

**Concurrent Design at JPL
-Status and Plans-**

*Presented
by*
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at the
New Design Paradigms 2002
Workshop

Double Tree Hotel
Pasadena
June 25-27, 2002

Pasadena, CA, June 25, 2002

1. Contributing Organizations
2. Basics
3. Challenge
4. Meeting the Challenge
5. The NPDT
 - a, Status
 - b, Latest Developments (CFD, VT, Immersive 3D)
7. Beyond Engineering
8. A Systems Design Curriculum
9. Future Visions

The work described in this presentation was carried out in part at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.



Contributing Organizations

Jet Propulsion Laboratory (JPL)/California Institute of Technology

- Mission Development
- Modeling and Simulation
- Payload Division
- Ground Operations
- Power
- Science
- Thermal
- Telecom
- Mars Rover Technology

Mars Program Office

NASA

- Code FT HQ
- Marshall
- Langley

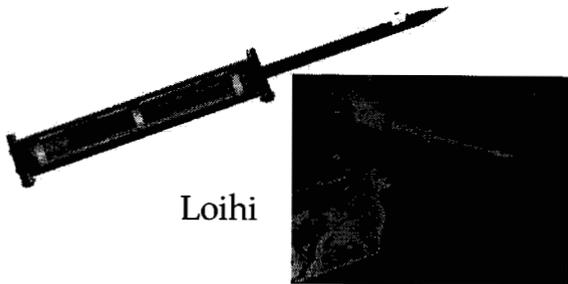
NASDA

- Tsukuba Space Center

Stanford University, CA

Old Dominion University, VA

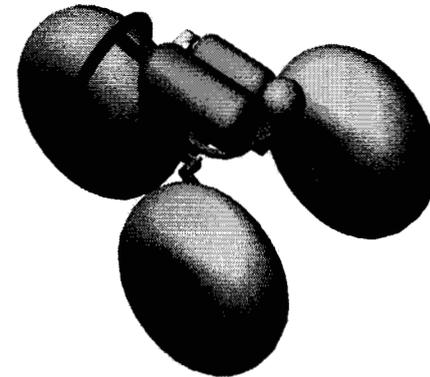
Track Record...



Loihi

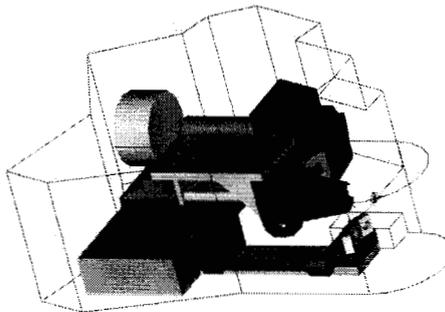


IIP/OSIRIS



Mars Outpost
Rover

**Concurrent Design Teams
Supported ~ 60 Studies
Over the Last 3 Years**



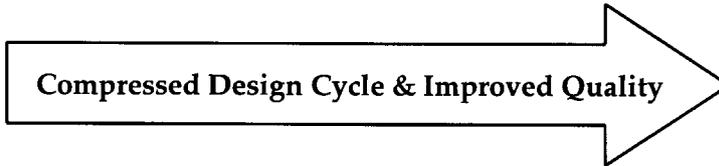
DS (ST)-4/CIRCLE

**Design Maturity
Improvements: <10
Time Compression: <4**

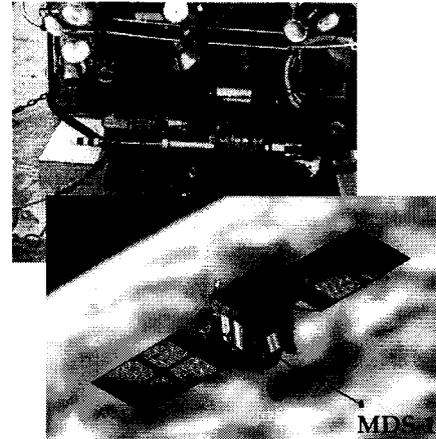
Goal!



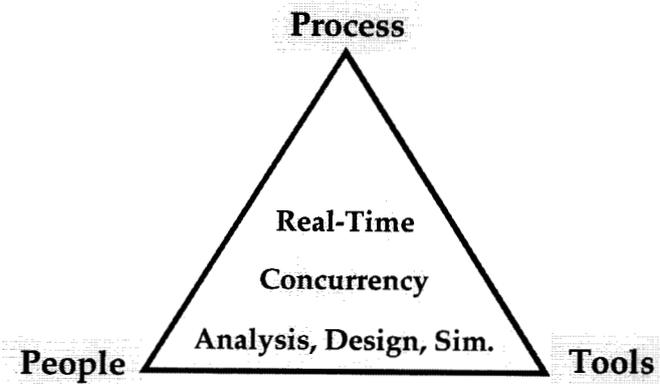
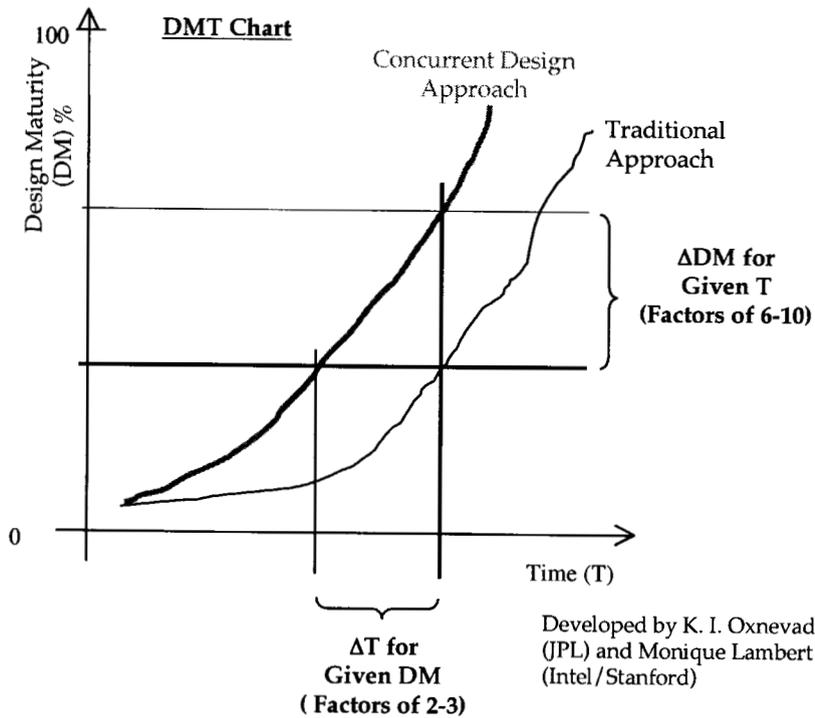
Concept



Space System (HW/SW)



It's About...

