Agile Design and Development For Future Space Systems

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Advanced Systems &Technology

The IC Incentive

Imperatives for Advancing Space Mission Design Process

- **To preserve our "asymmetric advantage" in space, we must transform our design process**
  - Our prime contractor industrial base requires upgrading (even to maintain current design capability)

- **We must skip a generation in the normal evolution of design methodology**
  - Applied research exists in all these fields
  - Varying levels of maturity need to be developed, integrated, tested and infused

"The Department…will undertake an aggressive effort to achieve a transformation in business practices."

"Sensors should…allow for agile and flexible responsiveness [and] adapt to the evolving threat environment."

-DPG FY2003-2007, Aug 2001

The Agile Vision: What Could Be

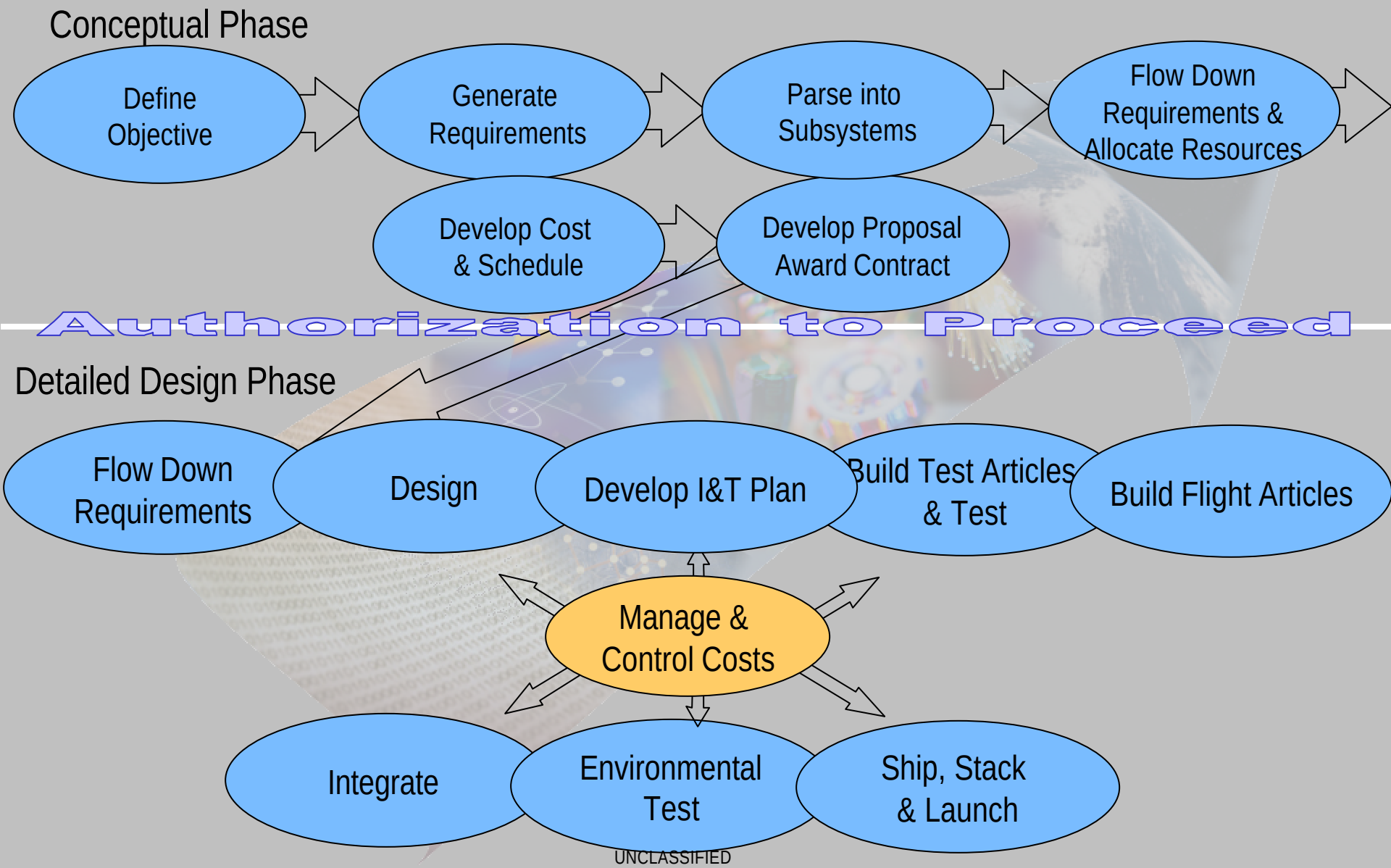
We could . . .

