Innovations in Managing Complexity

The second major theme of the four-day PPMI/ PMSEP focused on innovations in the management of complex programs and projects. The first theme, NASA's strategic planning, ended with a series of parallel breakout sessions on each of the five Enterprise strategic plans.

After a short break, the second theme opened up as the first closed down, with a set of parallel breakout sessions on complex programs inside and out of NASA. There were six such sessions, the first two dealing with integrated product teams in two different programs.

1. Integrated Product Teams: High Speed Aircraft

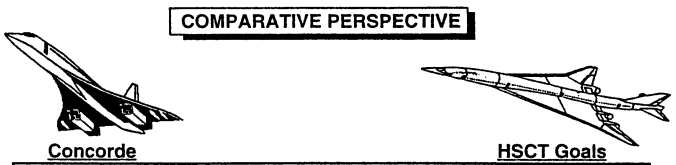
by Wallace C. Sawyer

Wallace C. Sawyer, director of the High-Speed Research project office at NASA's Langley Research Center (LaRC), leads the development of aerodynamics, airframe materials and structure, flight deck and propulsion technologies, and system integration of the High-Speed Civil Transport—an economically viable and environmentally acceptable 300-passenger, 5,000 M. mi., Mach 2.4 aircraft. In less than a decade, the program could mean a $200 billion swing in U.S. aircraft sales and 140,000 new jobs.

Integrated Technology Development (ITD) teams have provided technical focus and visibility to all involved, including five NASA Centers, two Enterprise Offices at Headquarters, five major aerospace contractors and more than 40 subcontractors and major suppliers.

NASA team members include the Office of Aeronautics, Office of Mission to Planet Earth, LaRC, LeRC, Ames, JPL and the Dryden Flight Research Center. Industry team members include Boeing, McDonnell Douglas, GE Aircraft Engines, Pratt & Whitney and Honeywell.

"HSCT economic impact is enormous," said Sawyer. The ITD team approach is expected to discover and resolve problems early, account better for customer requirements, identify and reduce risk quicker, and place decision authority with the most knowledgeable sources.



Concorde		HSCT Goals
North Atlantic	Market	Atlantic & Pacific
1976	Entry into Service year	2005
2.0	Speed (Mach No.)	2.4
3000	Range (nautical mi.)	5000-6500
100	Payload (passengers)	250-300
400,000	Takeoff Gross Weight (lb.)	700,000
87	Required Revenue (¢/RPM)	10
Premium	Fare Levels	Standard
Exempt	Community Noise Standard	FAR 36 - Stage 3
75	Noise footprint (sq. mi.)	5
20	Emissions Index (gm/Kg fuel)	5

Figure 14. *The Concorde and the High Speed Civil Transport.*

2. Integrated Product Teams: International Space Station

by Lyn Gordon-Winkler

Lyn Gordon-Winkler, assistant manager of the Business Management Office and strategic planning advisor to the program manager of the Space Station Program Office, is responsible for managing the process by which Integrated Product Teams are used. She describes the International Space Station program management approach as product-oriented rather than function-oriented.

The Space Station Program is organized into teams which are delegated authority, budget and schedule. These teams are responsible for meeting technical requirements within their resources and schedules. Team metrics are used to maintain accountability and assure program success. The station is described as "the key to NASA's future." Contractors and NASA work together on teams pursuing a common goal.

3. Advanced Concepts: Virtual Research Center

by John Mankins

John C. Mankins described a new approach for NASA strategic planning and management—his Advanced Concepts division of the Office of Space Access and Technology. The idea is to create a NASA "Virtual Research Center," an Internet-based interface that stimulates on-line discussion, analysis, simulations, gaming and conceptual prototyping of new concepts.

Linked to NASA's World Wide Web/Mosaic homepage, the "Virtual Research Center" will operate and interact through a unique 3-D graphical user interface (GUI) and publish the results for the Advanced Concepts Team, the broader NASA community and the general public.

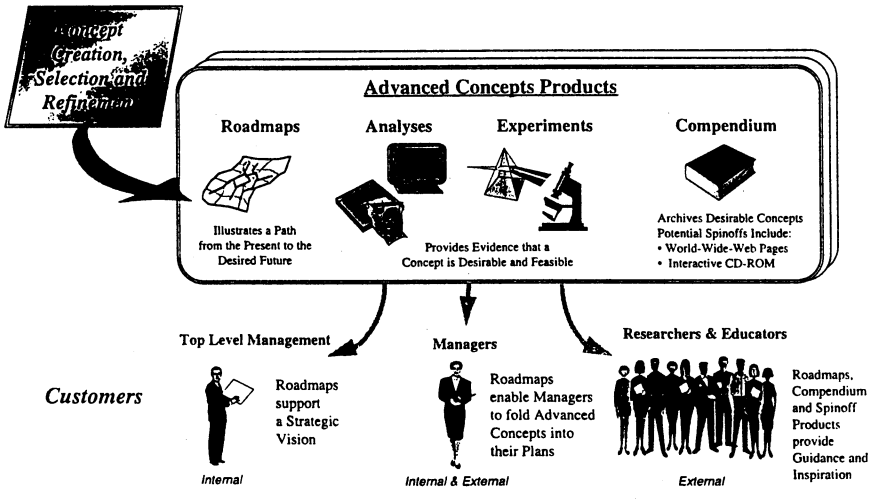


Figure 15. *Advanced Concepts Products.*

4. Systems Engineering: WES 21

by Dona M. Lee

Dona Lee, PE, is a strategic and program planner at Strategic Insight, Ltd. in Arlington, Virginia, specializing in complex, high technology Federal and commercial programs. She reported on Naval Surface Warfare Center's first "Workshop on the Engineering of Systems in the 21st Century" (WES 21).

