the Air Defense Identification Zone (ADIZ) in violation of airspace rules
- NORAD warns pilot using the Visible Warning System
- The Cessna is escorted to Leesburg Airport by F-16 interceptors



NASAMS Integration Timeline

FY04						FY05					
A	M	J	J	A	S	O	N	D	J	F	M

Chairman JCS Direction ▲



AT&L funding ▲

Fire Control Cue Developed ▲

Integration with fire control unit ▲

Fire Distribution Center

Live Fire Tests ▲ ▲

NORAD Validation and Acceptance Testing ▲ ▲

NASAMS IOC in NRC ▲

NASAMS developed, deployed and operational in nine months

NCR IADS

Key Attributes for Rapid Fielding

- **Clear Charter with Clear Priorities**
  - **Schedule was #1; field ERSA by inauguration day 2005 (18 months)**
- **Senior DoD, Joint Staff, US Air Force, & US Army leadership buy-in**
  - **Short chain of command facilitated quick decisions**
- **Small, Focused, Empowered Team; 5 – Program Office, 7 Contractor, plus key external POC's**
  - **Experienced, solution oriented, A-team type personnel**
  - **QRC focus – Long hours, 6 & 7 days/week were routine**
- **Recognition of Need for After-Fielding Clean Up**
  - **Formalized needed leases and MOAs/MOUs**
  - **Minor safety adds to installed equipment**
  - **Long-term transition planning**

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  - Enablers to rapid development
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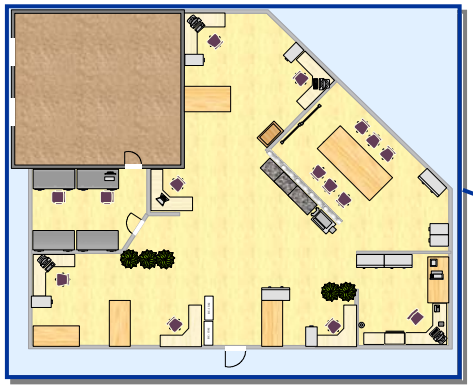
Enablers to Rapid Development