. . . design and
build spacecraft
in 12 months

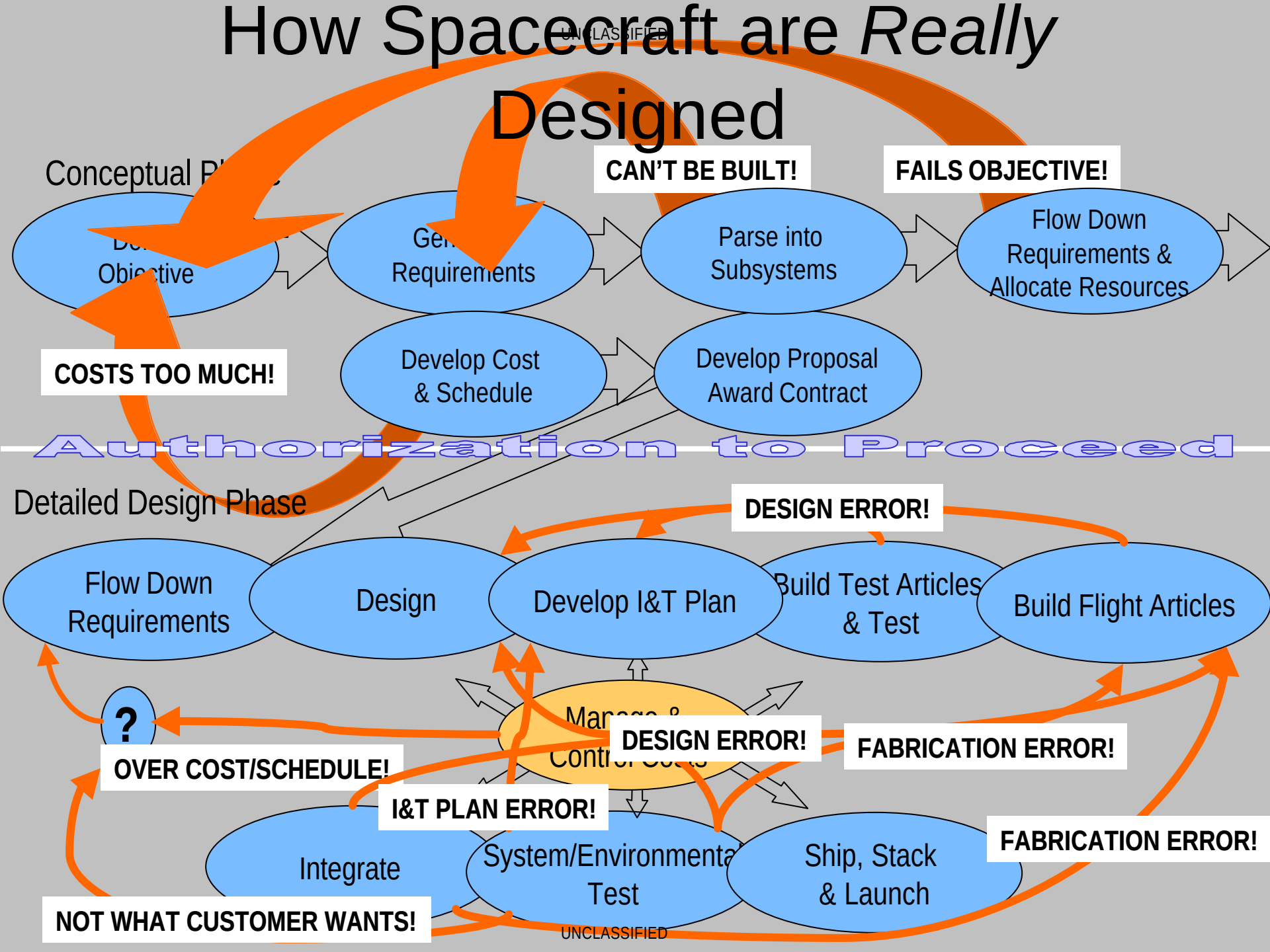
. . fully explore CONOPS
and design tradespaces

