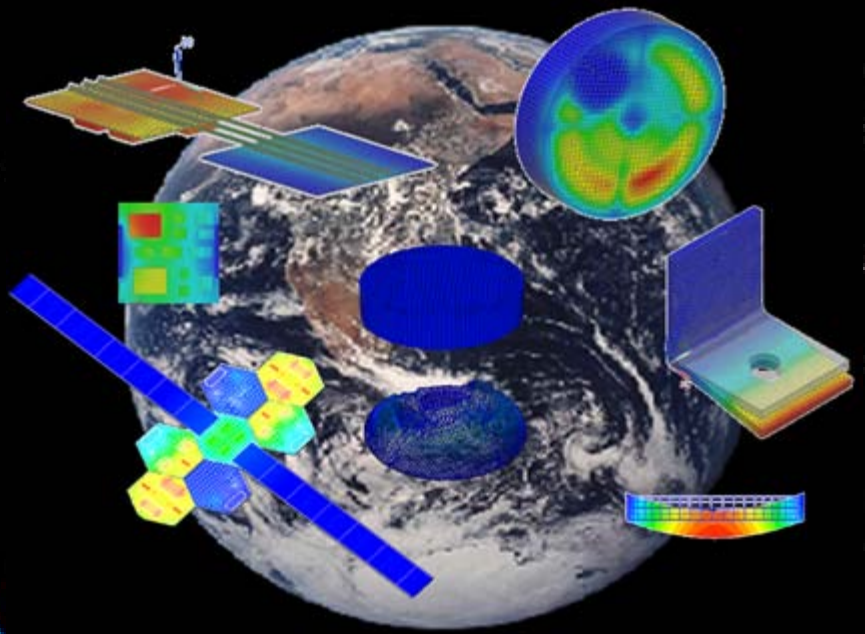
Physics-Based Modeling In Design & Development for U.S. Defense

Virtual Prototyping & Product Development



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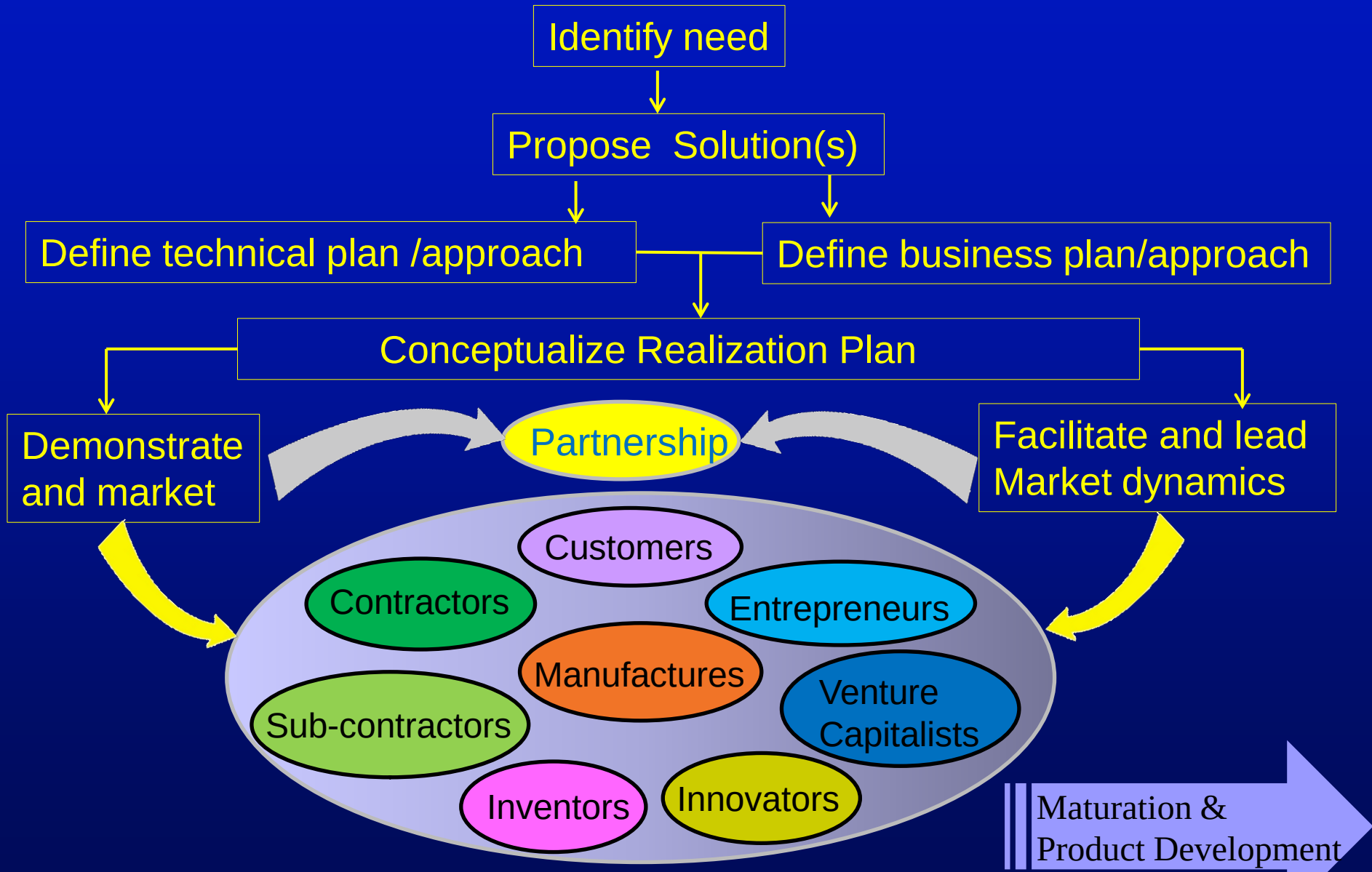
November 7, 2012