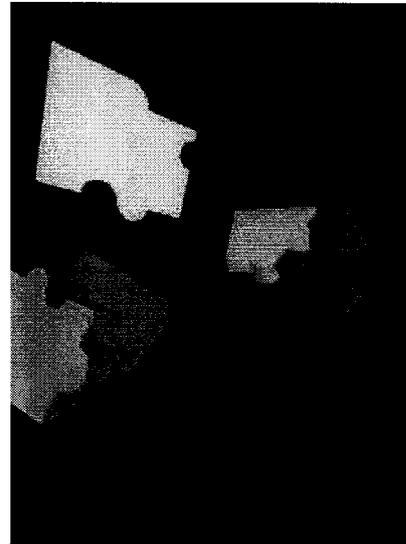


PPT Model

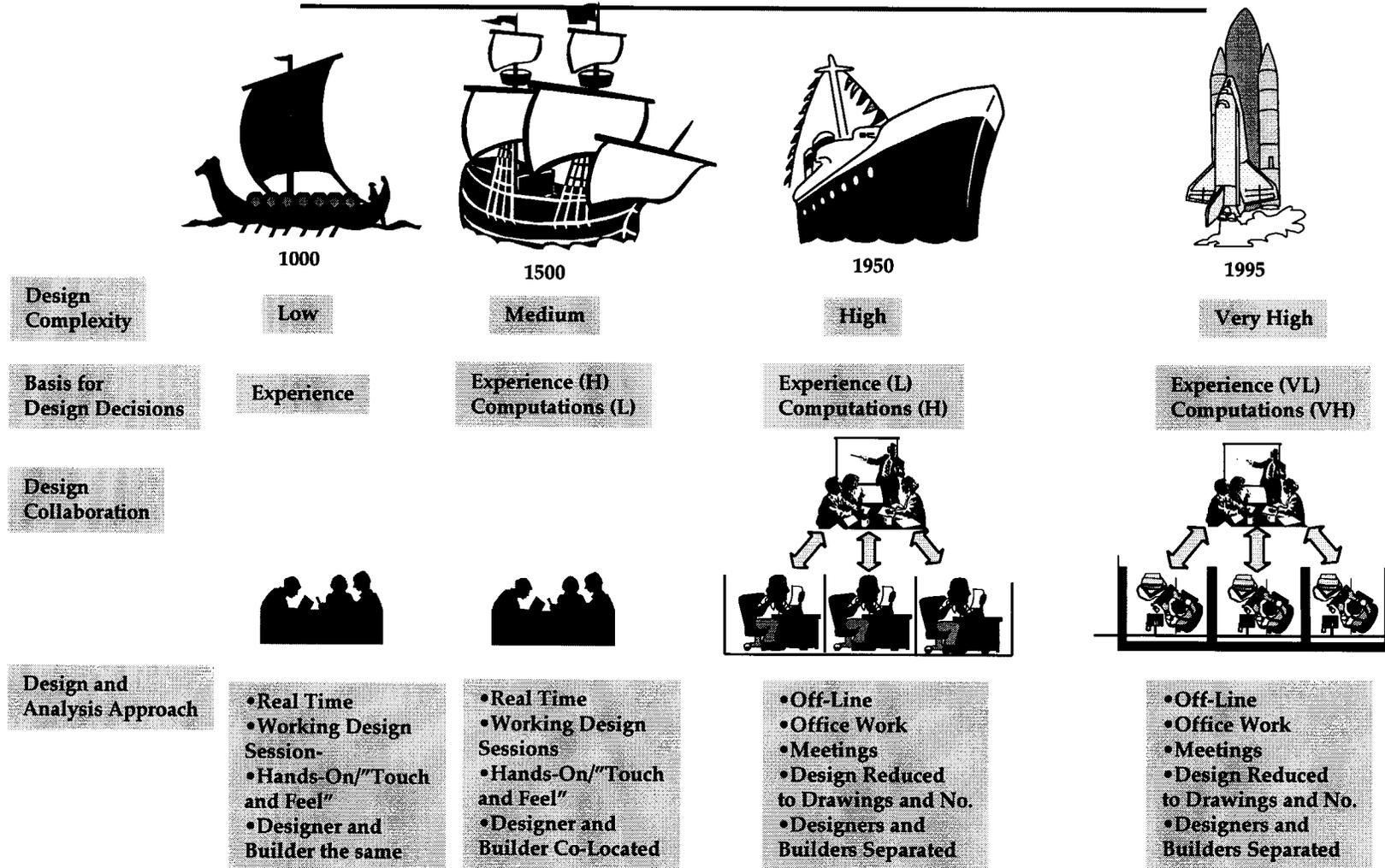
The Challenge

*The biggest Challenge facing Space Development today does not lie within a specific **technology/discipline**, but rather in our ability to make these **technologies/disciplines** work efficiently together to achieve our objectives.*

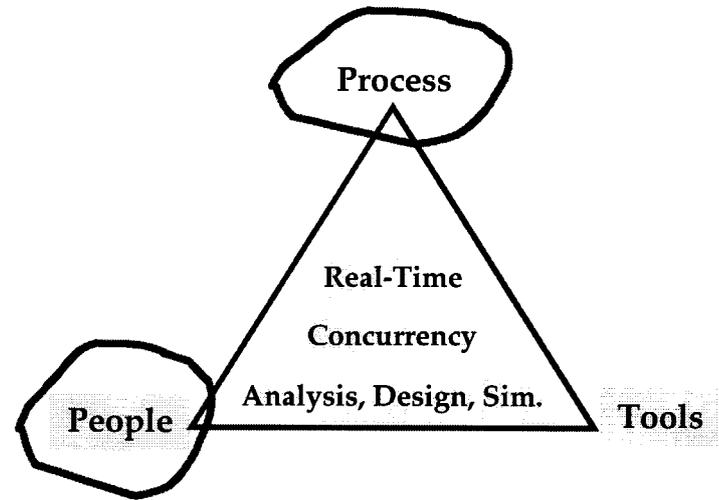
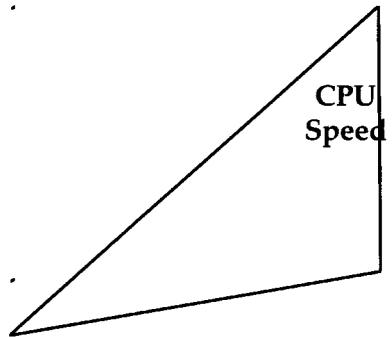
We must find entirely new ways to achieve our objectives ----- Sean O'Keefe