. . . model our
designs early and
virtual test

How Spacecraft are Designed

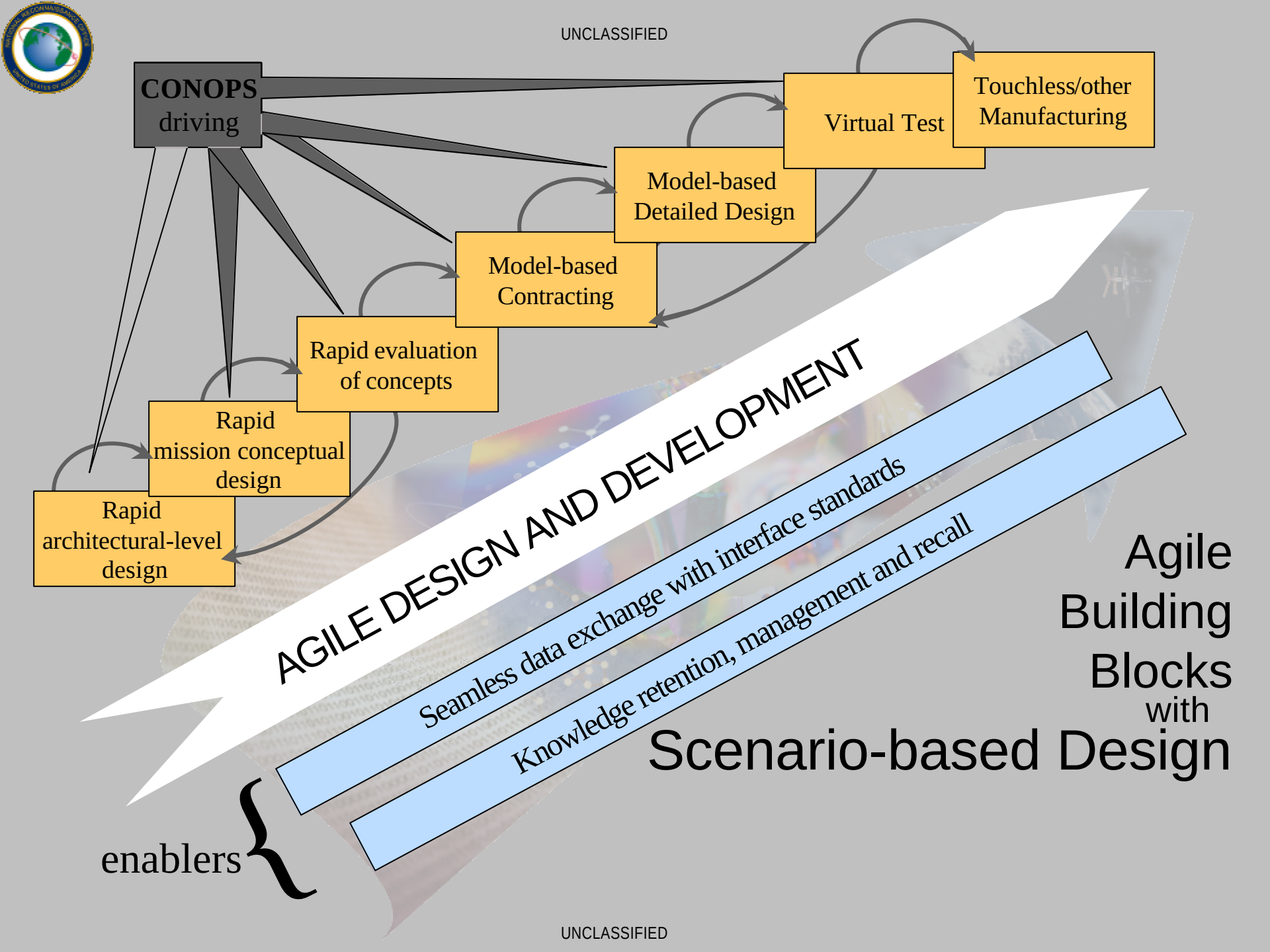


How Spacecraft are *Really* Designed



The Agile Design and Development Program

- Agile is an AS&T Program to skip a generation in the normal evolution of engineering design and development
  - Virtually eliminates rework through early modeling and expanded tradespace exploration
  - Replaces current contracting mechanisms
  - Leverages emerging manufacturing methods
- Liaisons with major US aerospace primes and design tool vendors
- Co-sponsors multi-agency working group to coordinate related activities (Currently AS&T, DARPA, NSF, NIST, AFMC, NASA – others in work)

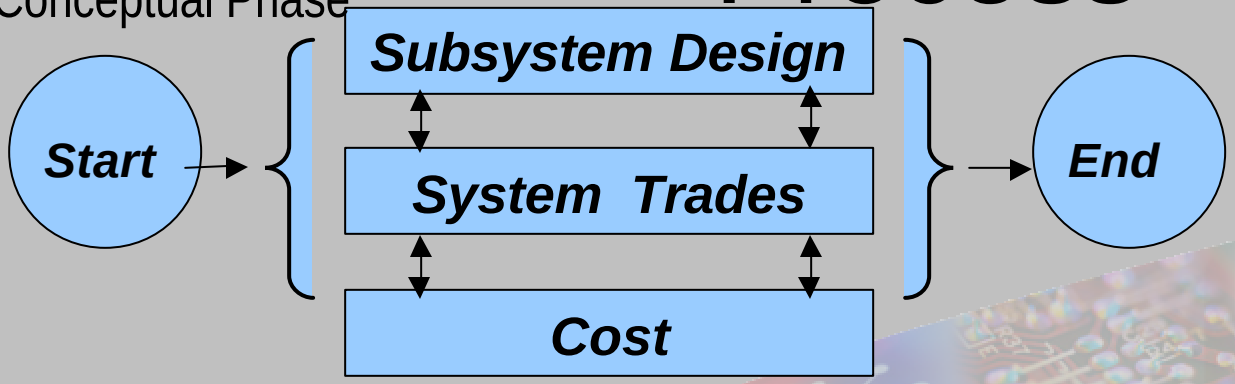

CONOPS driving
Virtual Test
Touchless/other Manufacturing
Model-based Detailed Design
Model-based Contracting
Rapid evaluation of concepts
Rapid mission conceptual design
Rapid architectural-level design
AGILE DESIGN AND DEVELOPMENT
Seamless data exchange with interface standards
Knowledge retention, management and recall
enablers
Agile Building Blocks
with
Scenario-based Design

Elements of the Agile Program

PROBLEM	PROGRAM ELEMENT	PAYOFF
Insufficient Design Space Exploration	Rapid Synthesis-Analysis Loop in Concept Phase	Optimized Systems
Slow Technology Insertion	Shorter Design/Development Time	Just-in-Time Technology On Orbit
Poor Costing	Linked Parametric Cost Models	Cost/Scope Match
Poor Time Mgmt	Concurrent Engineering	Rapid Design
Configuration Mismanagement and Poor Tool Intercommunication	IT-based Data Exchange Mechanisms Between Models and Tools	Rapid, Accurate Design
Rework due to design errors	Early Design Modeling and Virtual Test	Less Rework
Changing Customer Needs	CONOPS Modeling	Systems that Respond to Evolving Customer Needs
Inflexible Sponsor-Contractor Relationships	Model-Based Contracting	Flexible, Responsive Primes That Can Still Profit
Costly/Design-Limiting Manufacturing	Advanced Manufacturing Methods	Responsive Production
Cultural Resistance to Infusion	AGILESat, X-Sat Demos and Early DDSE Involvement	Timely Infusion of Agile Methods
LOW INNOVATION, LONG TIME TO MARKET	***THE AGILE PROGRAM***	***REDUCED DESIGN/DEVELOPMENT TIME & INCREASED INNOVATION***

