Using Spiral Development To Reduce Acquisition Cycle Times

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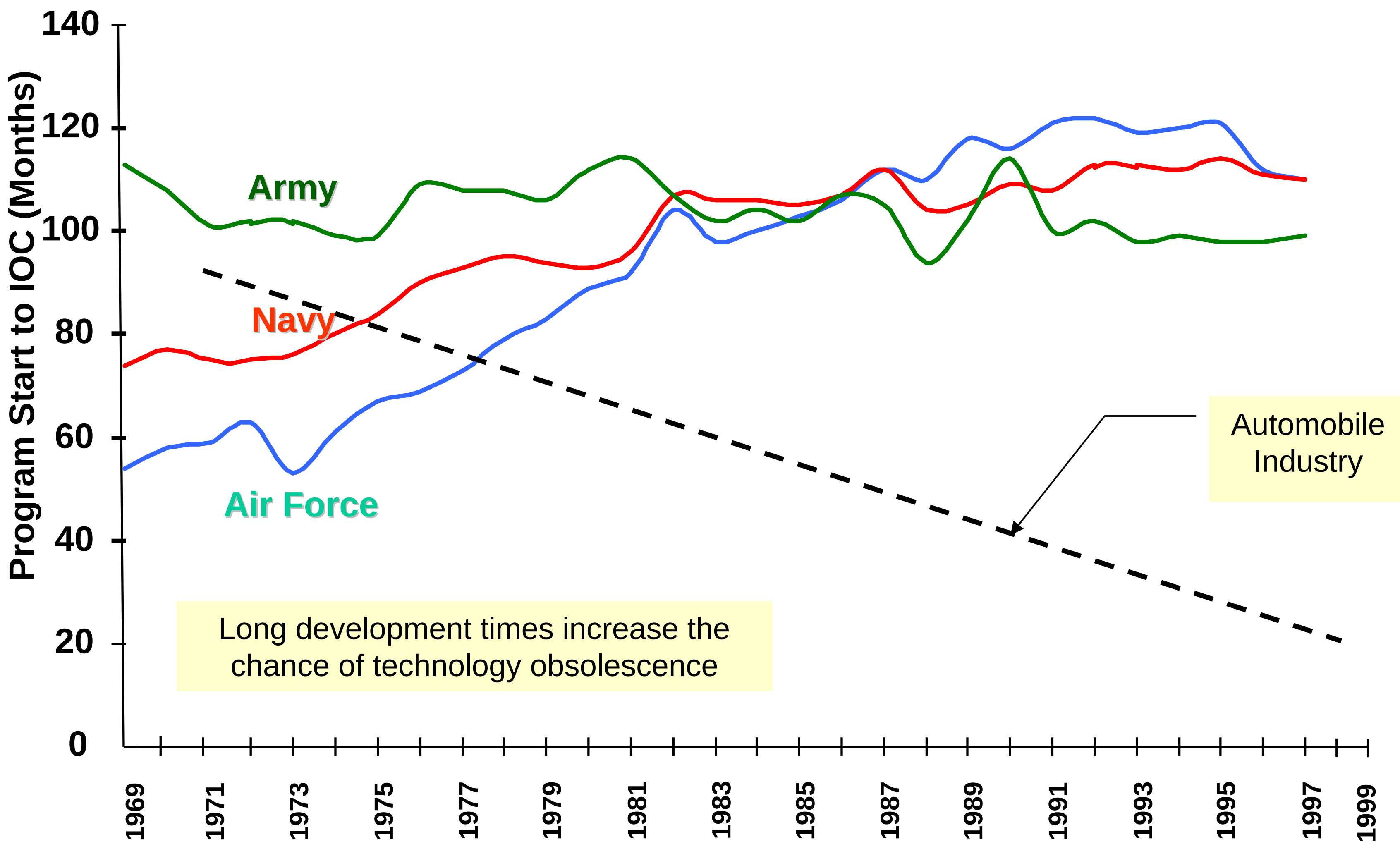
Spiral Development Study