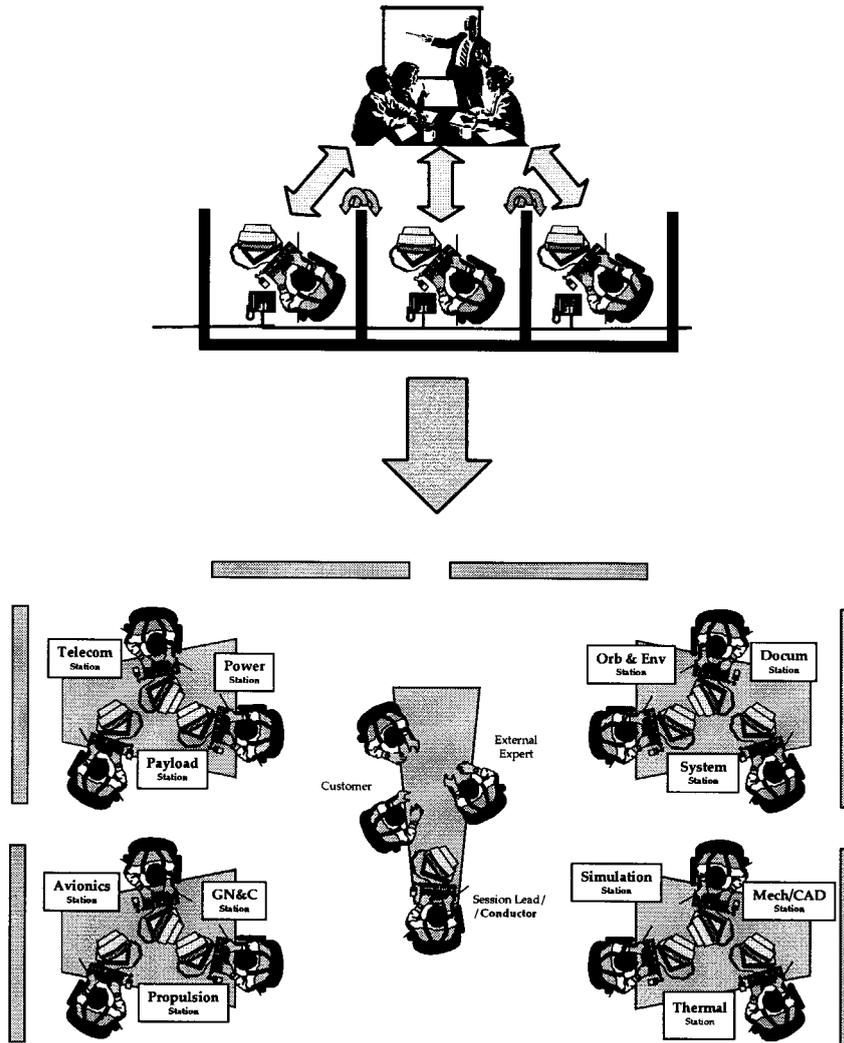
A Historical Perspective



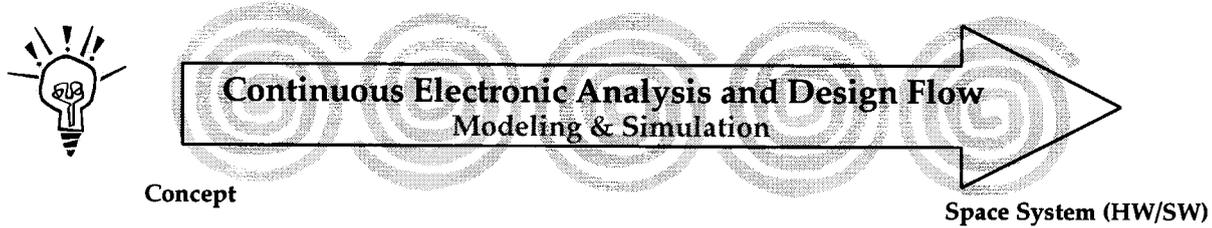
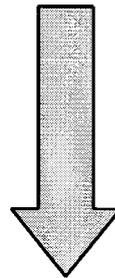
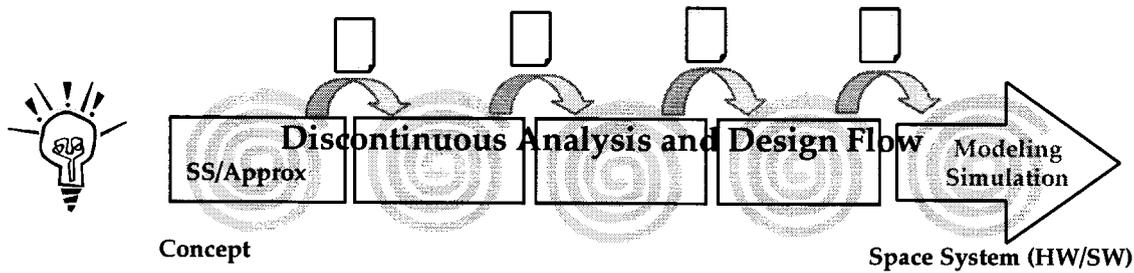
The NPDT