Agile Spacecraft Design Process

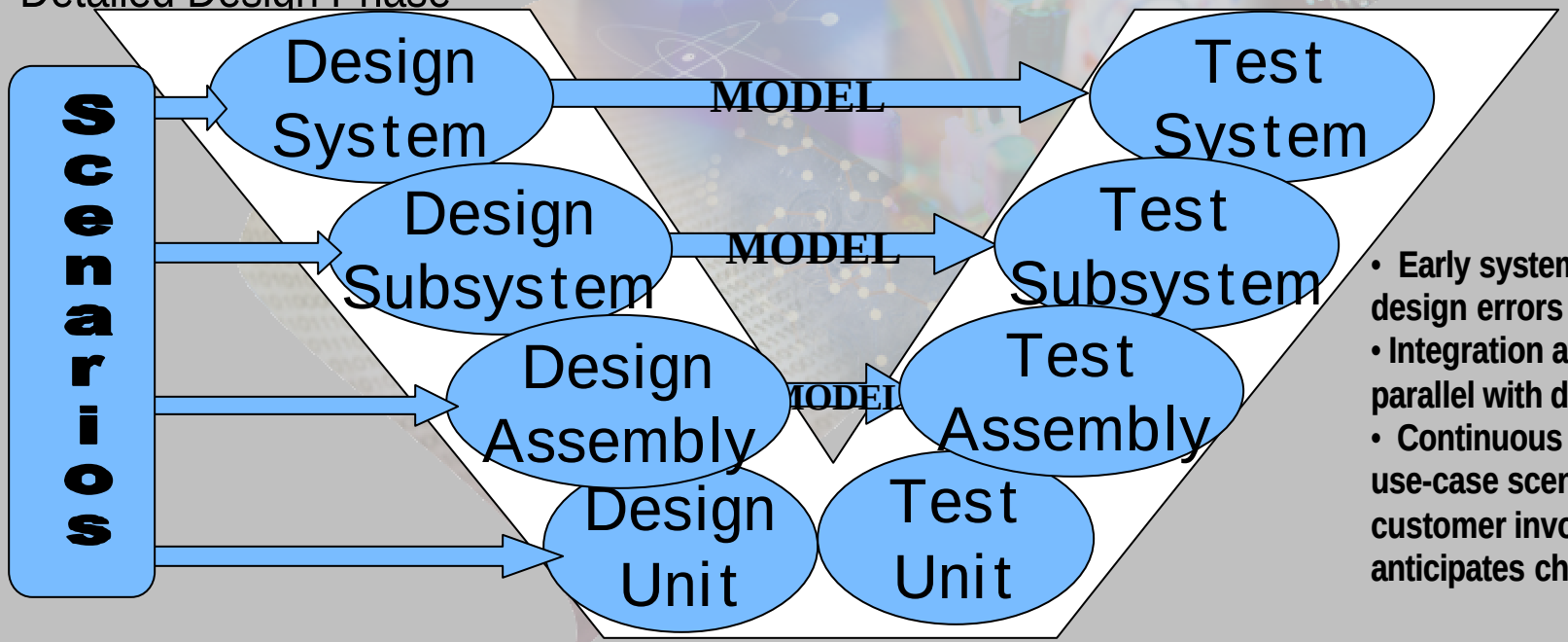
Conceptual Phase



- Parallel design, trade and cost efforts
- Full tradespace exploration through early performance modeling
- Iteration to reduce chance for operability issues

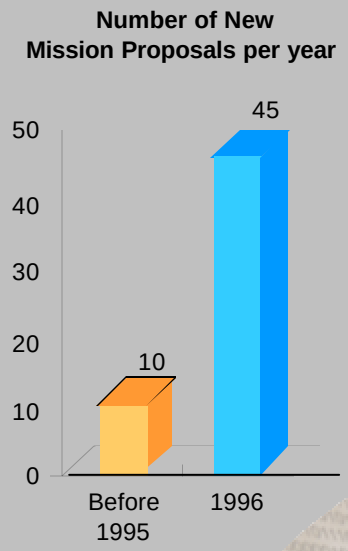
Authorization to Proceed

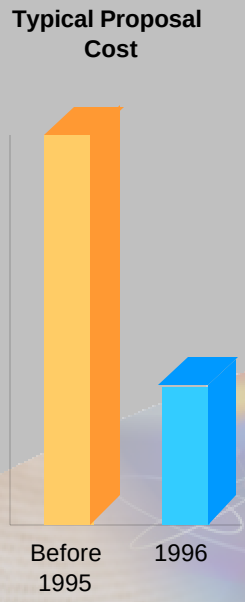
Detailed Design Phase

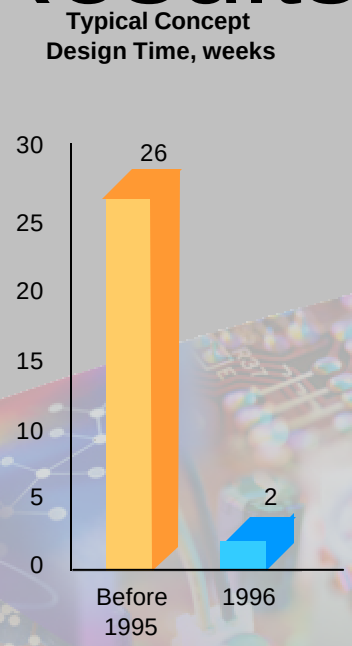


- Early system modeling reduces design errors
- Integration and test proceed in parallel with design
- Continuous interaction through use-case scenarios keeps customer involved and anticipates changes