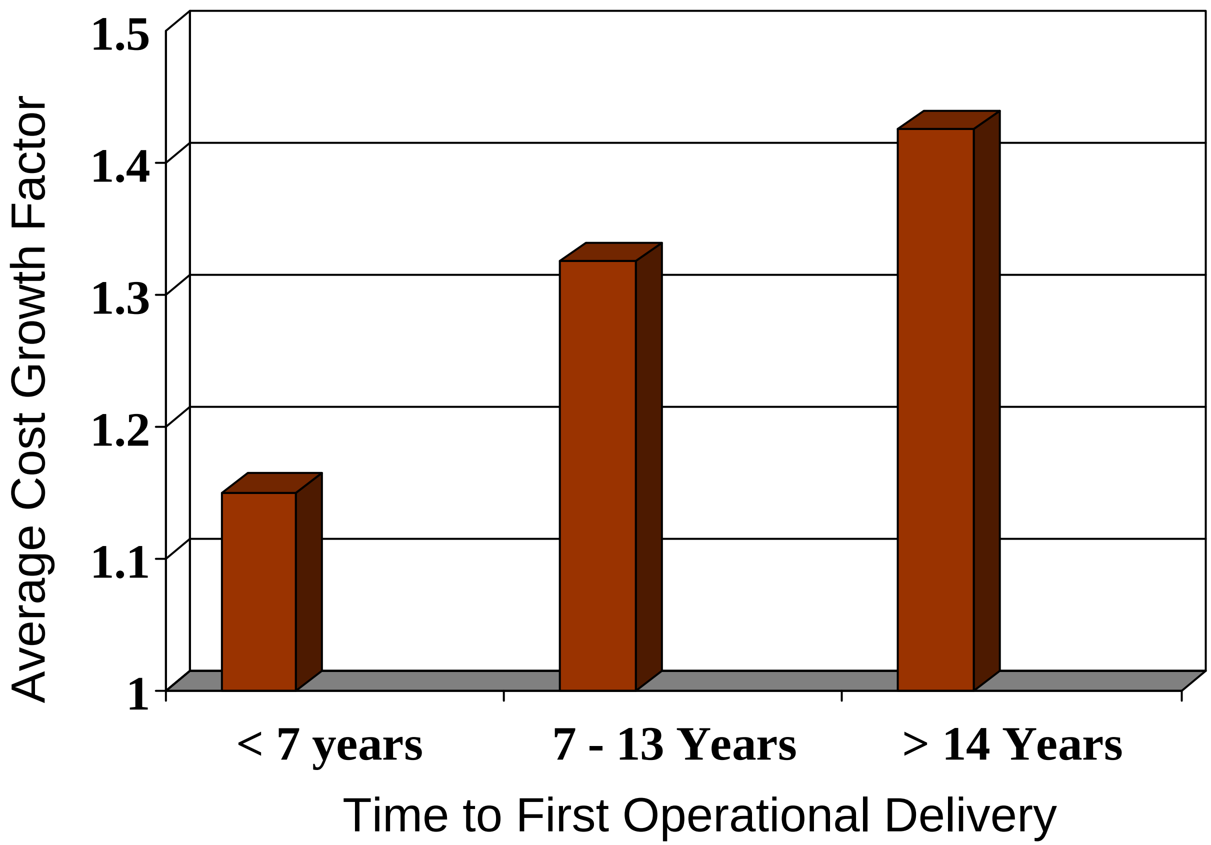
- Review history and policies
- Cases
  - – Predator UAV
  - – Global Hawk
  - – Littoral Combat Ship
- Preliminary Findings

Average Cycle Times (by SAR Reporting Years)



Source: DSB Briefing, Dan Czelusniak, 12 June 1998

Likelihood of Cost Growth



Issues with Linear Acquisition

- Serial, “big-bang” solution drove long cycle times
- Difficult to incorporate user feedback that reflected warfighter experience and evolving asymmetric threats
- Technology reach too long and process lacks flexibility for timely insertion
- Too much time for things to “go wrong” (budget instability, schedule changes, cost increases, new technology, requirements “creep” etc.)

Software Development moved to Spiral Model

- Spiral Development came out of the software community as a response to the high number of large software development failures
  – The spiral model was defined by Barry Boehm in his 1988 article *A Spiral Model of Software Development and Enhancement*.
  – The cyclical approach allowed users to provide feedback earlier and developers could identify potential trouble spots at an early stage.
  – He concluded that it "was particularly applicable to large, complex, ambitious software systems."