Back to Working Design Sessions Concurrent Design

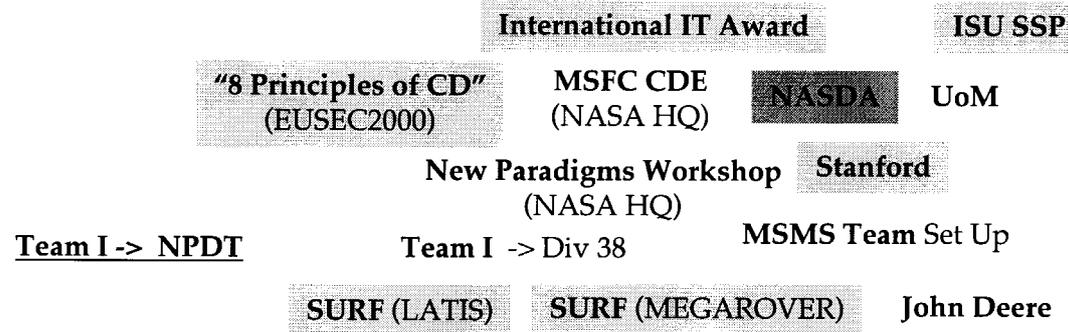


Design Flow Improvements

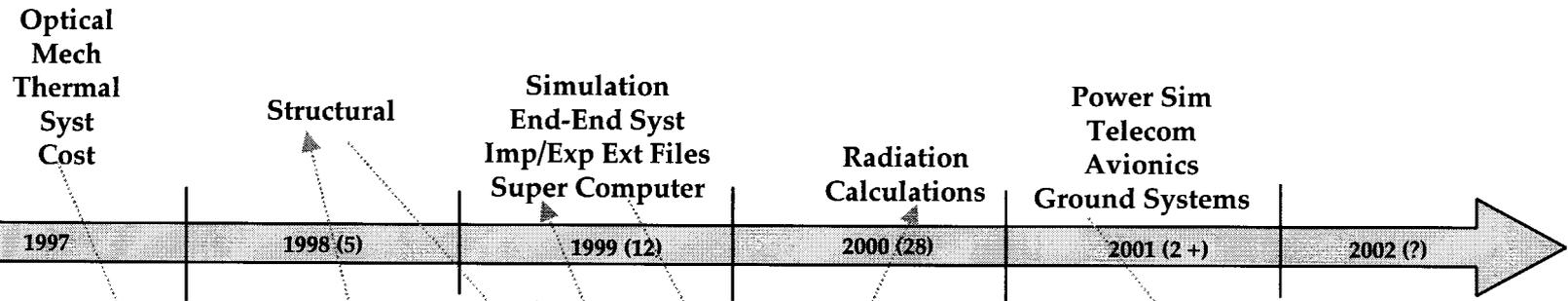


The Steps...

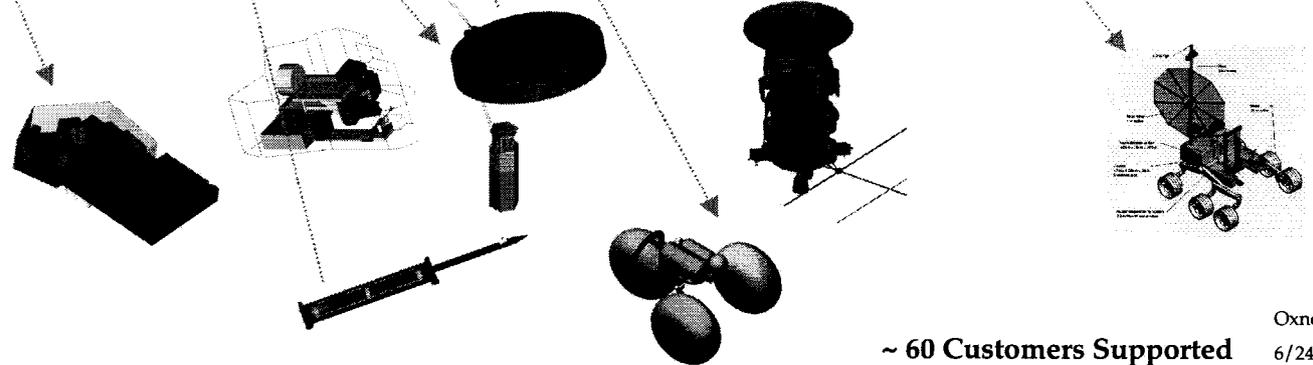
Related



R & D



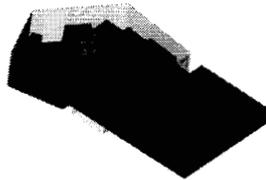
Customer Support



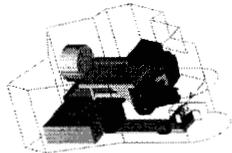
~ 60 Customers Supported

In A Nut Shell

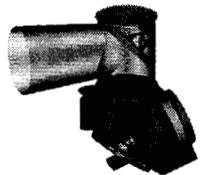
Discovery Phase 1
Gulliver



DS (ST)-4/CIRCLE



Search Camera for the
CNES Orbiter



- *Concurrent Design and Analysis Environment*
- *Real-Time Analysis and Design*
- *Total Systems Approach, Multi-Disciplinary Team*
- *Standing Design Team*
- *Customer Actively Participates in the Design Sessions*
- *Input Parameters are Challenged in Real-Time*
- *Involved External Experts in the Design Sessions*
- *Joint Sessions with other NASA Centers*
- *From Concept to Engineering Drawings*
- *Interconnected, High-End Optical, Microwave, Mechanical/CAD, Thermal, Structural, Dynamics, Simulation, Orbital, Electronics Analysis and Design Tools, such as Code V, ZeMax, Mechanical Desktop, (Inventor), NASTRAN, Thermal Desktop, Adams, MODTool, and visualNASTRAN + (PowerTool, Telecomm., Avionics)*
- *Applications Utilize a Common CAD Developed Geometry*
- *Open Environment, import/export of STEP, NASTRAN files, etc., from/to JPL, other NASA centers, and Industry*
- *Technology Insertion Through Cooperation with MDL/TAP*
- *Analysis and Design Time Cut from Months to Weeks*