Facilities

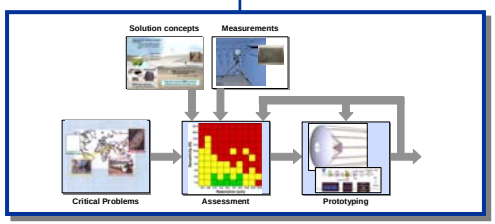


Hardware / Software Enablers

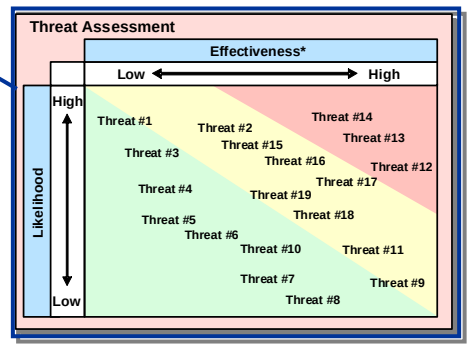
Rapid Innovation Cell

User Connection

Blue Team Process



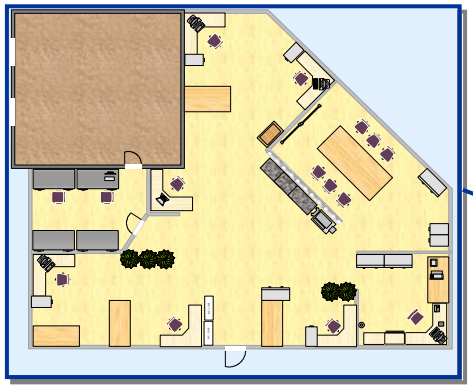
Red Teaming



- **Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities**

Enablers to Rapid Development

Facilities



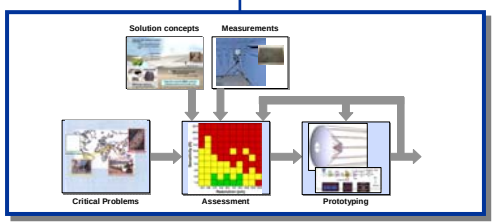
Hardware / Software Enablers

Open System Architectures

Rapid Innovation Cell

User Connection

Blue Team Process



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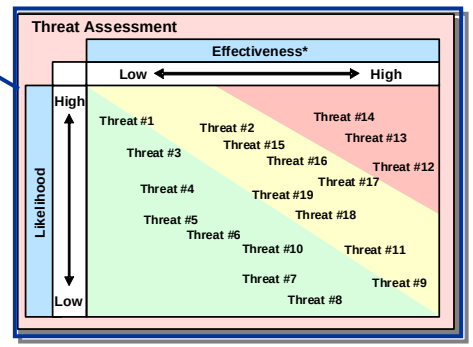
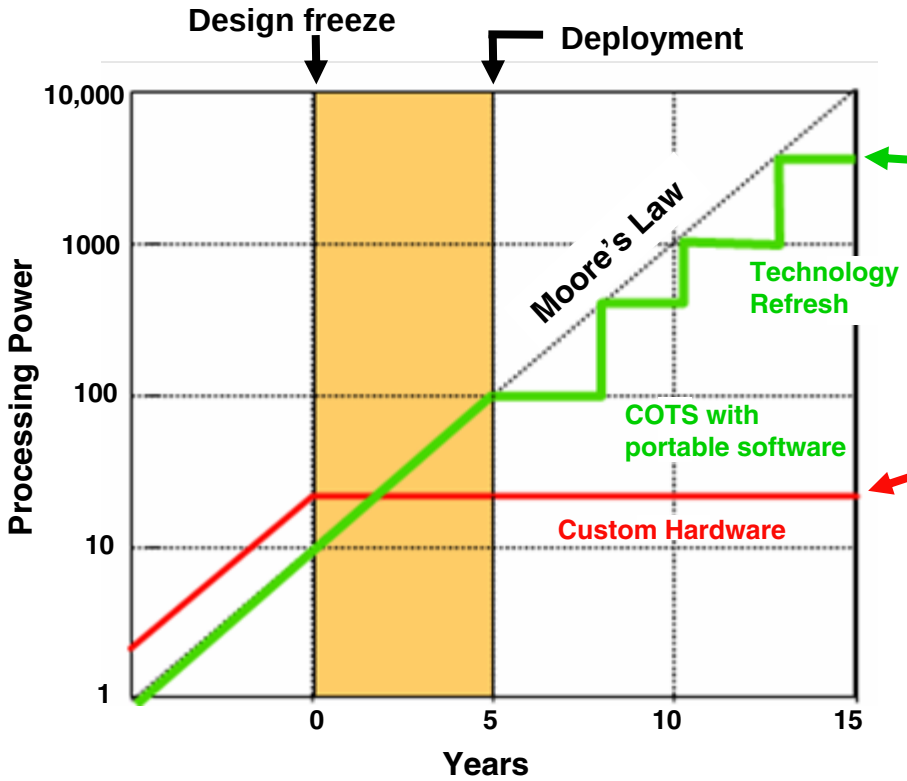


- **Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities**

Open System Architecture
Advantages

- ***Commonality allows lower cost …***
  - **Plug and play pieces reusable from system to system**
- ***Innovation enabler …***
  - **Allows entrance of "smaller" players, often with innovative ideas**
- ***Rapid development & rapid upgrades …***
  - **Open design allows replacement of individual components**
  - **Allows isolation of components that evolve technically at differing rates (e.g., rapid Moore's Law advance in computing)**
  - **Upgrades vs. replace; more responsive to agile threats**

Open Systems Support "Leverage Adapt" Strategy



"Leverage & adapt"

- Good for rapidly changing technology
- Good for rapidly changing requirements
- Built-in refresh and improvements
- More difficult to manage