Concept is Extended to Weapon Systems

- **May be less than full capability (…and less than fully tested), but…**
- **Affordable, risk-reduced, agile, and earlier delivery of a product**

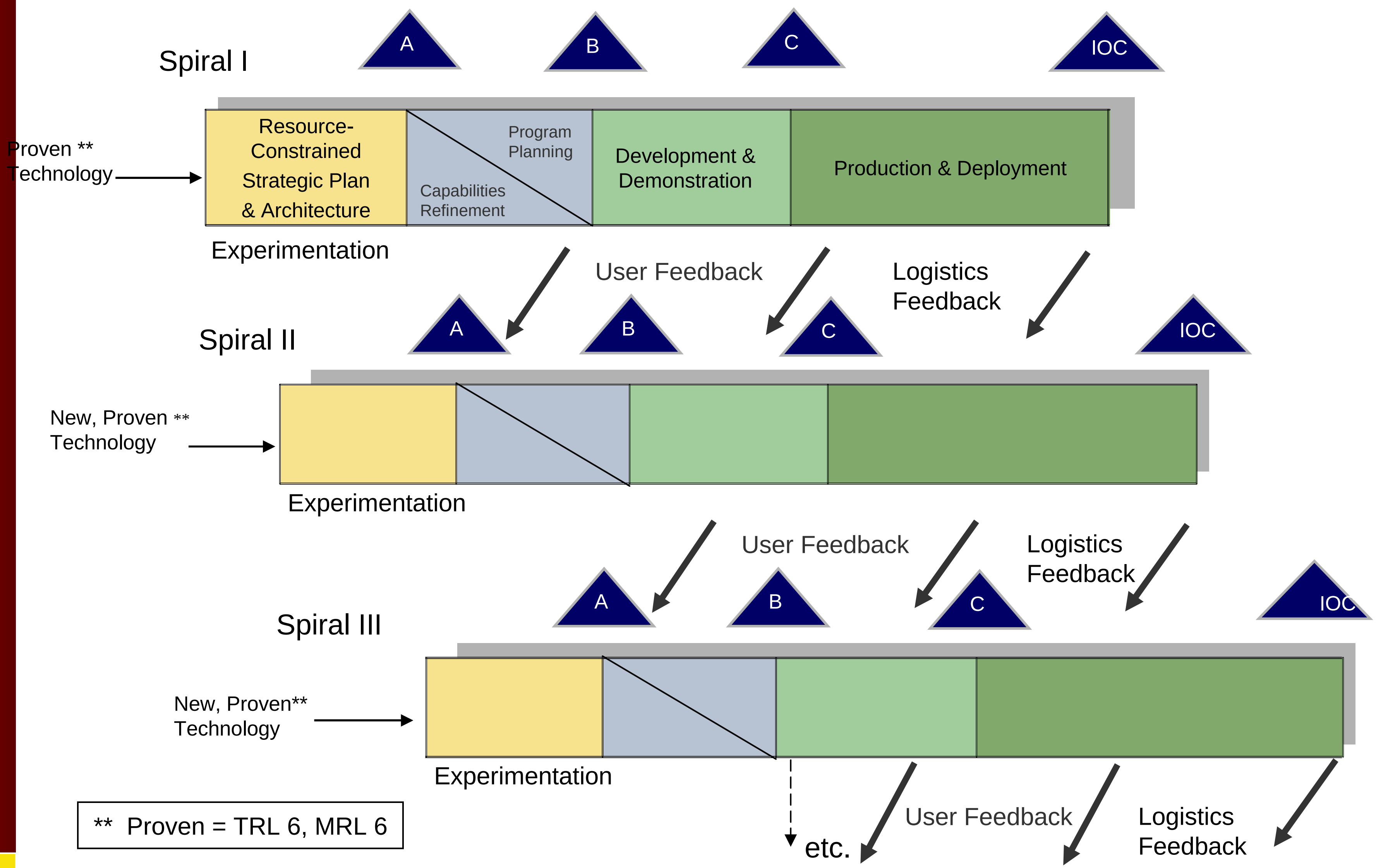
A "spiral development" acquisition process should be the norm for long-term weapons and systems development to achieve lower cost, lower risk, and more rapid fielding.