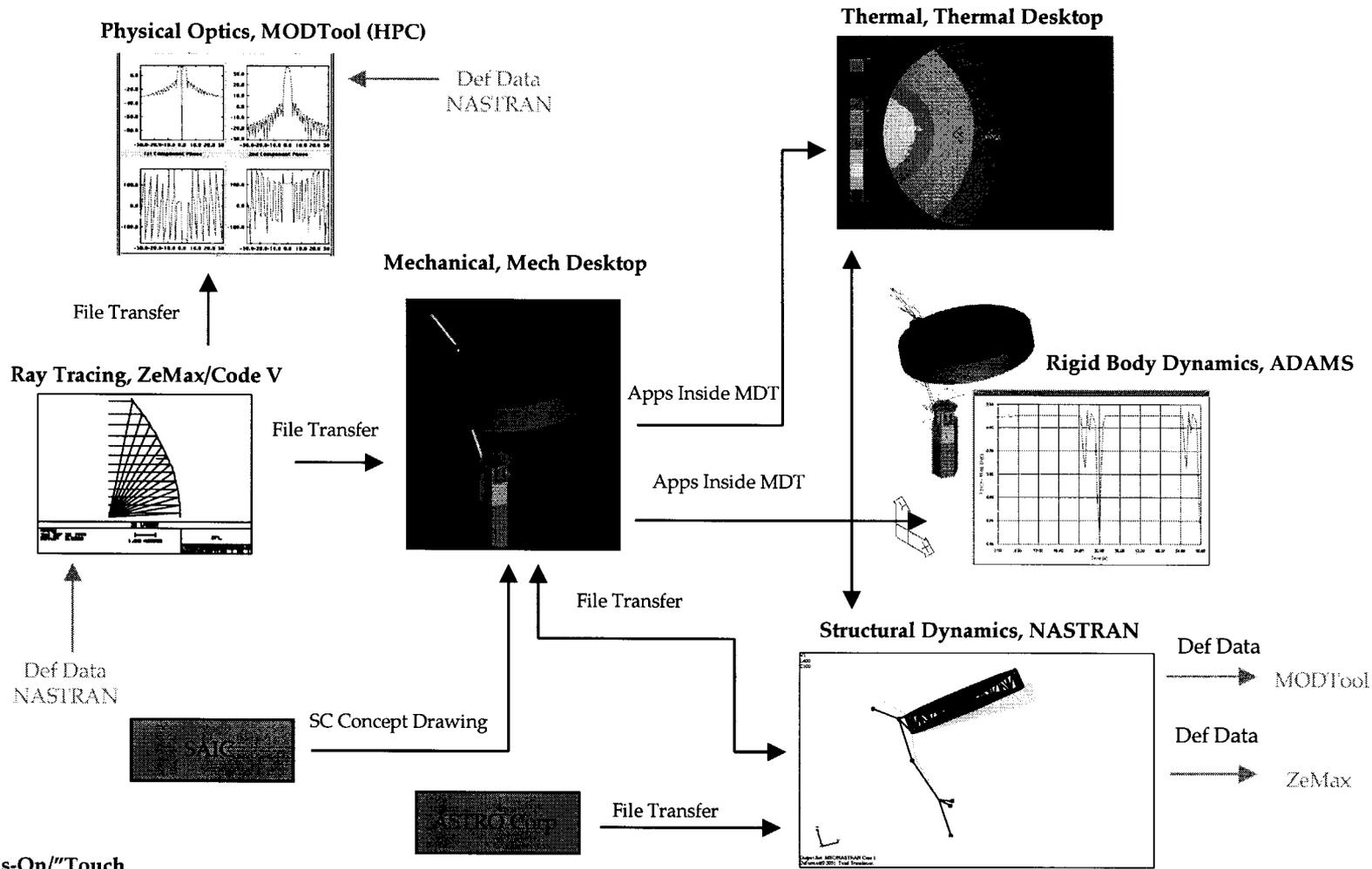
IIP/OSIRIS



Loihi Deep Ocean,
Volcanic
Vent Probe



Approach (Design Paradigm): Integrated, High-End Analysis and Design

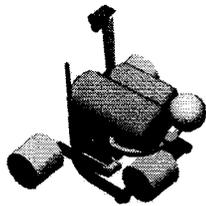


•Hands-On/"Touch and Feel"

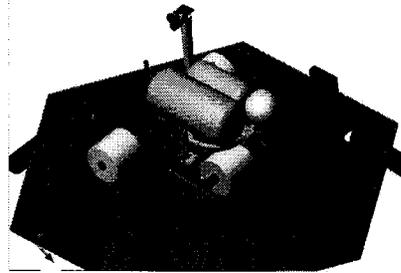
Approach

Sizing, Configuration, and Simulation

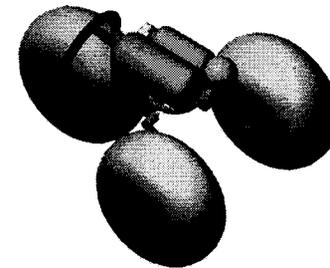
Mars Outpost 50km Fuel Cell Rover



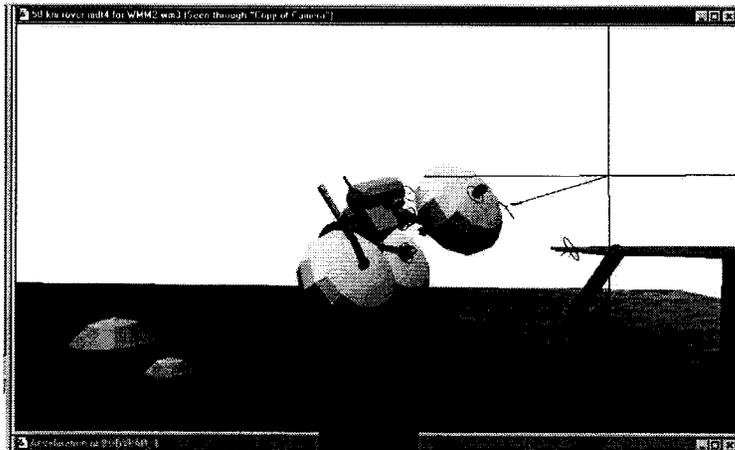
Lander Configuration



Deployment Sequence

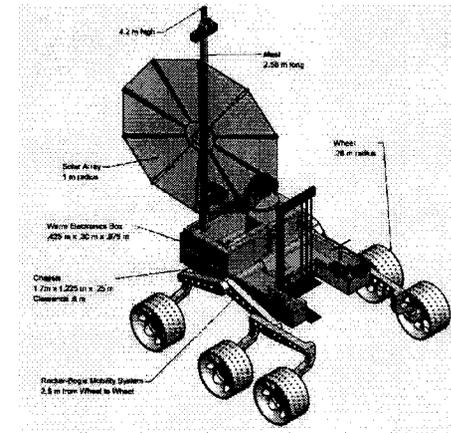


Surface Configuration



Operational Scenario
Simulation

SURF 2001 Rover
(MSMS Rover Team)