Outline

- Innovation & Technology Development
- Business Imperatives
- Traditional Product Development
- Virtual Prototyping Definition
- Technology Maturity
- Product Life Cycle
- Managing Product Life Cycle
- Product Development
- Affordability & Agility
- Evolution and Path Forward

Innovation & Technology Development

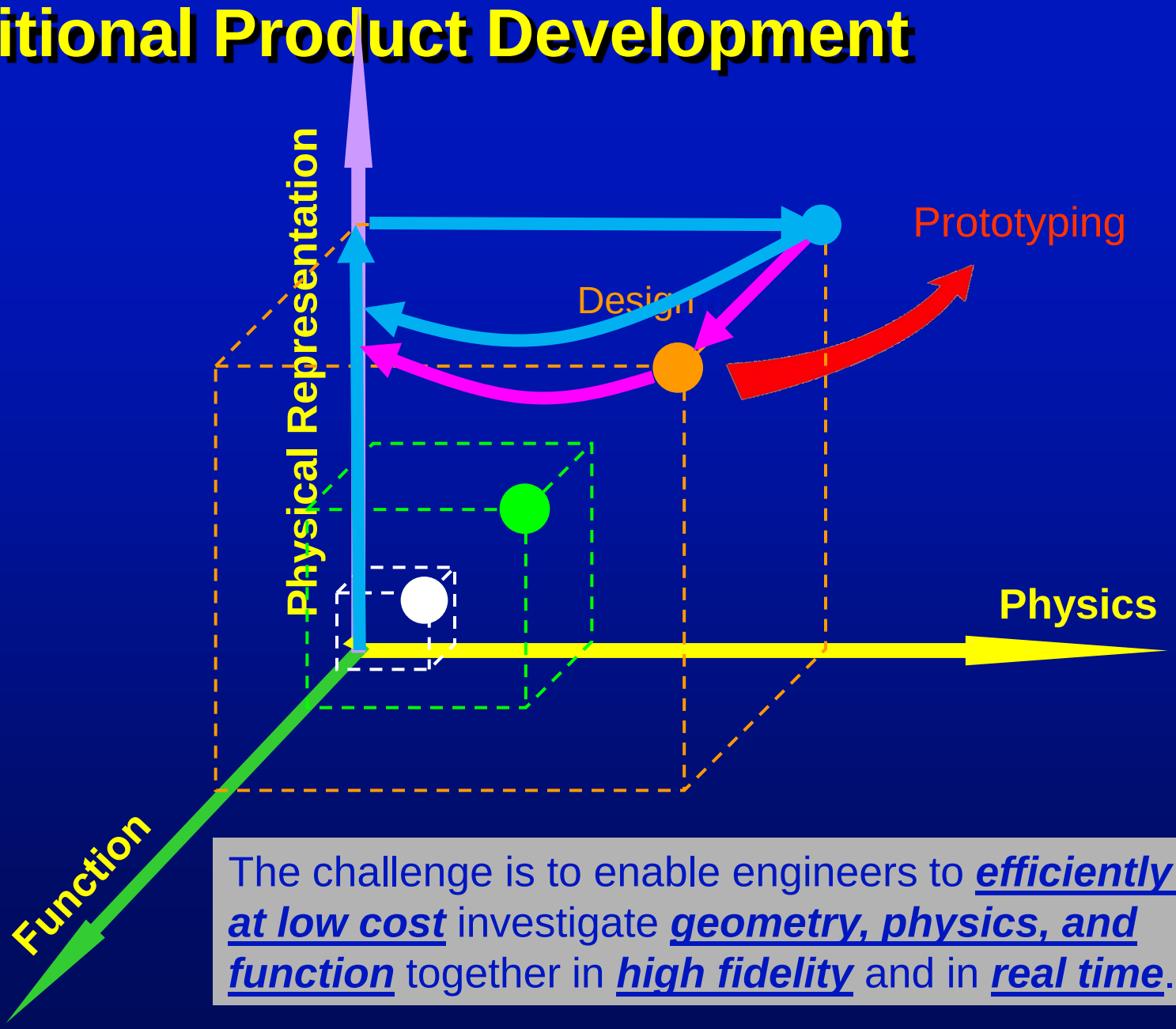


Business Imperatives

- **Traditional product development process requires design, analysis, and testing that are time consuming, expensive, with sluggish response to changes in market conditions and technology demands.**
- **Iterative analysis and testing are often the main vehicle for product development, proof of concept and business campaigns.**
- **While maintaining *evolutionary* technology, a *revolutionary* approach is required to streamline design, analysis, innovation and product development to meet *affordability* requirements of business challenges.**
- **Industry is moving ahead with *virtual product development and marketing*.**

Due to use of variety of tools and processes, development of an open-architecture virtual prototyping capability is essential in the context of Model Based Engineering for agile product development, operational excellence, affordability and sustainment.