DoD Instruction 5000.2

- **Evolutionary Acquisition (EA)** Evolutionary acquisition is the preferred DoD strategy for rapid acquisition of mature technology for the user. Deliver capability in increments more quickly
  - Allow for improvements and introduction of new technologies
  - Balance needs and capabilities with resources
  - Take advantage of user feedback in refining requirements and capabilities
- There are two process approaches to evolutionary acquisition.
  - **Spiral Development—**Desired capability is identified, but end-state requirements are not known quantitatively at Program Initiation. Requirements for future increments dependent upon technology maturation and user feedback from initial increments.

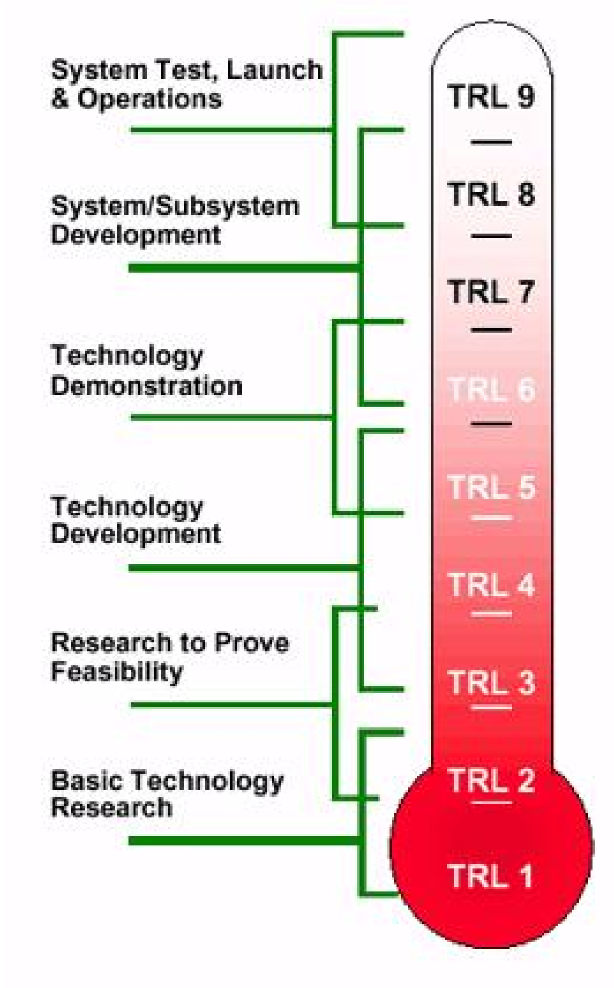
Evolutionary Acquisition is the preferred broad **strategy** to satisfy operational needs; while **Spiral Development** is the preferred **process** for executing such a strategy