Conceptual Phase: Demonstrated Results



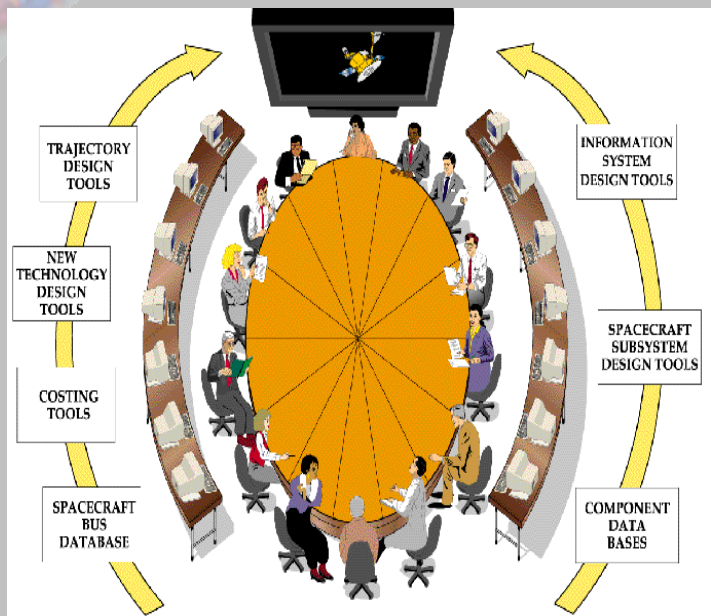




- in place and operational

- multiple instances (Aerospace, JPL, NASA/G, ESA)

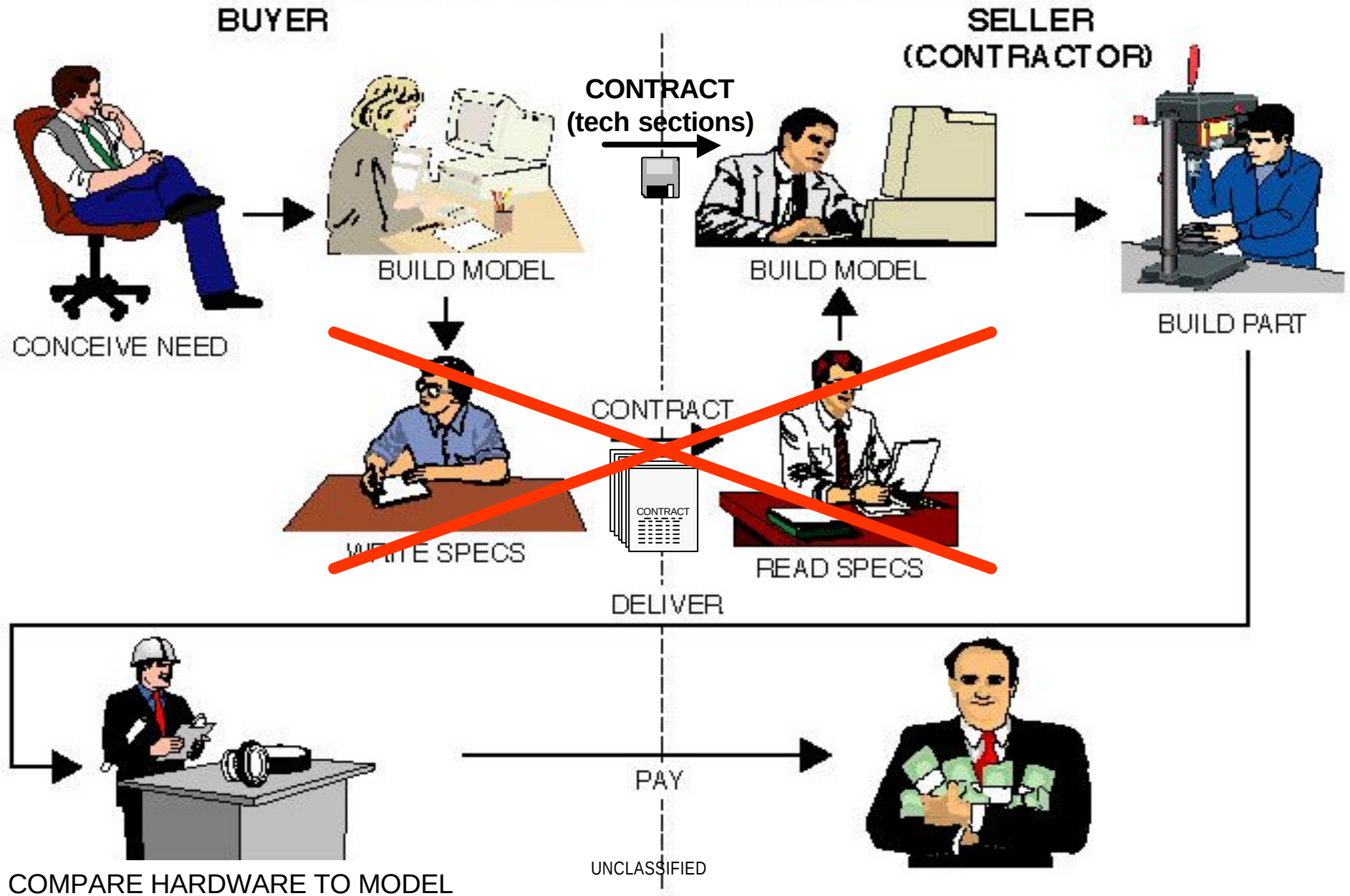
- proof that new methods and teaming changes can produce fundamental improvements in design time and cost