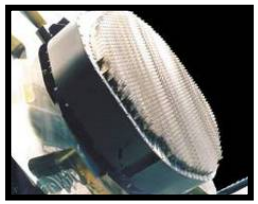
"Freeze & build"

- Freezes technology and builds to fixed design
- Acceptable for slow moving technologies
- Requires stable requirements throughout lifecycle
- Easier to manage with current acquisition strategy

- Open Systems supports "leverage and adapt" strategy; allows DoD to leverage commercial industry's investment
- Continuous upgrade/refresh possible to meet evolving threats and obsolescence

Layered Open System Architecture Approach

OSA = Open System Architecture
SOA = Service Oriented Architecture
COI = Community Of Interest



OSA Sensor Control SOAs

Open Radar
Middleware
AESA | RX/ Exciter | Signal Processor | Control Processor

Open AMRAAM System | Open EW Sensor System | ...

Avionics SOAs

Communications Middleware

Open Mission Computer | Open System Mass Storage | Comm Link (with Network Adapter) | Open Display System | Open Comm/Nav/ID | ...

Data Link

Multi-INT Centers Ground Station SOAs

C2 Services | Other Sensor Adapters | Comm Link (bridge to GIG) | ISR Tasking | ...

Global Information Grid (with NCES)

Global Network COI User SOAs

Intel User | Intel Sensor Adapters | Exploitation App | Federated Search Service | ...

Extend SOA Concepts

- Change with technology and readily add new capabilities

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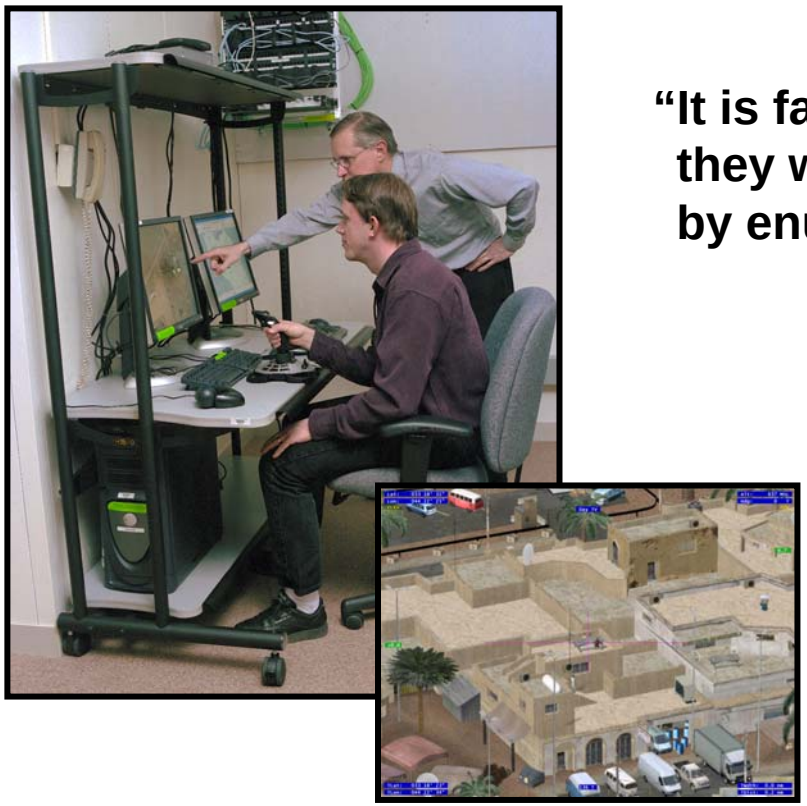
Prototyping Facilitates Innovation



"It is far easier for [users] to articulate what they want by playing with prototypes than by enumerating requirements."†