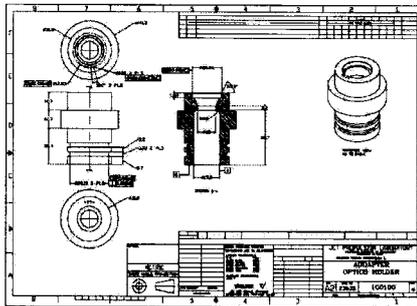
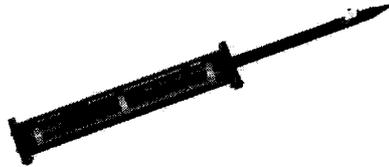


Support: Mechanical (parts and assemblies), Structural, Surface Mobility/Ops Simulations, Trade Studies, Mass Summary

The NPOT

Approach

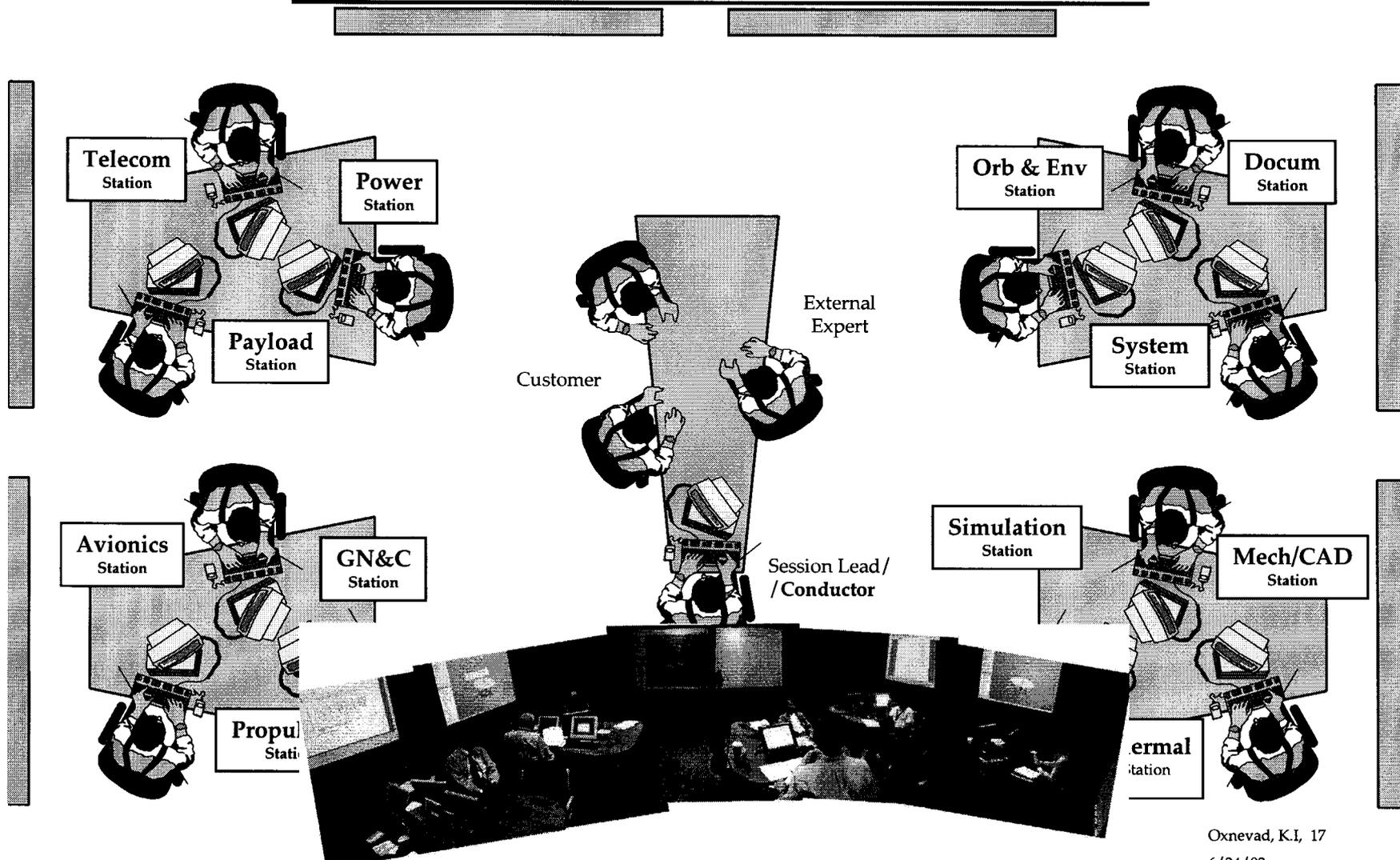
Concept, Hardware, Science Data



Support: Mechanical (parts and assemblies), Structural, Electronics, Optics, and Engineering Drawings

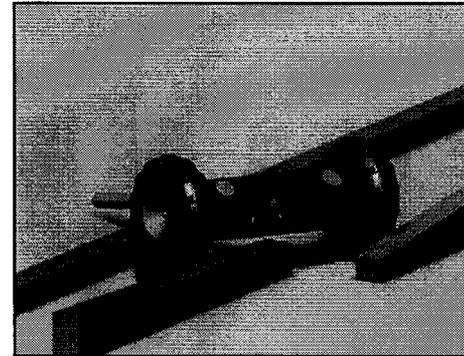
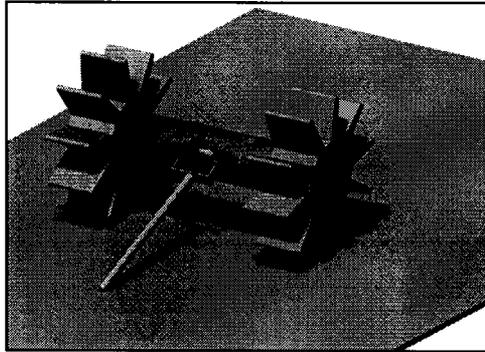