Spiral Development



** Proven = TRL 6, MRL 6

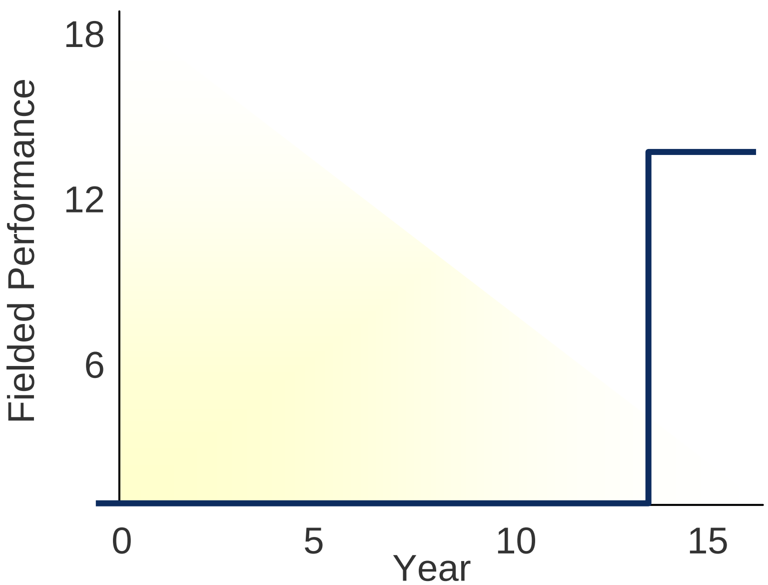
Technology Readiness Level



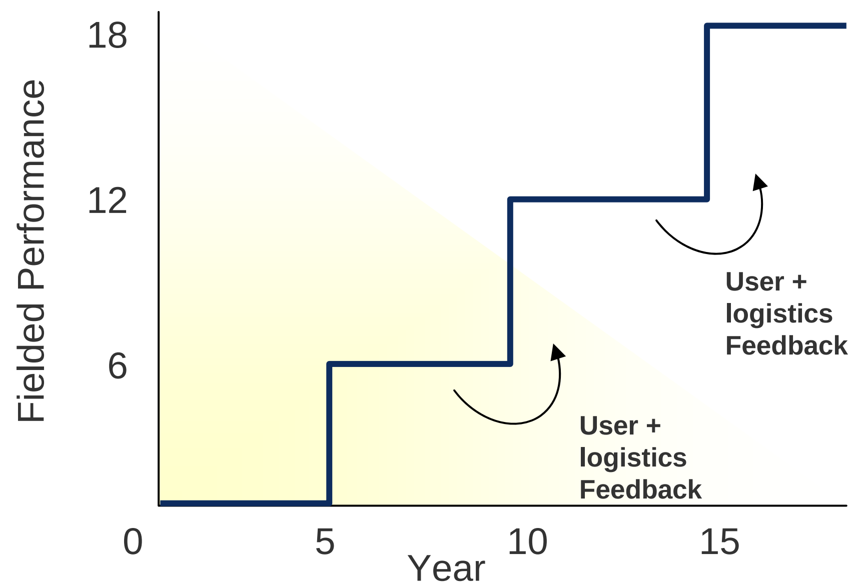
This NASA graphic illustrates the progressive steps necessary to mature technologies and integrate them into subsystems, systems, and programs

Spiral Development Can Provide Near-Term Fielded Capability

Legacy Acquisition Process



Spiral Process



- **Less Cost**
- **Less Risk (technical, schedule, cost)**
- **Provide fielded capabilities earlier**
- **Greatly reduces technological obsolescence**
- **Allows for a more robust and competitive industrial structure**

Predator UAV

- Developed as an Advanced Concept Technology Demonstrator
- Initial requirement for inexpensive unmanned aircraft to provide real-time reconnaissance
  - Loiter up to 24 Hrs
- ACTD aircraft performance in Roving Sands 1995 exercises very successful, and led to deployment in Bosnia in summer 1995
- It performed so well that, decision was made to forgo formal engineering development (SDD) and **modify as technology and funding permitted—spiral development**

Initial capability was delivered while requirements for upgrades were generated by feedback from operational use

Predator UAV

- As a result of operational use, new requirement to strike time-critical targets
  - Armed with Hellfire missile
  - Can carry laser designator
  - Larger Predator B was developed to increase operational ceiling above icing and SAM threat
- Further improvements in work as the result of operational feedback are improved engines, sensors and increased payload
- Lessons learned from Iraqi Freedom may lead to more improvements

Predator B

Predator UAV—Lessons

- Program was successfully executed
- Used mature technologies
- Maintained cost requirement (for Predator A). However, unintended consequence of cost limits may be to not fund or neglect support considerations, such as retrofits.

The Predator is a great example. Warfighters identified a need and we made incremental improvements to the Predator in short order, sometimes in a matter of weeks. We develop them, test them and have them in the field.