Traditional Product Development

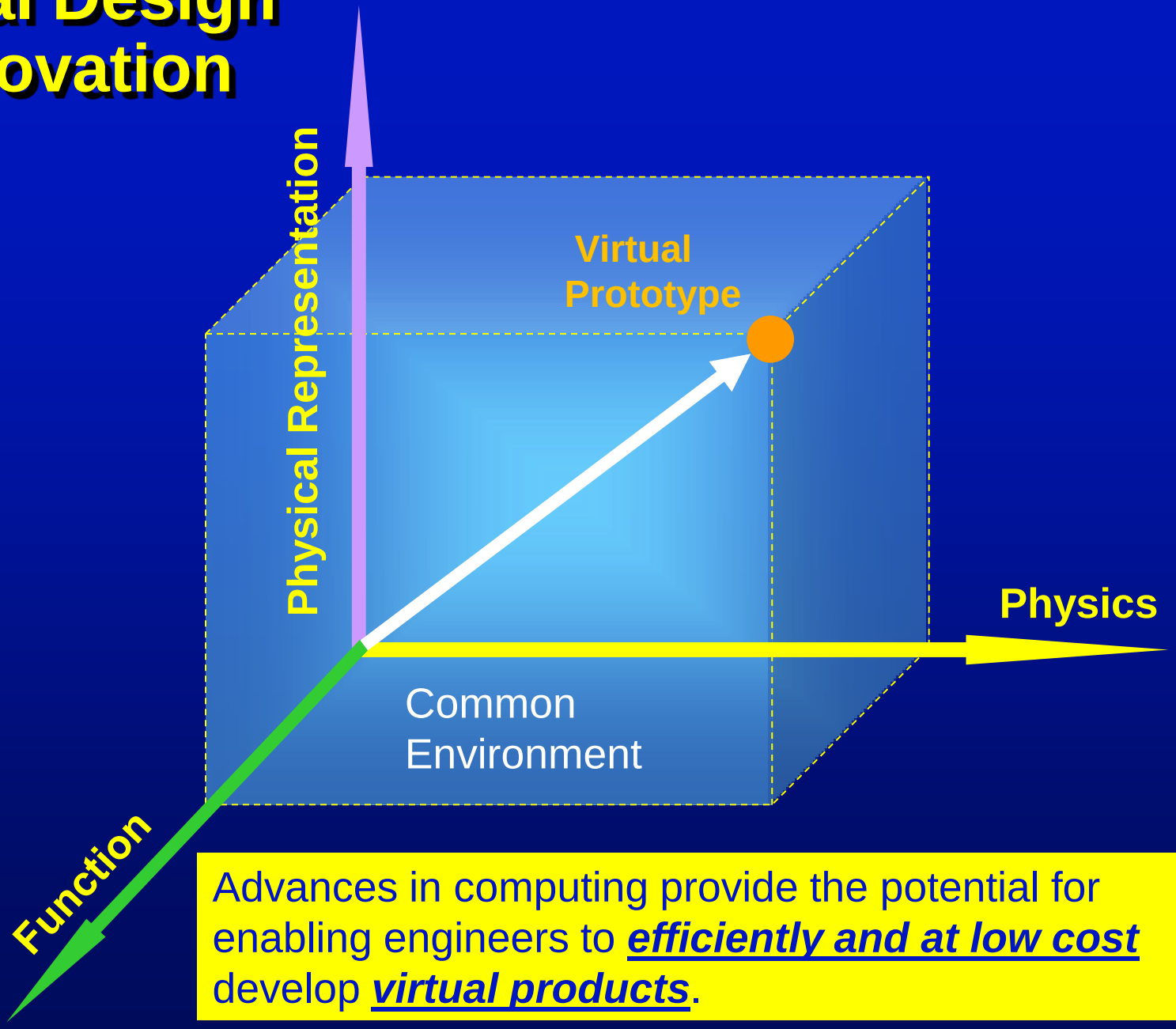


The challenge is to enable engineers to ***efficiently and at low cost*** investigate ***geometry, physics, and function*** together in ***high fidelity*** and in ***real time***.