After a graphic description of turmoil and rapid change in technology, organizations, corporate environments and the dislocated work force, Lee indicated what she called "Trends du Jour," namely dual use, concurrent engineering, re-engineering/reuse, evolutionary systems and the new affordability. WES 21's approach encourages joint interagency, academic and industry coordination for continuous improvement in the management of complexity.

"WES 21's approach encourages," she noted, "future investments in Systems Engineering research."

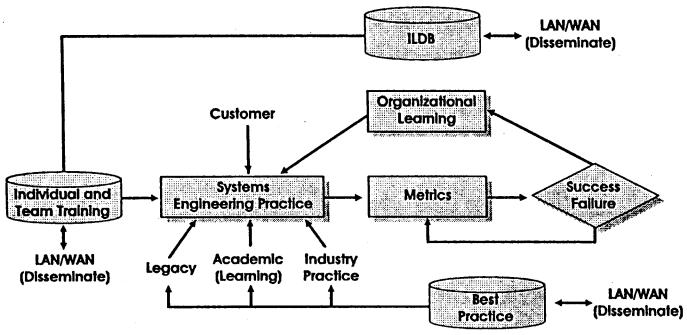


Figure 16. *Continuous Improvement Process Model.*

5. Rapid Prototyping: Single Stage to Orbit

by Bill Gaubatz

Dr. William A. Gaubatz, director of program development in Reusable Launch Vehicle programs at McDonnell Douglas Aerospace, described the rapid prototyping of a totally reusable system, the Delta Clipper experimental spacecraft. The DC-X was the first of the X-flight systems for single-stage-to-orbit technology featuring a seven-day turnaround for the vertical takeoff and landing of a three-person crew.

"Design the team before you design the product," he advises. Integrated Product Teams were responsible for requirements definition, design, assembly, checkout, schedule and budget.

The DC-X rolled out 18 months after authorization to proceed, and the first flight took place in 24 months, on August 18, 1993. It had no solid rocket boosters or external tanks, no fairings or separation devices and very little ordnance but did have reusable engines. Key elements of design included maximal use of off-the-shelf hardware, software, parts and processes, as well as existing embedded facilities.

Program management philosophy called for a single customer program manager empowered to make all decisions and a single contractor program manager empowered to make company decisions.

6. Project Management: Planning NMI 7120

by Ernie Hahne and Susie Mauzy

Ernest Hahne is a private international consultant and Susie Mauzy is with Johnson Space Center's Mission Operations Directorate, which developed a prototype training and project application approach in 1993 using the new NMI and the new Systems Engineering Handbook.

The basic NMI 7120 training focused on the Mission Needs Statement (MNS), the Non-Advocate Review report and the Program/Project Commitment Agreement. It was found that a young team can follow the NMI 7120 process with adequate training, on-the-job training and mentor support, but help is needed in determining what tailoring is appropriate. Also, management has to support the effort. Some false starts will be made, but those are part of the learning process. "War room" data may appear more complex and labor intensive than the "usual" process, but it is not. And, among many other "lessons learned," the process holds people accountable and relies on hard data and metrics to determine if performance is acceptable.

"Understand that 'Business as Usual' cannot continue," they noted. "Take advantage of Lessons Learned."

They add: "Keep things simple at start-up (KISS) and learn by doing." They call this "an evolutionary approach to reengineering."

After a short break, each of the six breakout sessions on "Innovations in Managing Complexity" were repeated, preparing participants for a full day of international, interagency and government/industry collaboration in the management of complexity.

- Three KEY documents:
  - The Mission Needs Statement (MNS)
  - The Non Advocate Review (NAR) Report
  - The Program/Project Commitment Agreement (PCA)

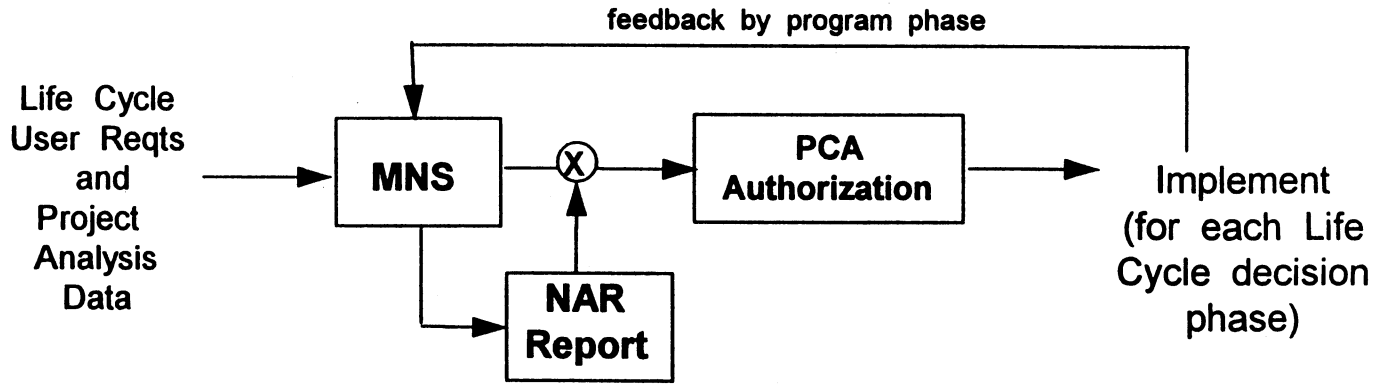


Figure 17. The Basic NMI 7120 Training Scope.