The Mars Surface Mobility Study (MSMS) Team



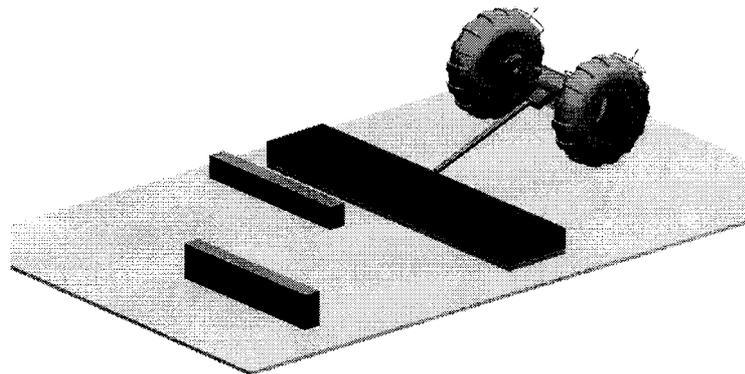
Photo, Courtesy Ben Shaw

Simulation/Virtual Testing



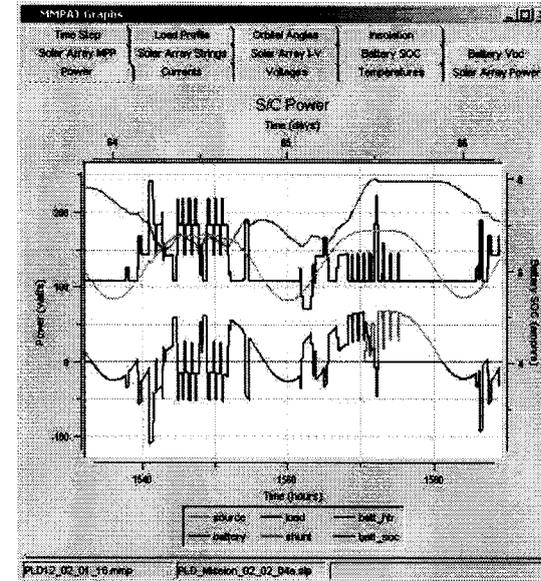
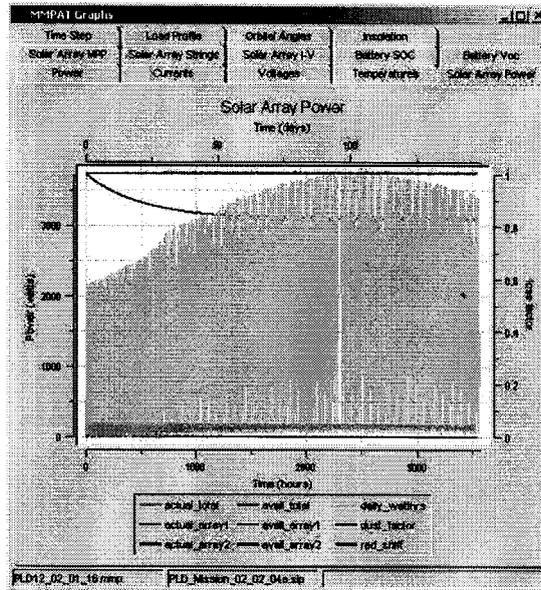
Trades

Wheel Diameter
Castor length
Wheel Base
Wheel plus rim
Castor Mass
Axelrod Mass
Axel Mass



Tools Used
Inventor
and visualNASTRAN

Power Analysis/Simulation Tool Mars Mission Analysis Tool (MMAPT)



JPL's Mars Mission Analysis Tool (MMAPT) Included in Environment

Calculates, for a Given Location, Date, and Mission Power Profile:

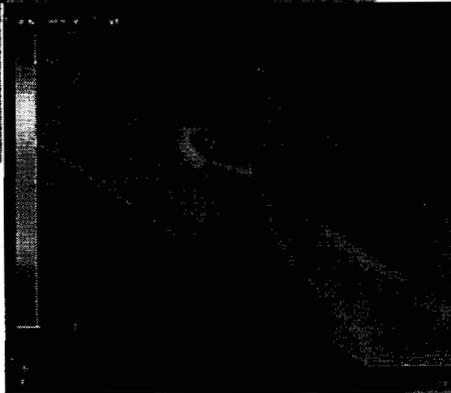
- Solar Power Available
- Battery Charge and Voltage
- Solar Panels and Battery Sizes/Capacities

Plan to Introduce Avionics and Telecom Tools Later

CFD and Immersive 3D COTS Tools



Closeup Meshed
probe - CFdesign



Sample temperature
distribution - CFdesign

Dr Tibor Balint, Assessment of Commercial Off the Shelf
Computational Fluid Dynamics (COTS-CFD) Tools to Enhance the
Concurrent Design Environment at NASA-JPL, JPL, May 2002

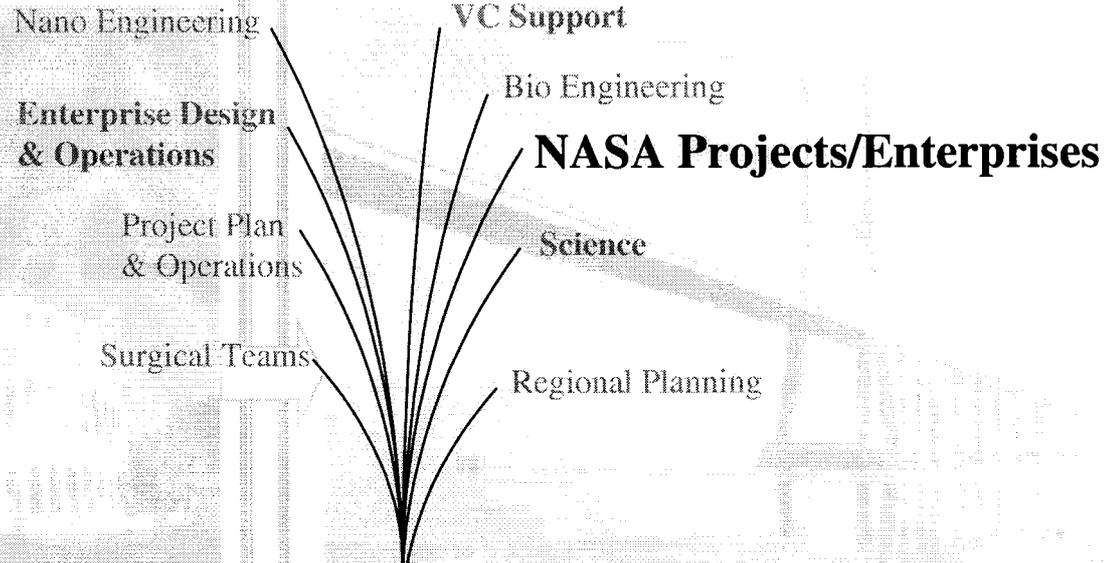
Objective

Evaluate CFD and 3D Immersive Tools For use in a
Real-Time Concurrent Design Environment