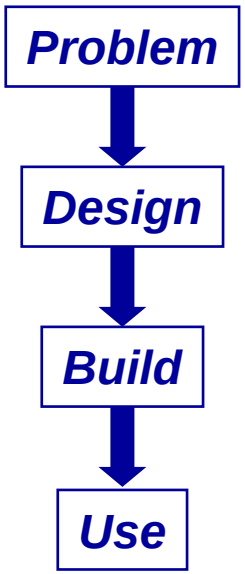
† **Schrage, Michael, *Serious Play: How the World's Best Companies Simulate to Innovate,* Harvard Business School Press, December 1999.**

- **Key additional use of rapid prototyping is for innovation; "simulate to innovate" concept**

Development Approaches

Linear / "Waterfall" Approach

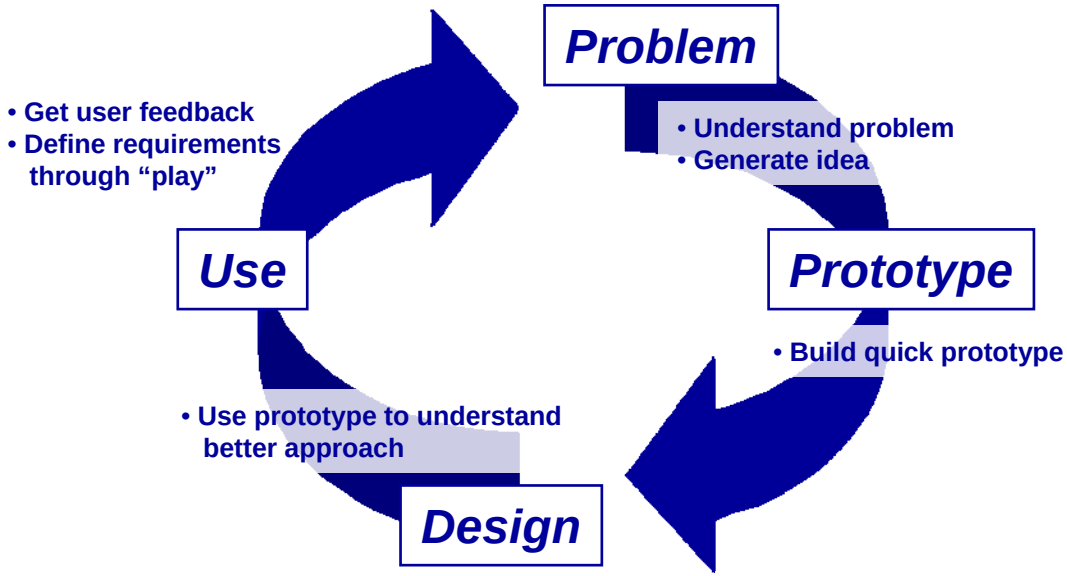
Fixed Design



- Assumes "design" can be accomplished apriori
- No developer / user co-design

Rapid Prototype Approach

Inherent Feedback



- Build prototypes to explore "design" approach
- Iterate based on user feedback; design influenced by user response

Prototype to Innovate

National Capital Region IADS

- **Integrated Air Defense for protection of the National Capital Region**

Touch Table

- **Vehicle for novel data extraction / representation and action**

X-37B Orbital Test Vehicle

- **Unmanned reusable vehicle test platform for new space technologies**

Summary

- Rapid prototyping permits timely, cost effective military capability development
  - Strongly motivated by increasing pace of threat cycle
- Air Force Rapid Capabilities Office (SAF/RCO) established to expedite development of selected DoD systems
  - Number of successful projects (e.g., ERSA, NASAMS)
- Success of rapid developments dependent on variety of factors
  - 80% solution mindset, strong team, enabling investments (e.g., Open system architectures)
- Additional rapid prototyping role in innovating new military capabilities
  - Rapid prototyping cycle allows refinement of solution

Challenge to S&T Community

- **Traditional "S&T Gap" still exists; greater warfighter interchange needed**
- **Apply rapid prototyping approach earlier in S&T development**

Early insertion of new technologies
Faster innovation
Discovery of new / advanced capabilities

Mr. Randy Walden / (703)696-2407 / safcroworkflow@pentagon.af.mil