THE USE OF DESIGN-TO-DEBRIS PROTOTYPES IN SPACE-GROUND TRADES

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AGENDA

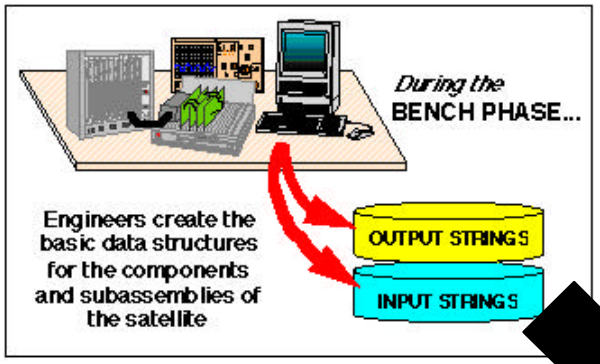
- Costly Historical Practices
- The Bench, I&T, and Operational System Prototype
- Simulation-Based Design
- Principles of Automation
- Space-Ground Trades

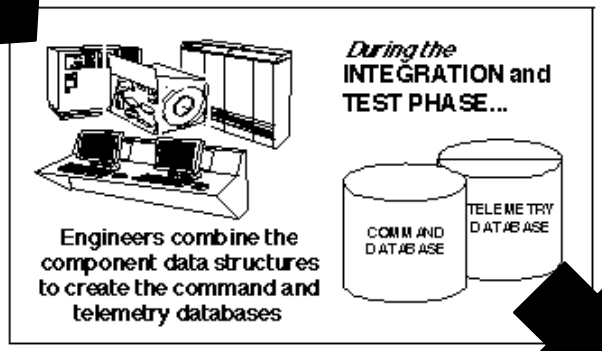
COSTLY HISTORICAL PRACTICES

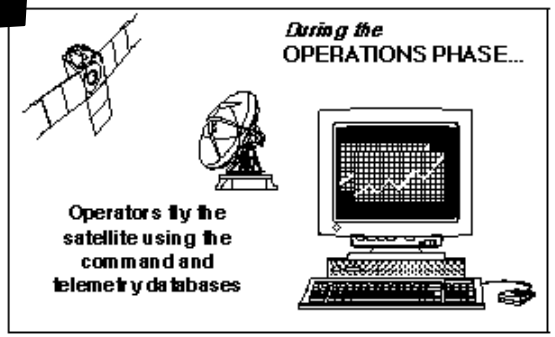
- **Building three separate ground data systems**
  - **component and subsystem phase**
  - **integration and test phases**
  - **operational phase**
- **Sequential engineering of space and ground segments**
- **Adding automation post-launch**
- **Space-ground trades not made over full lifecycle**

ADDRESS THESE PROBLEMS WITH
CONCURRENT ENGINEERING

THE BENCH, I&T, AND OPERATIONAL SYSTEM PROTOTYPE







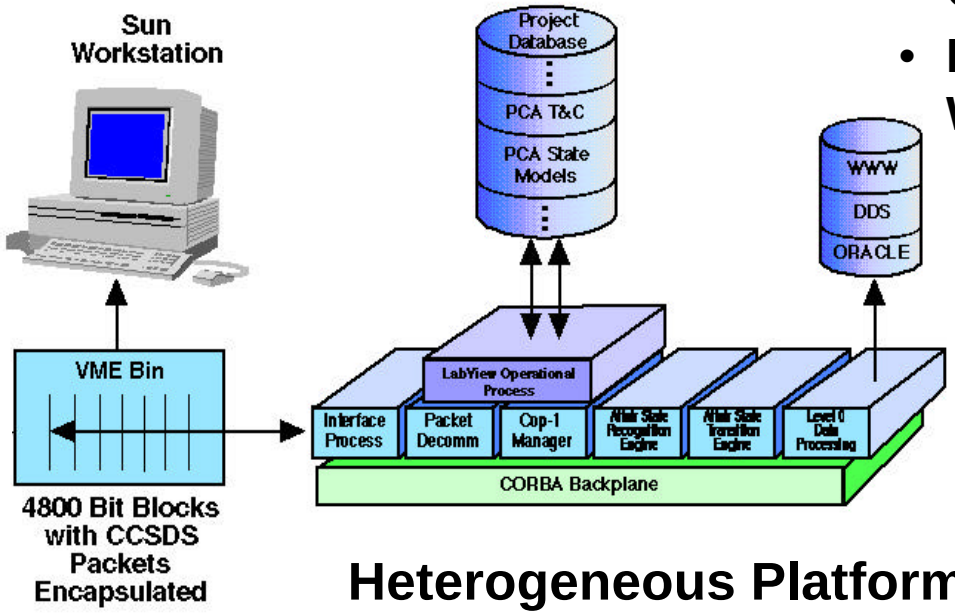
Capture system data

- input and output words at the component level
- combine into telemetry and commands
- flexibility for I&T
- automation models