Evaluation and Recommendation Completed

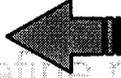
Beyond Engineering

Background Image, Courtesy, S. Shariq



Vision: **Empower 21st Century Managers to Design and Operate Organizations the way Engineers and Scientists Work**

Computer Sciences
Social Sciences
Cognitive Sciences
(Stanford)



Economics
Finance
Marketing
(EDL)

Concurrent Design Basics
Real-time, concurrent, teams, sophisticated true physics modeling and simulation to create designs in shorter time and with higher quality that can be successfully developed and operated

Systems Engineering

Oxnevad, Dissertation

Concurrent Engineering

Curriculum/Support

B. Discipline., Performance, and Design Team Training

1. Concurrent Design Exercise

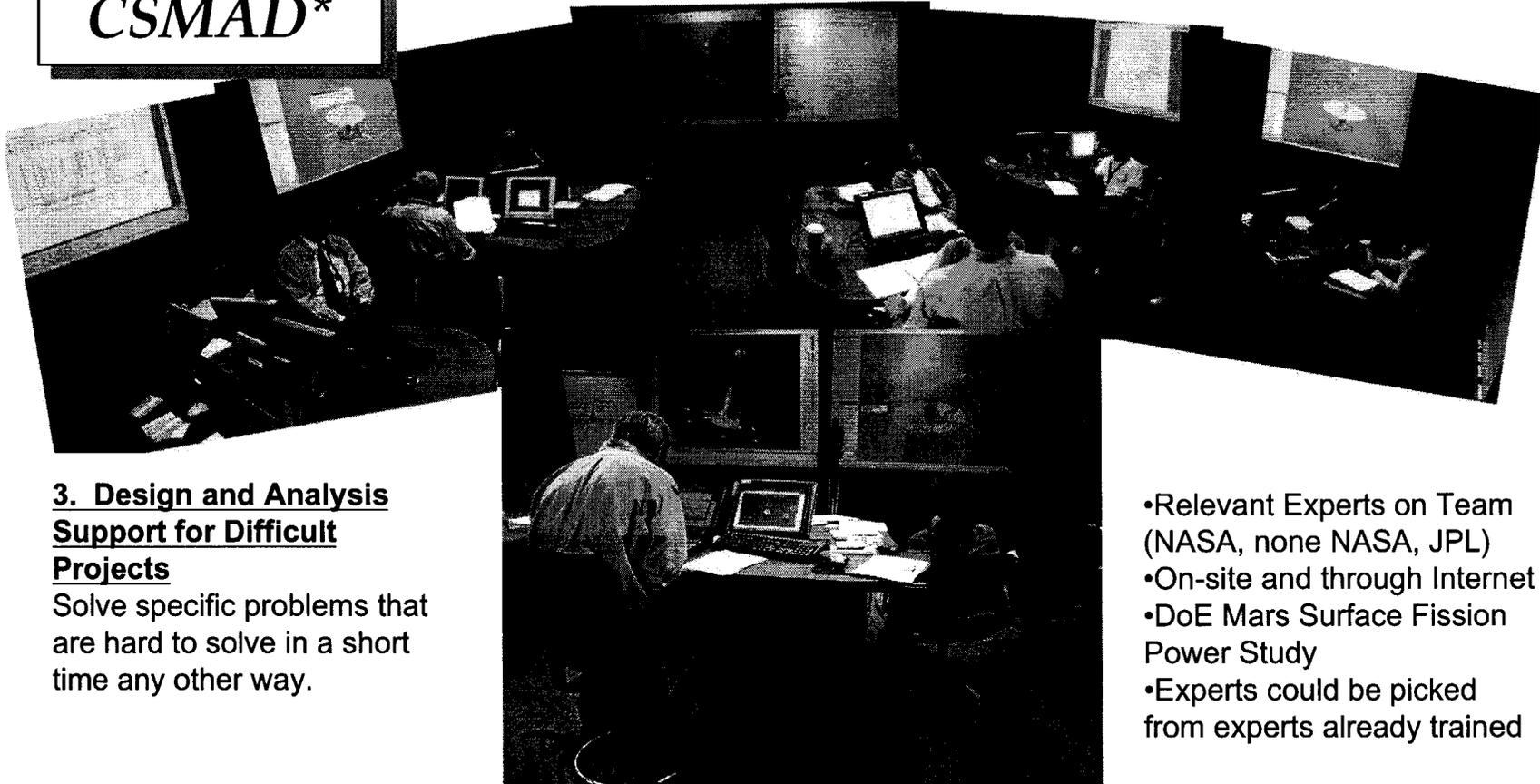
Train people from Cross-Centers to work together as a team, utilize the concurrent design approach (real time, concurrency), utilize higher-end tools to develop a specific technology/project/mission.

- Relevant topics to be selected by Programs, Centers, or Enterprises.
- Such training possible at the CSMAD at JPL: 5-7 days
- Process and Tools Training
- Learn to Live in** a Concurrent Design Environment
- Member and Leader Training
- History: SURF, University of Michigan (Mars Program)



MSR Study, University of Michigan, April 1-5, 2002
Week Training and Problem Solving

CSMAD*



3. Design and Analysis Support for Difficult Projects

Solve specific problems that are hard to solve in a short time any other way.

- Relevant Experts on Team (NASA, none NASA, JPL)
- On-site and through Internet
- DoE Mars Surface Fission Power Study
- Experts could be picked from experts already trained

Future Directions

- Develop An Art to Part Design Process for space vehicles (Concept to Hardware)
- Better Utilization of COTS tools in the Analysis, Design, and Simulation Areas
- Better Utilization of STEP
- Use of HPC (supercomputers, parallel computing systems)
 - CFD, Thermal, Structural)
- Utilization of Concurrent Design Teams **throughout** the **Design Process**, and throughout the **Organization**
- Define, train, and **set up of new Design Teams** (JPL, NASA centers [MSFC, LaRC, NARC,], NASDA, **industry**, and academia [Stanford and MIT])
- Set up **Workshops** to Bring Focus on New Design Paradigms (<http://nsd2001.jpl.nasa.gov>)
- Develop Working **Relationships with Academic Organizations** / Initiate Research
 - Caltech (SURF, on-going)
 - International Space University (ISU)
 - MIT, Stanford, University of Irvine California, Pasadena Art Center, University of Southern California (TBD)
 - University of Michigan (April 2002)
- Transfer the Concurrent Design Process to New Domains (Stanford, in Progress)

The NPDT

Creates Winners!