Lt. Gen. Jack Hudson
Commander, Aeronautical Systems Center, 4/25/08

Global Hawk UAV

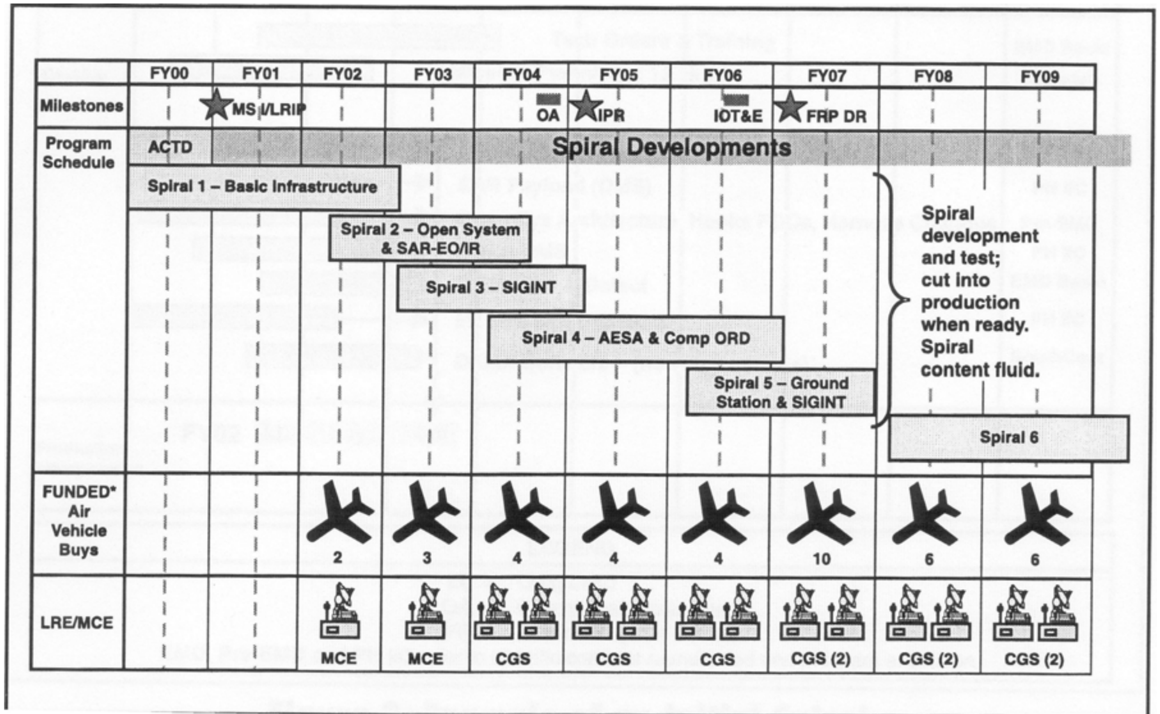
- Global Hawk system is a high altitude, long-endurance unmanned aircraft with integrated sensors and ground stations providing intelligence, surveillance, and reconnaissance capabilities.
- After a successful ACTD, the system entered development and limited production in March 2001.
- AF planned to slowly develop more advanced capabilities and acquire 63 vehicles

With just one aircraft deployed, the system was credited with identifying 38 percent of Iraq's armor and 55 percent of the time-sensitive targets using electro-optical, infrared, and synthetic aperture radar to target Iraqi forces.