Virtual Prototyping

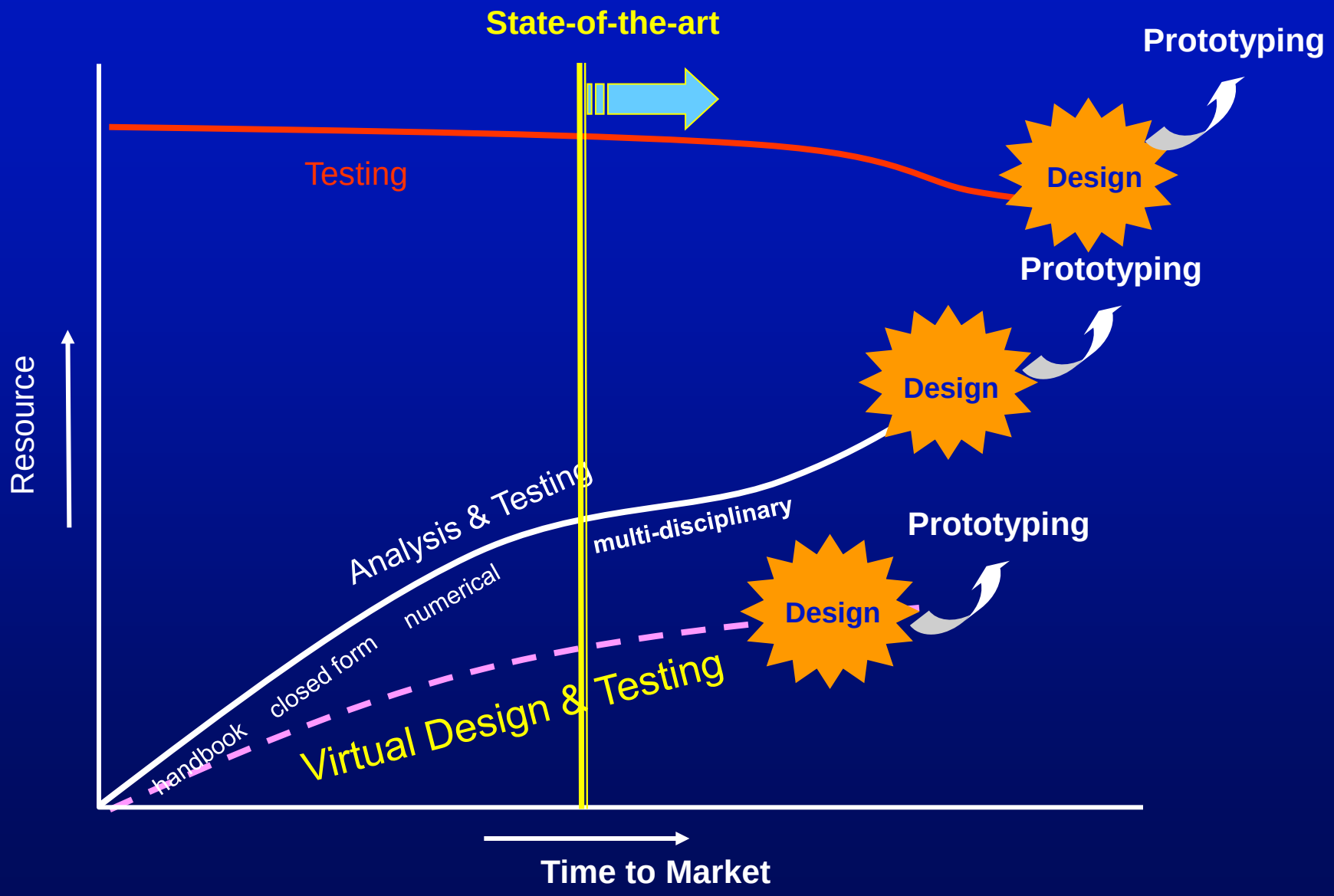
- **Virtual design and prototyping**
  - Is an associative process of design, analysis, performance evaluation, and visualization in a virtual environment based on mechanistic physical principles, accurate analysis, and reliable performance predictions
  - Streamlines design, analysis, innovation, and product development to meet the affordability requirements dictated by the current and future business environment.

Virtual Design & Innovation



Advances in computing provide the potential for enabling engineers to ***efficiently and at low cost*** develop ***virtual products***.