The Mission System Design Center

Model-Based Contracting Mechanism

Software models form the technical specifications of the contract

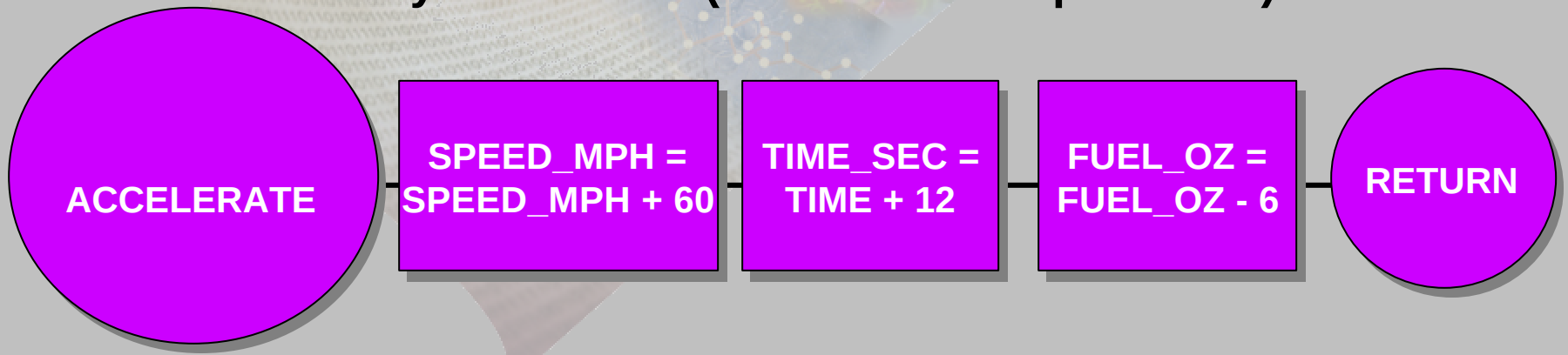


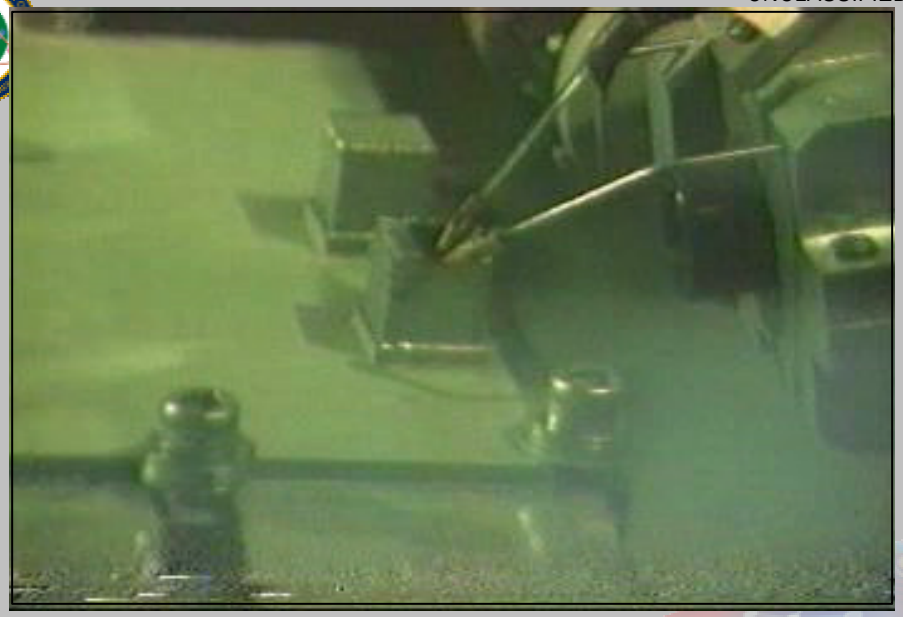
Statement of Requirements

Traditional Requirement (Text)

“[vehicle] shall accelerate from 0 to 60 mph in less than12 seconds using less than 6 oz. of fuel”

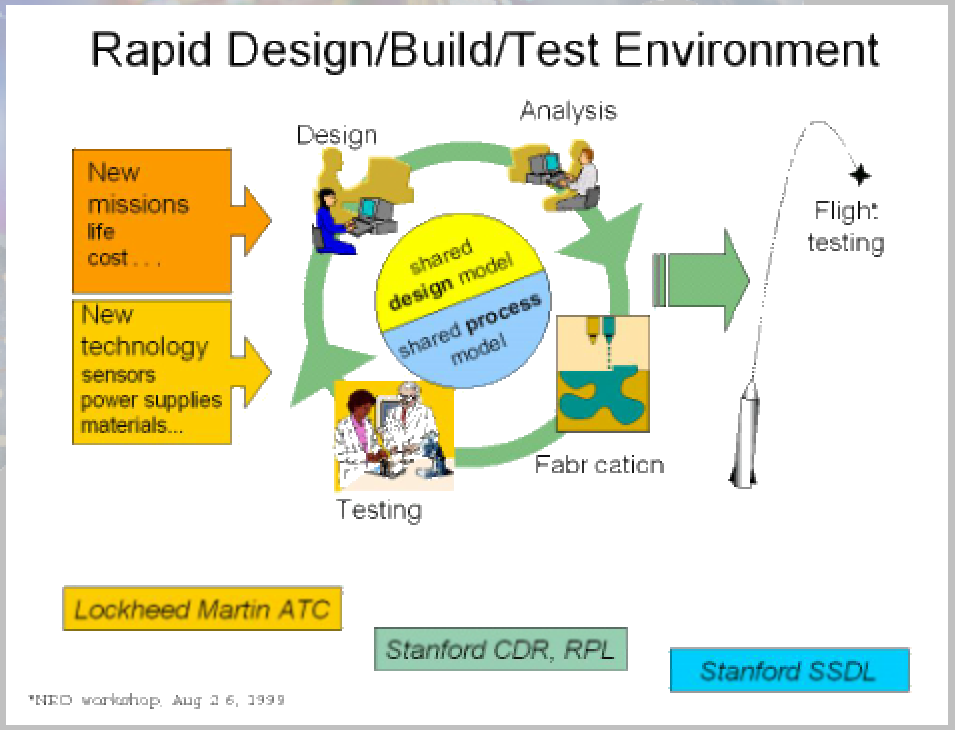
System Model (Executable Requirement)