Col. G. Scott Coal

Global Hawk UAV

The Original Spiral Strategy



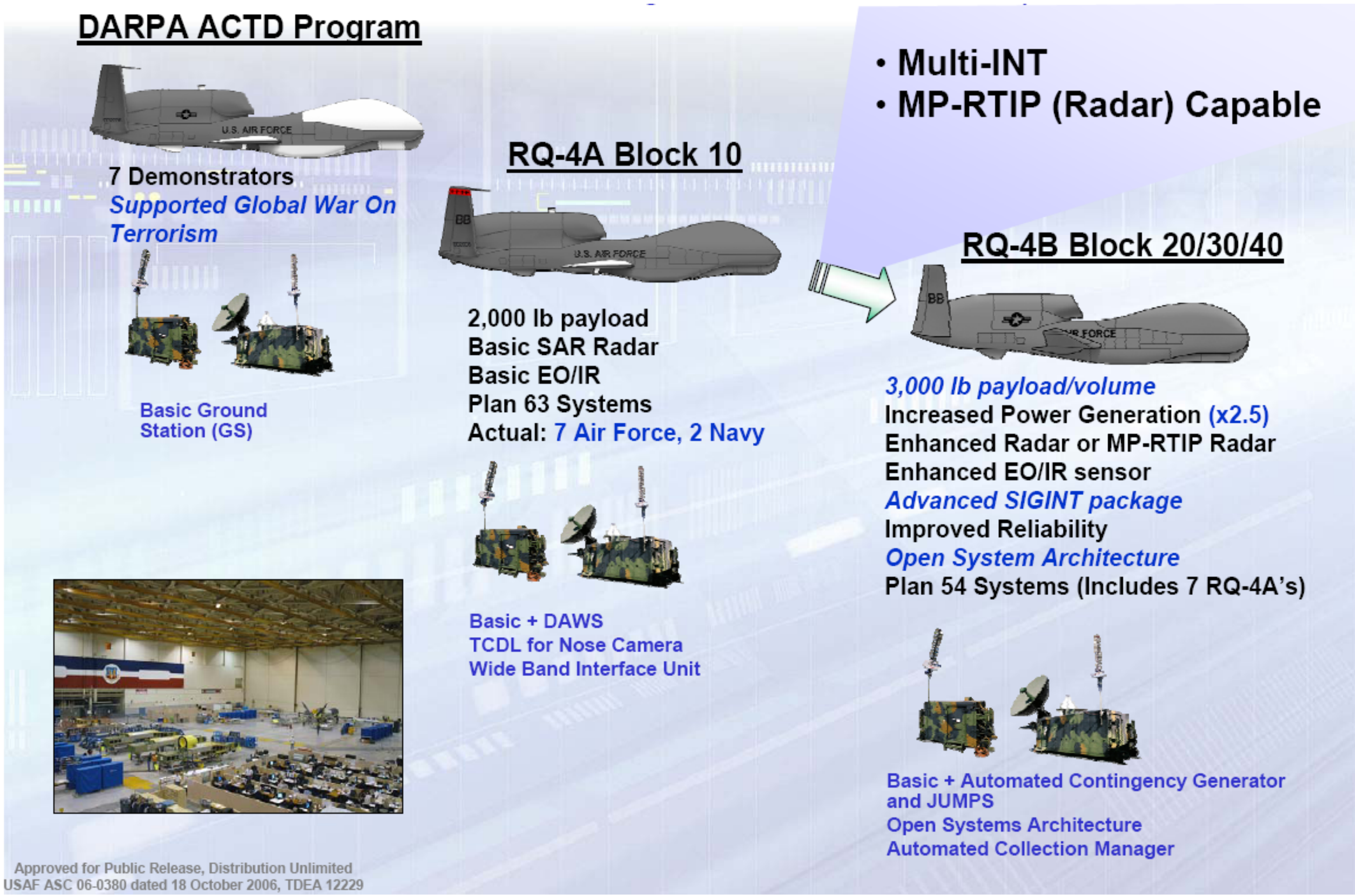
- First Spiral would deliver a baseline capability
- Additional spirals would follow rapidly, and drop capability into the production line when ready

Johnson, Col Wayne and Johnson, Carl, *The Promise and Perils of Spiral Acquisition: A Practical Approach to Evolutionary Acquisition,* Acquisition Review Quarterly, DAU Press, Summer, 2002

Global Hawk UAV

- March 2002, program was restructured to include a second, larger model RQ-4B
  - Total quantity was reduced to 51 AVs, 7 RQ-4A, and 44 RQ-4Bs
- December 2002, program was again restructured to change mission configuration
- RQ-4A production is complete
  - deployed in 2006 to support military operations
- RQ-4B, with a 50% payload increase, larger wingspan (130.9ft) and longer fuselage (47.6ft), is in production with key technologies mostly mature.
  - Required major design changes such as new landing gear, electric brakes, larger power-generating capability
- The resultant program shortened the schedule, while funding increased.

Global Hawk UAV



Global Hawk UAV - Issues

- The Air Force added new requirements, but did not keep the cost targets
- Included immature technology, such as automatic contingency generation (an emergency, capability to autonomously determine the optimum flight path to divert to an alternative airfield).
  - This requirement was after early production lots were negotiated
  - Time spent trying to field ACG in the first baseline delayed delivery of the first production hardware and training courses
  - Capability deferred to a future software release
- Aggressive schedule increased program concurrency

Littoral Combat Ship

- The Navy's LCS is a surface combatant optimized for littoral warfare with:
  - Fast, maneuverable, shallow draft
  - Reconfigurable single mission focus
  - Modular open systems architecture—”plug-and-fight” mission packages
  - Ship's mission focus to be changed by changing out mission packages
- Primary intended missions are shallow-water antisubmarine warfare, mine countermeasures, countering small boats, and intelligence, surveillance, and reconnaissance (ISR).
- Secondary intended missions include homeland defense, maritime intercept operations, and support of special operations forces.