Product Development Evolution

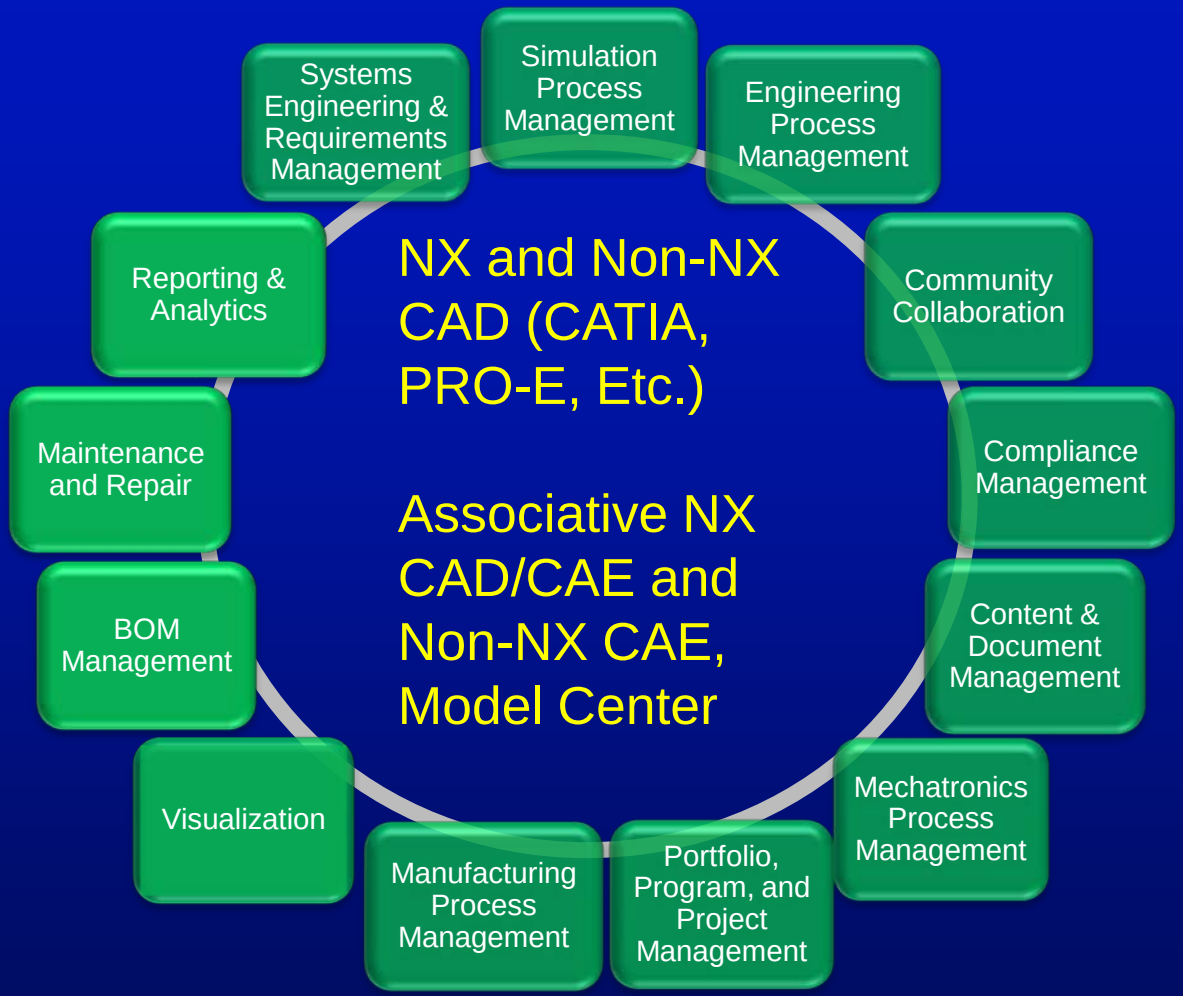


Technology Maturity & Product Development

- A best practice used in the commercial world and identified by GAO is to separate technology maturation from product development.
- In an ideal case, a research organization matures developing technologies in a laboratory environment.
- In a laboratory risk of failure is acceptable. The lab conducts experiments and naturally experiences some failures along the high road to knowledge.
- A product developer will use a specific new technology only after it has achieved a reasonable level of maturity in the research environment.

Use only mature technologies when developing products.

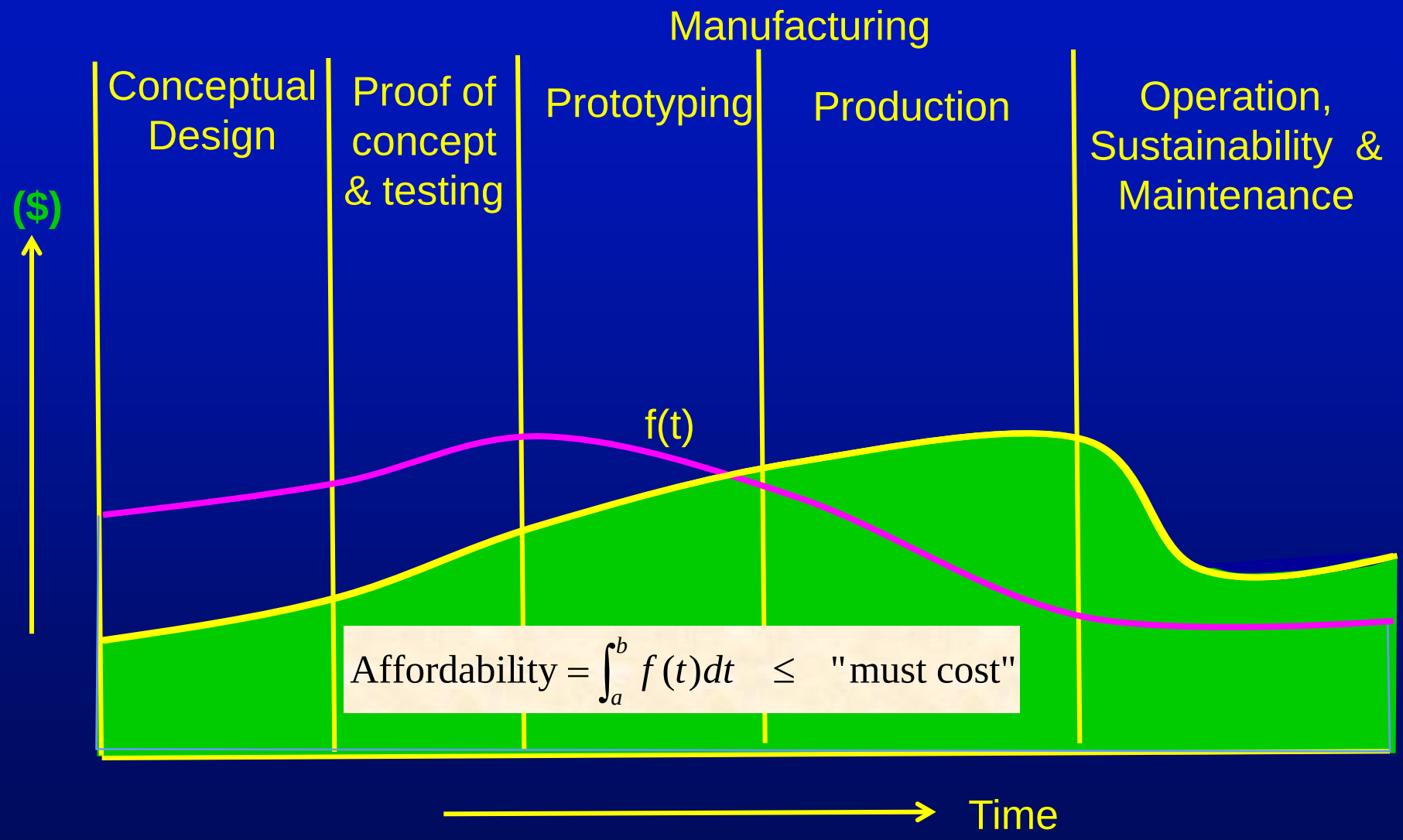
Product Life Cycle Development Architecture



Provides interchangeable CAD and CAE tools and accommodates and requires one-time customization & license for each tool—some exist.