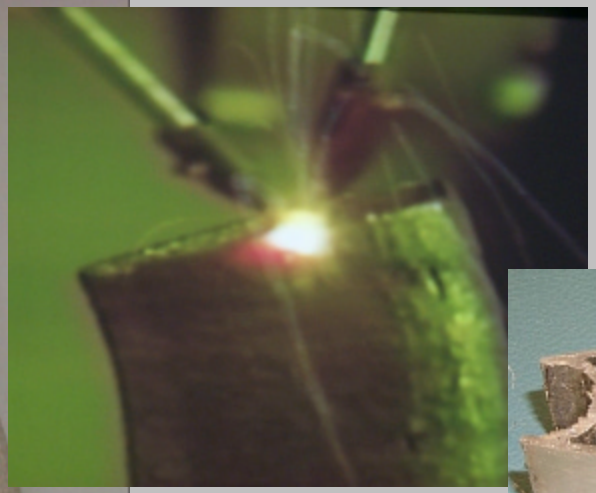


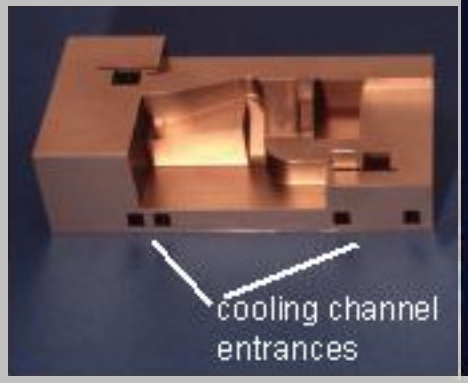
Recent research at Stanford University and Lockheed-Martin show that “touchless manufacturing”, wherein functional hardware assemblies may be deposited using laser and e-beam technologies, is within the 5-year horizon. Agile is sponsoring application of this research.

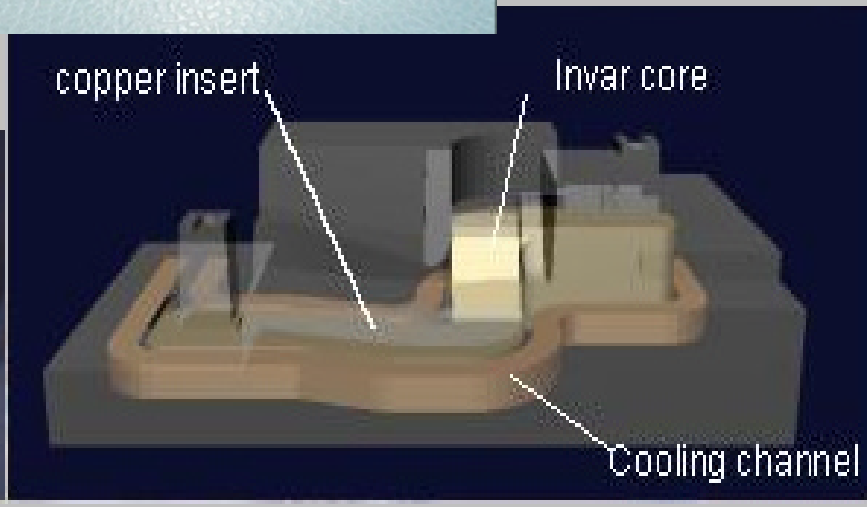
Agile is funding research on engineering design tools that have impact on design methods similar in scope to the arrival of CAD tools. These will short-cut detailed design and go immediately from early models to manufactured item.