Littoral Combat Ship

- The LCS is to displace about 3,000 tons, making it about the size of a Coast Guard cutter.
- Maximum speed of about 45 knots, compared, to something more than 30 knots for the Navy's larger surface combatants.
- Reduced "core" crew of 40 sailors, with up to 35 or so additional sailors to operate the ship's embarked aircraft and mission packages
  - Total crew of about 75, compared to more than 200 for the Navy's frigates and 300 or more for the Navy's current destroyers and cruisers.
  - Navy plans call for procuring a total of 55 LCSs, and a total of 64 mission packages for the 55 ships.

Littoral Combat Ship Acquisition Strategy

- Two industry teams awarded contracts (Lockheed Martin and General Dynamics)
- The ship and mission packages were intended to be in spirals
  - The first spiral of 15 ships, known as Flight 0, would be produced in two designs
- The LCS program began production in December 2004
  - Also began acquiring some elements of the mission packages
- LCS is significantly different from other classes of warships in a number of ways.
  - an aggressive spiral development acquisition process
  - design of mission modules that allows each LCS to have the flexibility and adaptability

Littoral Combat Ship—Issues

- Significant cost increases on LCS 1 (and projection of cost increases on LCS 3) drove Navy to issue a stop-work order to Lockheed on construction on LCS 3 in January 2007
- Program restructured in March:
  - Cancelled two LCS's funded in FY2007
  - Announced intention to lift stop–work order once contract was restructured from cost-plus to fixed price incentive 2007.
  - Also restructure GD contract for LCS 2 and 4 into a FPI-type contract
  - Operational evaluation to select favored design, that would be procured with a full and open competition
- Overly optimistic cost estimate for sea frame ($216M in FY 05 to $531M in FY 09)
- Building a ship requires precision sequencing-concurrent design and build strategy generated many design alterations, resulting in incomplete modules
- Commercial standard were considered (by Navy) as not adequate, required unanticipated design changes

Not a disciplined spiral development program

Spiral Development Findings to Date

- Spiral development changes everything, and will require major culture change for both the user and acquisition community.
  - **Requirements—** Users must allow more flexibility with their requirements
    - Users must accept less capable systems (80% solution) earlier, and then evolve to desired level in later blocks.
    - Acquisition team must develop a long-term system view, not a narrow focus on the current spiral
  - **Budgets**
    - Total program cost estimating is more difficult due to requirements evolution
    - Cost must be viewed as a design constraint--otherwise program baselines may be less well defined
    - Must budget for R&D in future blocks while current block is underway
  - **Logistics**
    - Spiral development creates greater demands on logistics concepts
    - different system configurations impacts on sparing, training, maintenance, etc
  - **Test and Evaluation**
    - Early operational feedback to shape **development** and formal testing
    - Test community must view partial capability of early blocks as a success
  - **Program Management**
    - Generates higher intensity of contract action
    - Requires different skill mix in program office
    - Planning for **Spiral** "N+1" is a critical **Spiral** "N" task

Spiral Development increases the need for disciplined program management

Recommendations

- Use a true "spiral development" process as the norm for long-term weapons and systems development (in order to achieve lower cost, lower risk, and more rapid fielding).
  - Based on proven technology, with a 5 year cycle goal for Block I, from milestone B to I.O.C.) and realistic budget funding
  - With the option of competition (prime and/or subsystem) at each block (depending on performance and cost results from prior block)
  - With R&D always being funded for subsequent blocks.
  - By moving more towards an Open Architecture framework, programs can facilitate spiral development

Spiral Development Requires Better Planning, Discipline, and Communications and Collaboration with Developer, User, Contractor, and Tester in Order to Achieve Success

Conclusion

- Cold war era – Concentrated on Performance
- Pre 9/11 – Concentrated on Cost
- 9/11 into foreseeable future – We must Concentrate on Schedule