Managing Product Development

Product Life Cycle Affordability



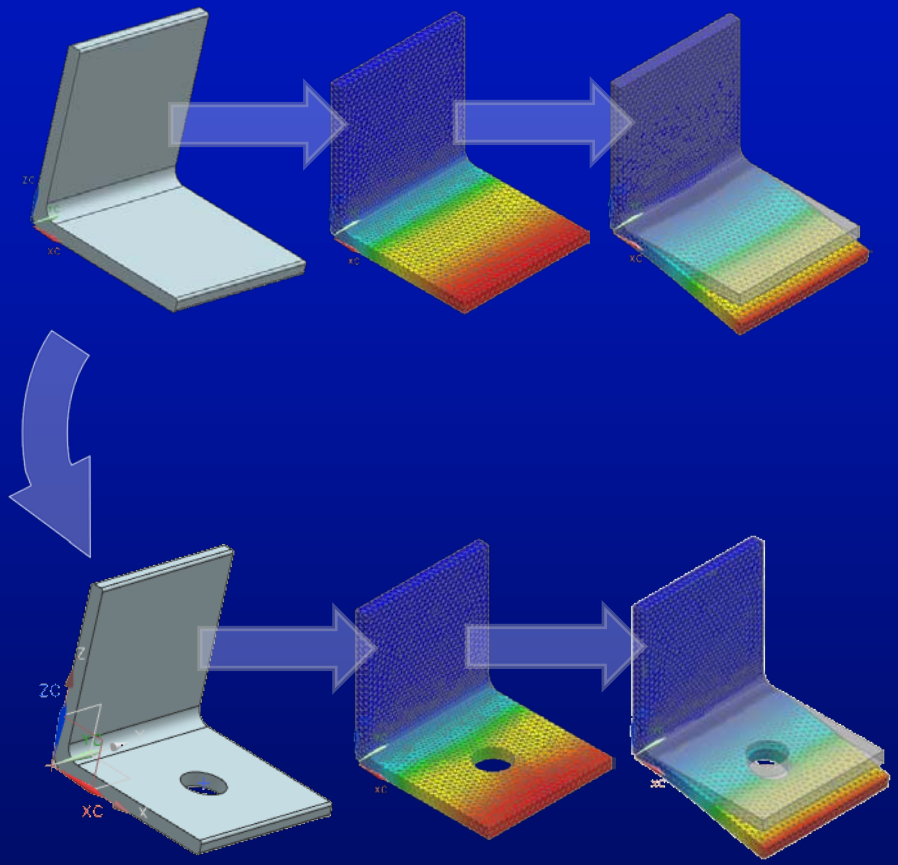
Traditional Versus Agile Project Management

Traditional PM	Agile PM
Focuses on processes and tools	Focuses on team communication and interaction
Anticipates limited changes and requires comprehensive documentation	Places priority on developing products and/or solutions that will be progressively modified and improved
Emphasizes the importance of contract negotiation and tasks delineated in the contract	Emphasizes the importance of customer — project team collaboration and daily communication
Works the plan; follows the plan to the end	Features flexibility and response to change
No restriction	Favors object-oriented technology

Traditional Versus Agile Process

	Traditional	Agile
Fundamental Assumptions	Systems are fully specifiable, predictable, and can be built through meticulous and extensive planning.	High-quality, adaptive products can be developed by small teams using the principles of continuous design improvement and testing based on rapid feedback and change.
Control	Process-centric	People-centric
Management Style	Command-and-control	Leadership-and-collaboration
Knowledge Management	Explicit	Tacit
Role Assignment	Individual — favors specialization	Self-organizing teams — encourages role interchangeability
Communication	Formal	Informal
Customer's Role	Important	Critical
Project Cycle	Guided by tasks or activities	Guided by product features
Development Model	Life cycle model (Waterfall, Spiral, or some variation)	The evolutionary-delivery model
Desired Organizational Form/Structure	Mechanistic (bureaucratic with high formalization)	Organic (flexible and participative encouraging cooperative social action)
Technology	No restriction	Favors object-oriented technology