Prototype Complete

- utilizes XTE PCA interface for bench hardware
- XTE commands and telemetry

THE BENCH, I&T, AND OPERATIONAL SYSTEM PROTOTYPE



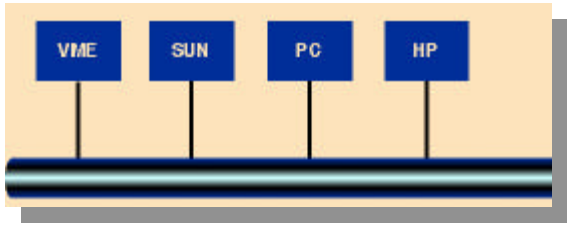
Exploit new COTS tools

- **CORBA (Orbix product)**
- **LabView (Windows 3.11, Windows NT, Unix)**

BIOS processes communicate through CORBA backplane

Heterogeneous Platforms:

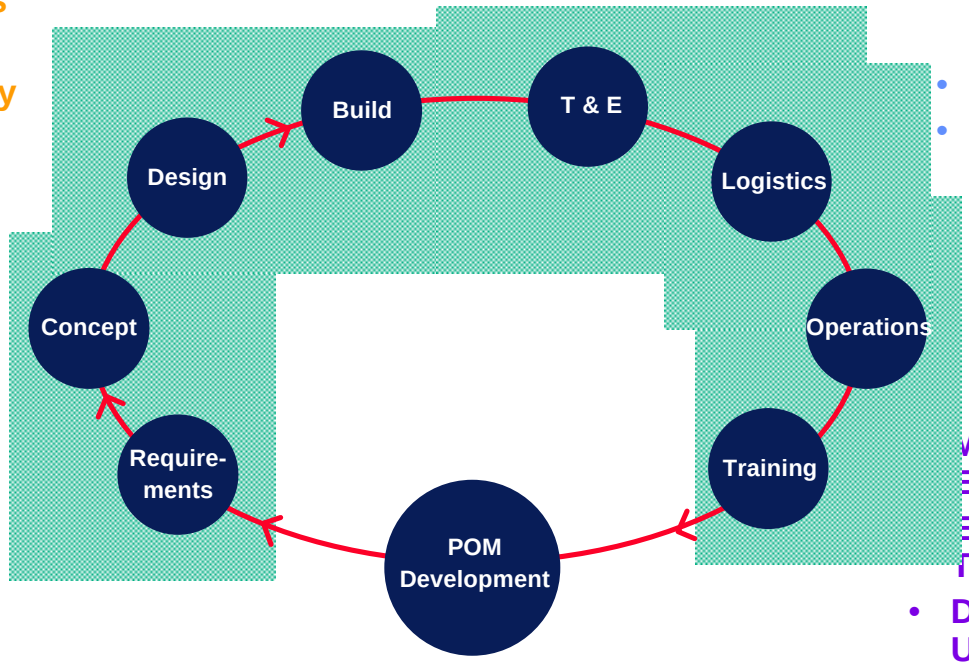
- **PCs (NT & Windows 3.1)**
- **Unix workstations**
- **Macs**



TYPICAL PRODUCT DEVELOPMENT LIFE CYCLE ACTIVITIES

- Product Model Definition
- Multi-Disciplinary Analysis
- Design Environments
- Simulation
- Solid Model Geometry
- Visualization

- Design for Manufacturability
- Virtual Manufacturing & Integration
- Design for Testability & Maintainability