Examples Of Laser-Deposited Material

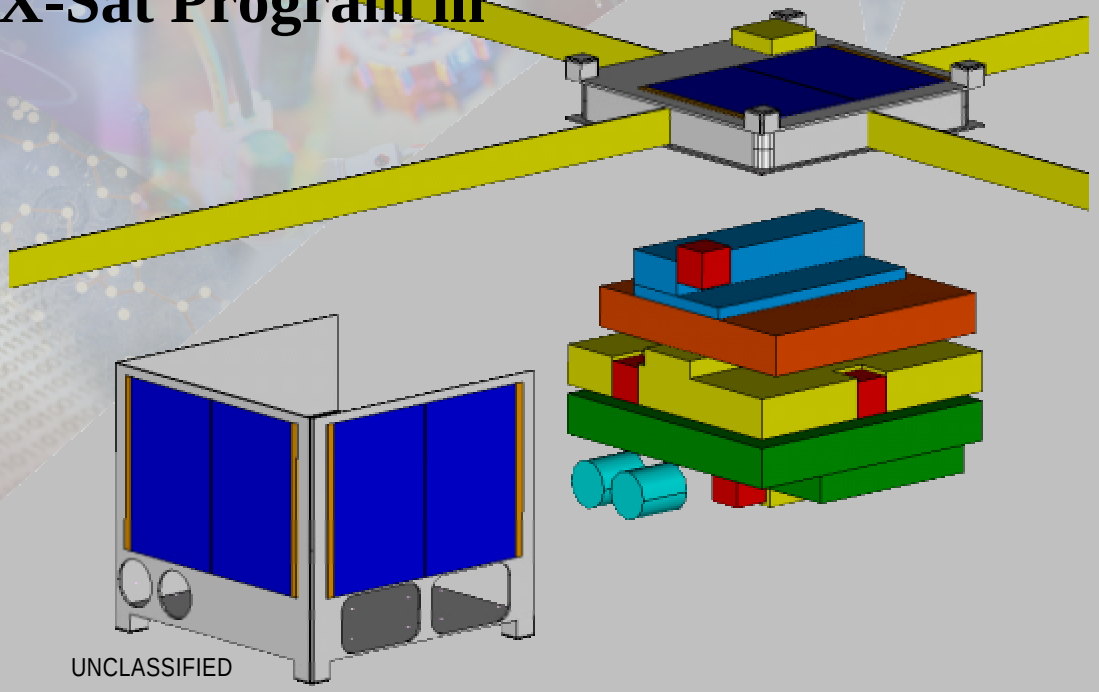




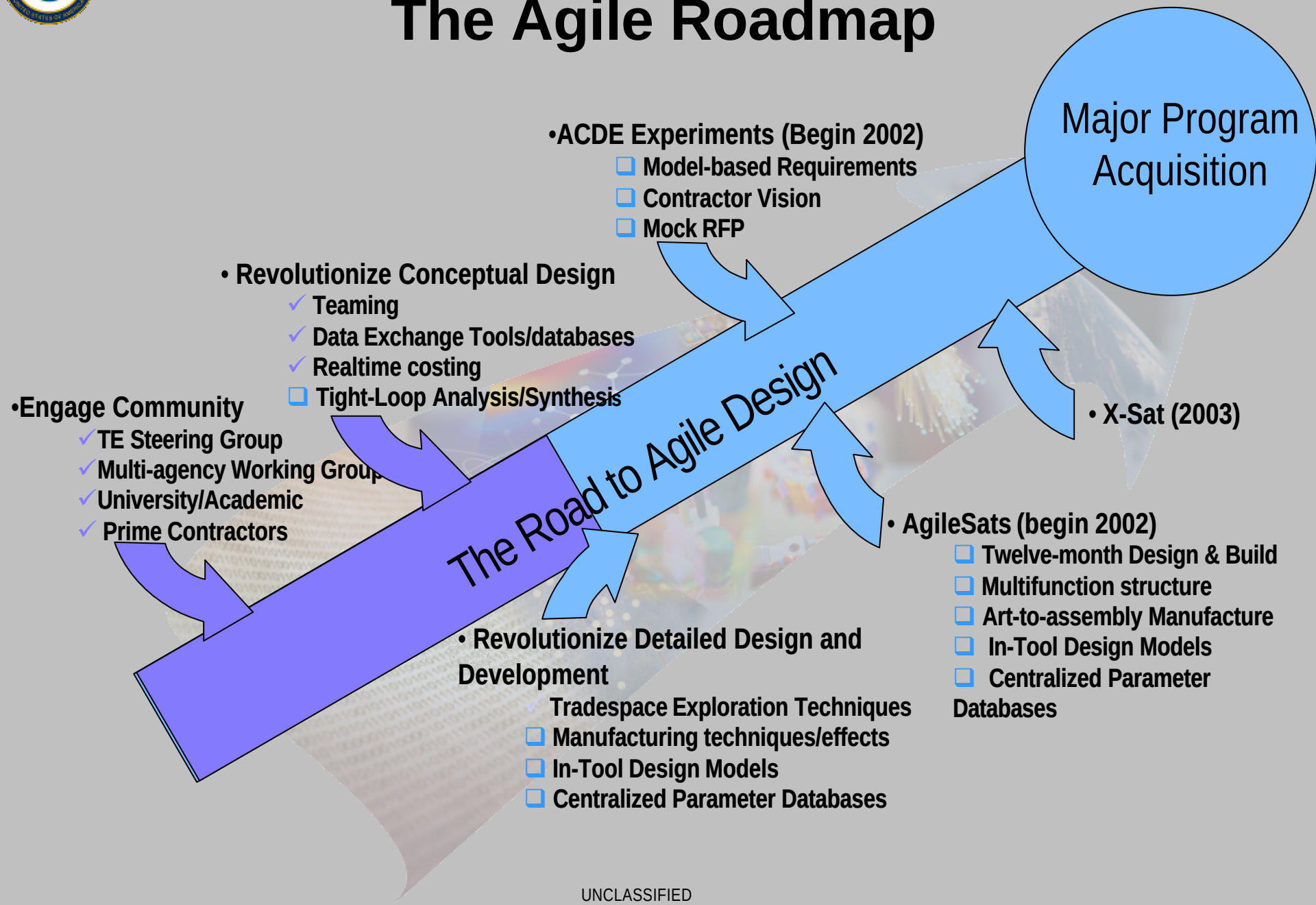


Proof of Concept: AGILESats and X-Sat

- **In 2003, Agile will launch AGILE I, our first proof-of-concept spacecraft**
- **12 cm x 12 cm, Shuttle-launched**
- **Demonstrates Touchless Manufacturing**
- **Linkages to Model-based Design**
- **AGILESats will continue annually**
- **Application to AS&T's X-Sat Program in FY04**



The Agile Roadmap



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