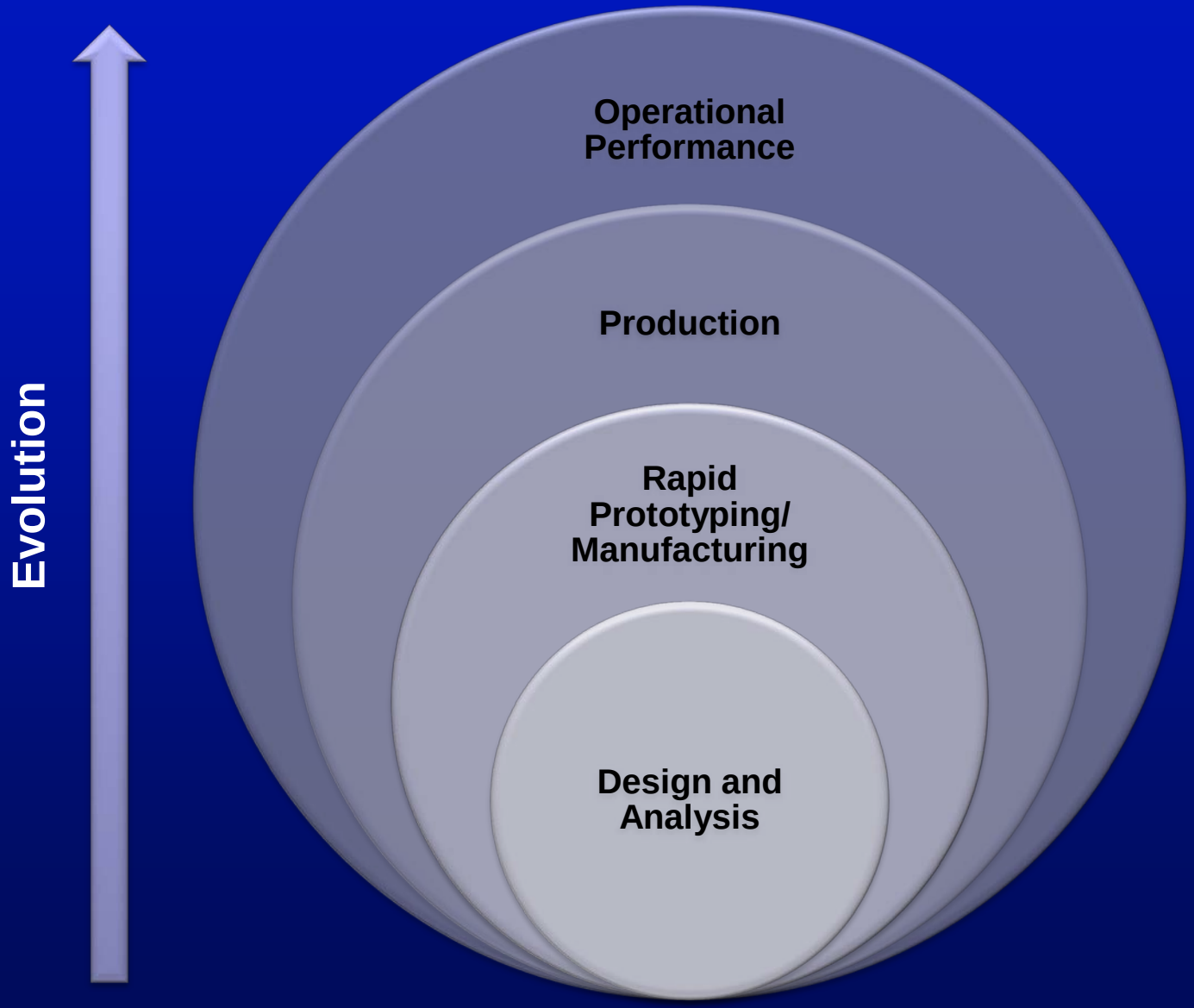
Virtual Prototype Example - Associative Design & Simulation Summary



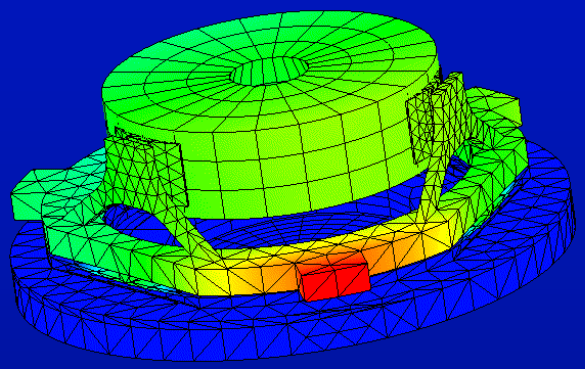
NX CAD/CAE – Bracket part/ Idealized part creation/ Mesh creation / Thermal analysis/ Structural analysis

New feature propagate to idealized part; previous simplifications preserved. Finite element model update automatically. Simulations associatively update.