- Asset Visibility
- Enterprise Infrastructure Connectivity

- Performance-Based Costing

Mission Effectiveness
Early/Continuous Training

- Design for User/Operator
- Train to Maintain

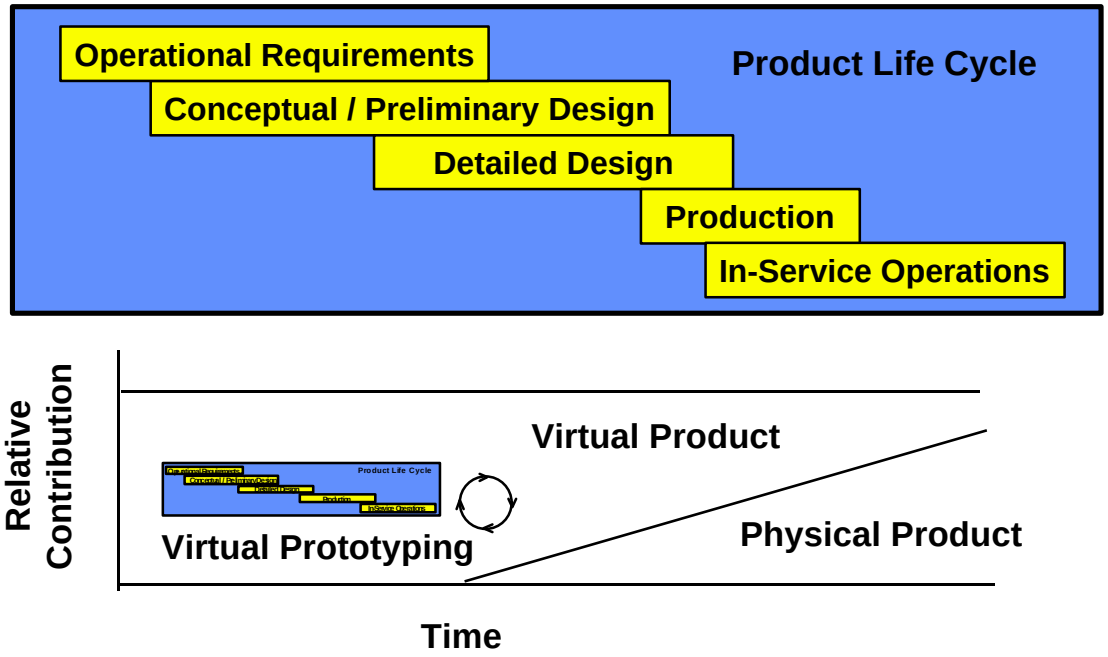
- Mission/Concept of Operations
- Procurement Strategy
- Other Life Cycle Considerations
- Process Issues

WHAT IS SIMULATION-BASED DESIGN (SBD)?

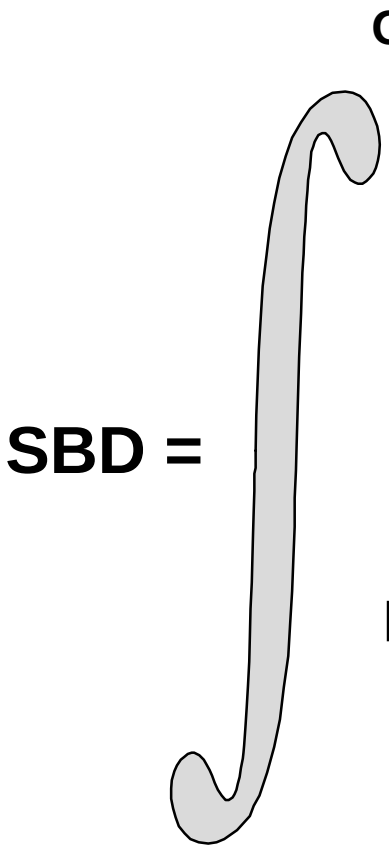
An Open, Distributed Collaborative Virtual Prototyping Environment That Provides:

- System Performance, Cost, and Schedule Insights and Trade-offs
- Integrated Solutions to Mission Needs
- Continuous Visibility Into System Options
- Total Value Assessment
- Timely Technology Insertion

SBD Supports Transition from Virtual to Physical Product during System Life Cycle::



SBD FRAMEWORK APPROACH



Your Legacy Data

+

Your Legacy Tools & Process

+

Integrated Product & Process Model
(The Smart Product Model)