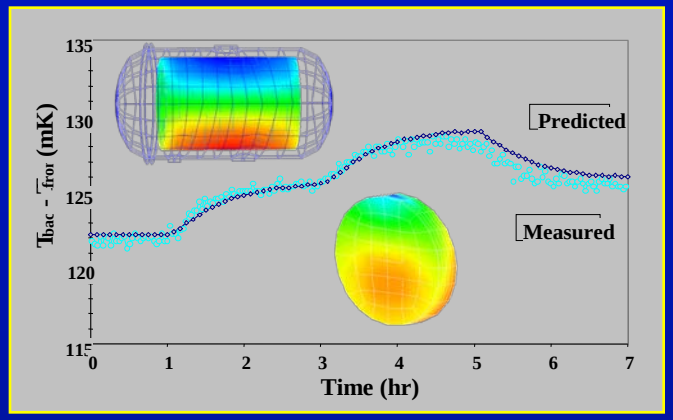
Virtual Prototyping Roadmap



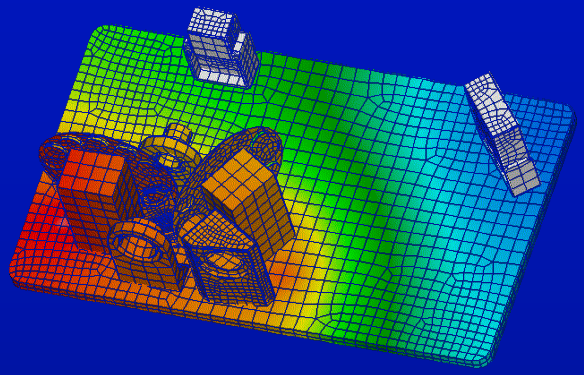
Technology Application



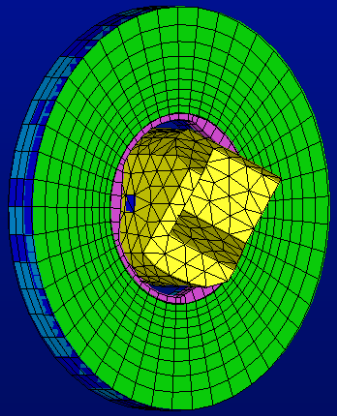
Enabling Better Design Decisions



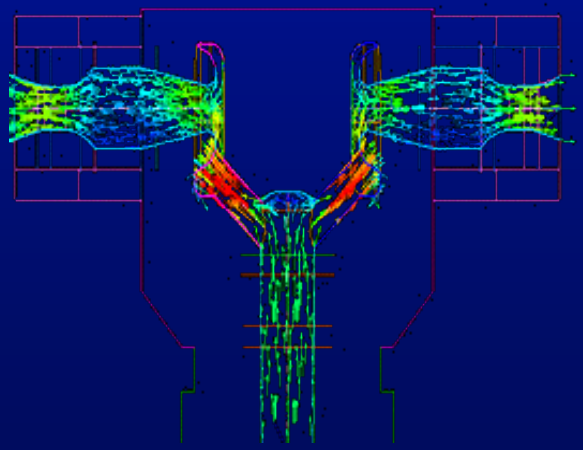
Validating Design



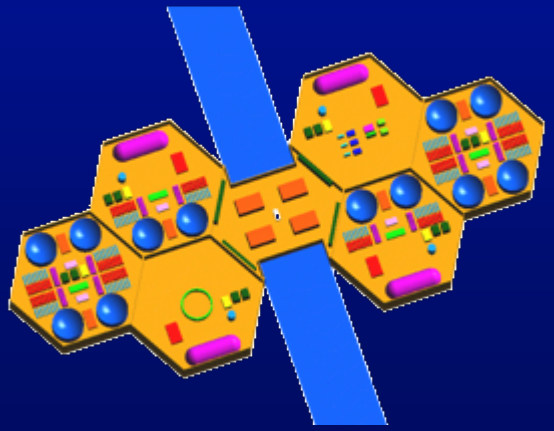
Winning New Business



Realizing Picometer Accuracy

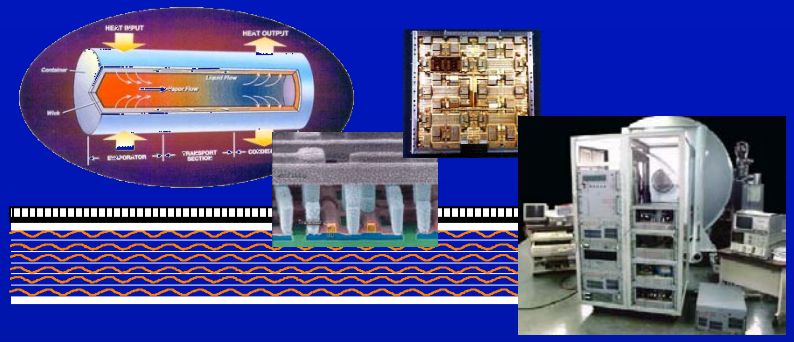


Emerging Applications



Testing New Concepts

Product Applications

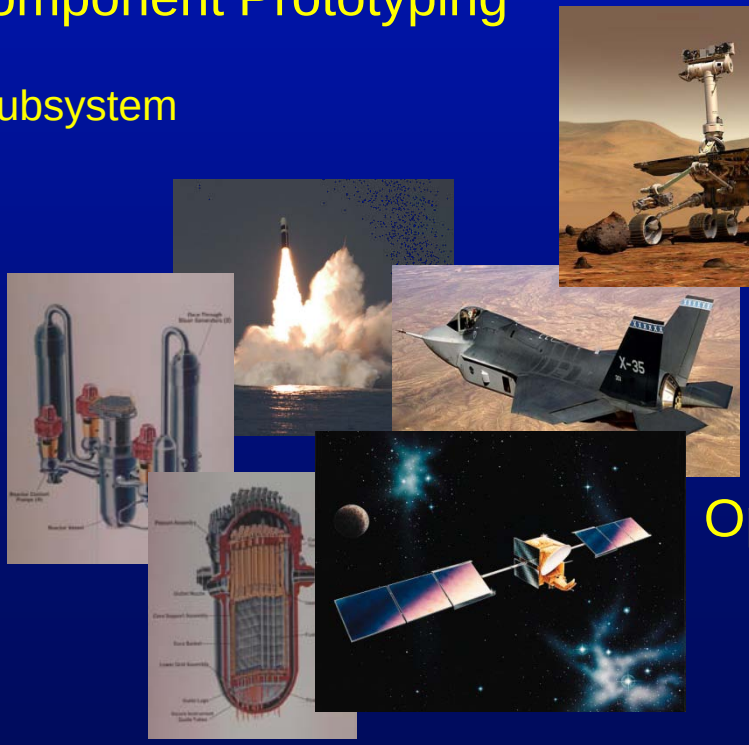


Advanced Component Prototyping

- Heat pipe
- Electronic Subsystem
- Transistor
- Chip MLI

System Development and Demonstration

- OC OTEC
- CC OTEC
- Geothermal
- Solar OV Farm
- Wind Farm



Operational System Development

- BWR/PWR
- Aircraft
- Spacecraft

Trend

- Integrated Multidisciplinary
- Modular Experimental Facility
- Virtual Prototyping
- Digital & Agile Manufacturing
- Seamless and Automated Quality Control

Thank You