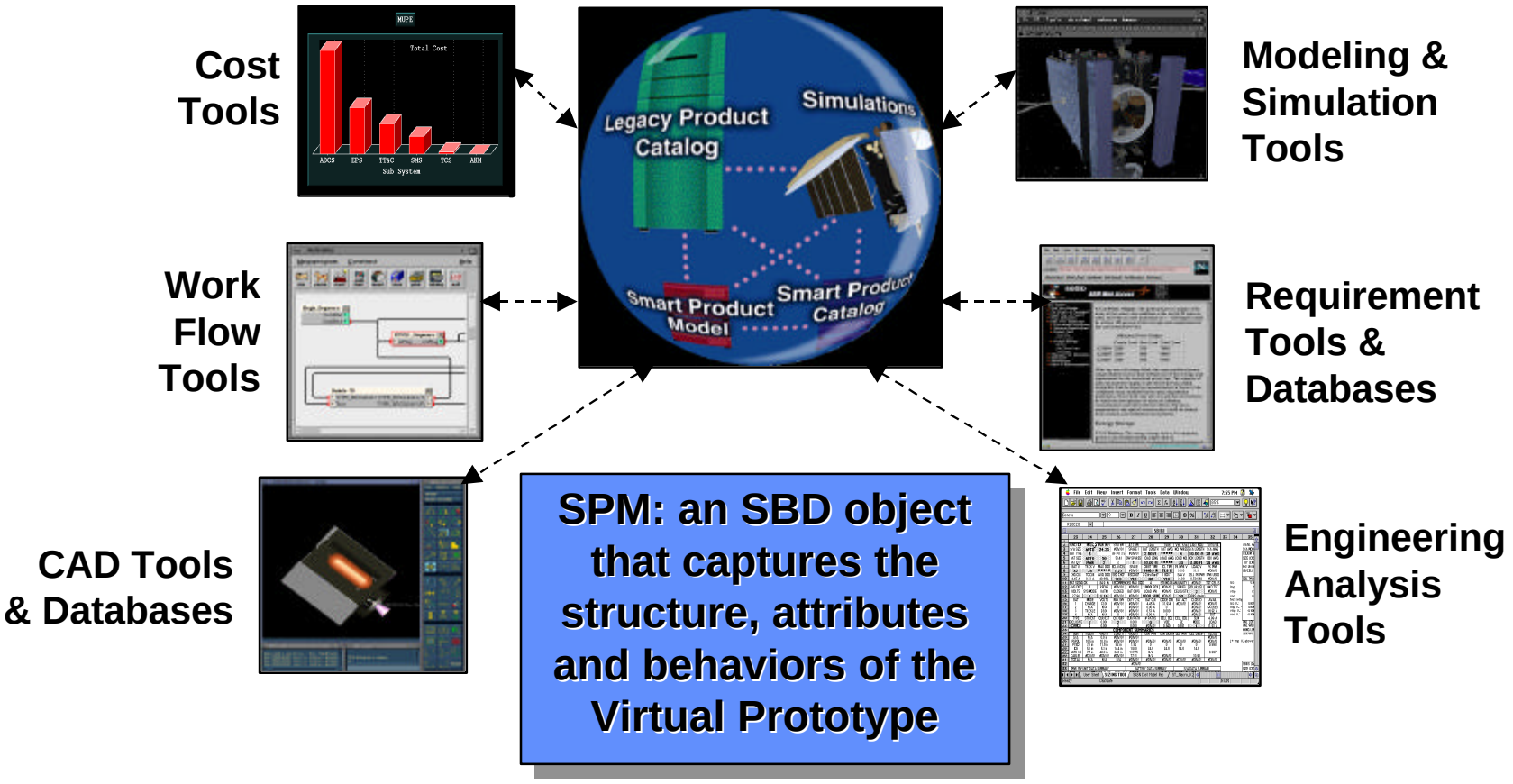
+

Distributed Collaborative Design Environment

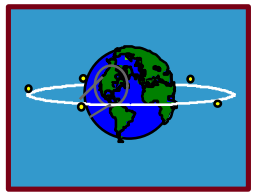
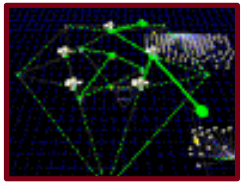
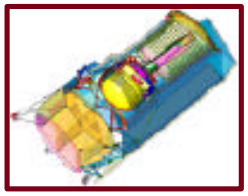
- **Integrating Application Layer**
- **Underlying Communication Backbone**
- **Unifying Graphical User Interface**

SMART PRODUCT MODEL (SPM)

Provides Data, Tool, & Process Integration

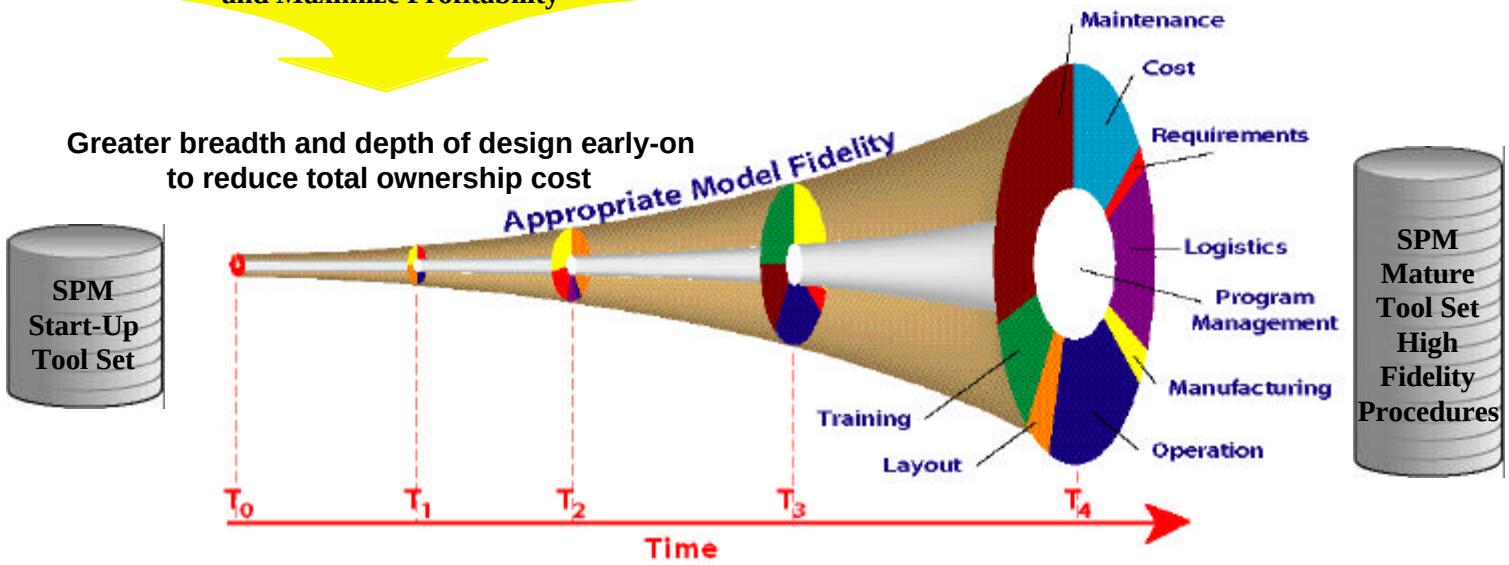


SBD COVERS THE ENTIRE LIFE CYCLE FOR COMPLEX SYSTEMS

Market Analysis	System Definition	Design and Analysis	Manufacturing and Testing	Launch and Orbital Insertion	On-Orbit Operations
					
Integration of Business with System Modeling Enables Detailed Market Analyses for Investment Decisions	Account for each aspect of system performance and risk on potential revenue generation	Mixed Fidelity Virtual Prototypes used to focus on cost / performance drivers	Virtual Manufacturing & Standard Processes used to improve quality and reduce Production Costs	Launch simulations employing MDO used to minimize time to orbit	Virtual Enterprise used to seamlessly integrate system management and operation functions to maximize profitability

Early End-toEnd System Simulation with Progressively Higher Fidelity Modeling to Minimize Risk and Maximize Profitability

Greater breadth and depth of design early-on to reduce total ownership cost



PRINCIPLES OF AUTOMATION

- **Multiple automation technologies**
  - **inference engines (RT works, G2)**
  - **finite state modeling (Altair MCS)**
  - **case-based reasoning (CBR Express)**
- **Multiple data drivers**
  - **telemetry**
  - **ground computed quantities**
  - **schedules and goals**
- **Allocation between ground and space**
  - **access to driving data**
  - **location of actions resulting from reasoning**

SPACE-GROUND TRADES

- **Benefits of concurrent engineering**
  - **lifecycle cost benefit analysis**
  - **trades within space and ground domains**
  - **trades between space and ground domains**
- **Benefits of network technology**
  - **simplifies space-ground interaction**
  - **permits reallocation of functionality during on-orbit operations**

Minimize lifecycle cost with continual trades based on
DESIGN-TO-DEBRIS PROTOTYPES