N92-23649

Space Station Freedom

Mr. Gilbert Keyes
President, Program Manager
Space Exploration Initiative
Boeing Commercial Space Development Company

ACCESS TO SPACE

SPACE STATION FREEDOM AND COMMERCIALIZATION

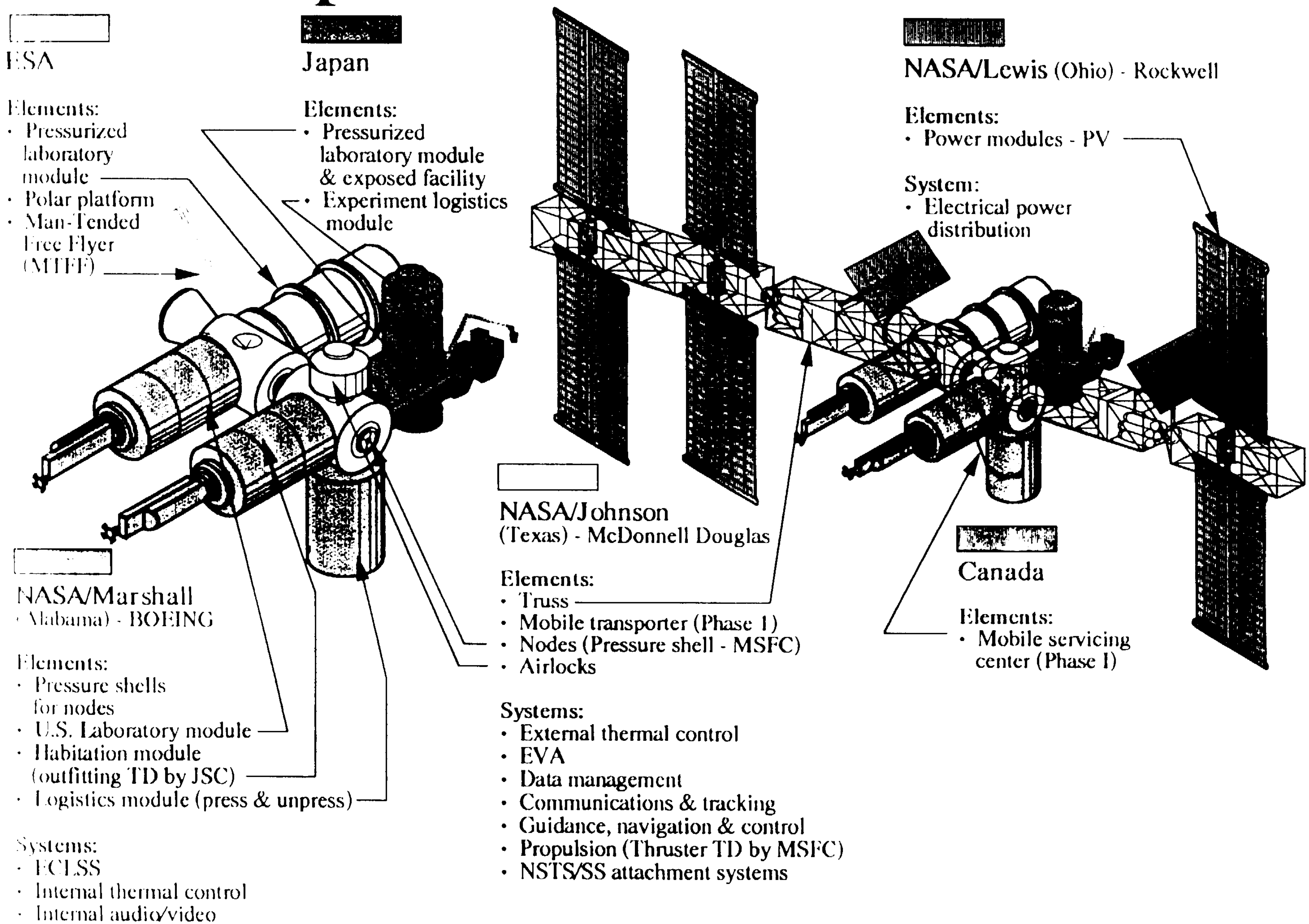
May 14, 1991

SPACE STATION FREEDOM

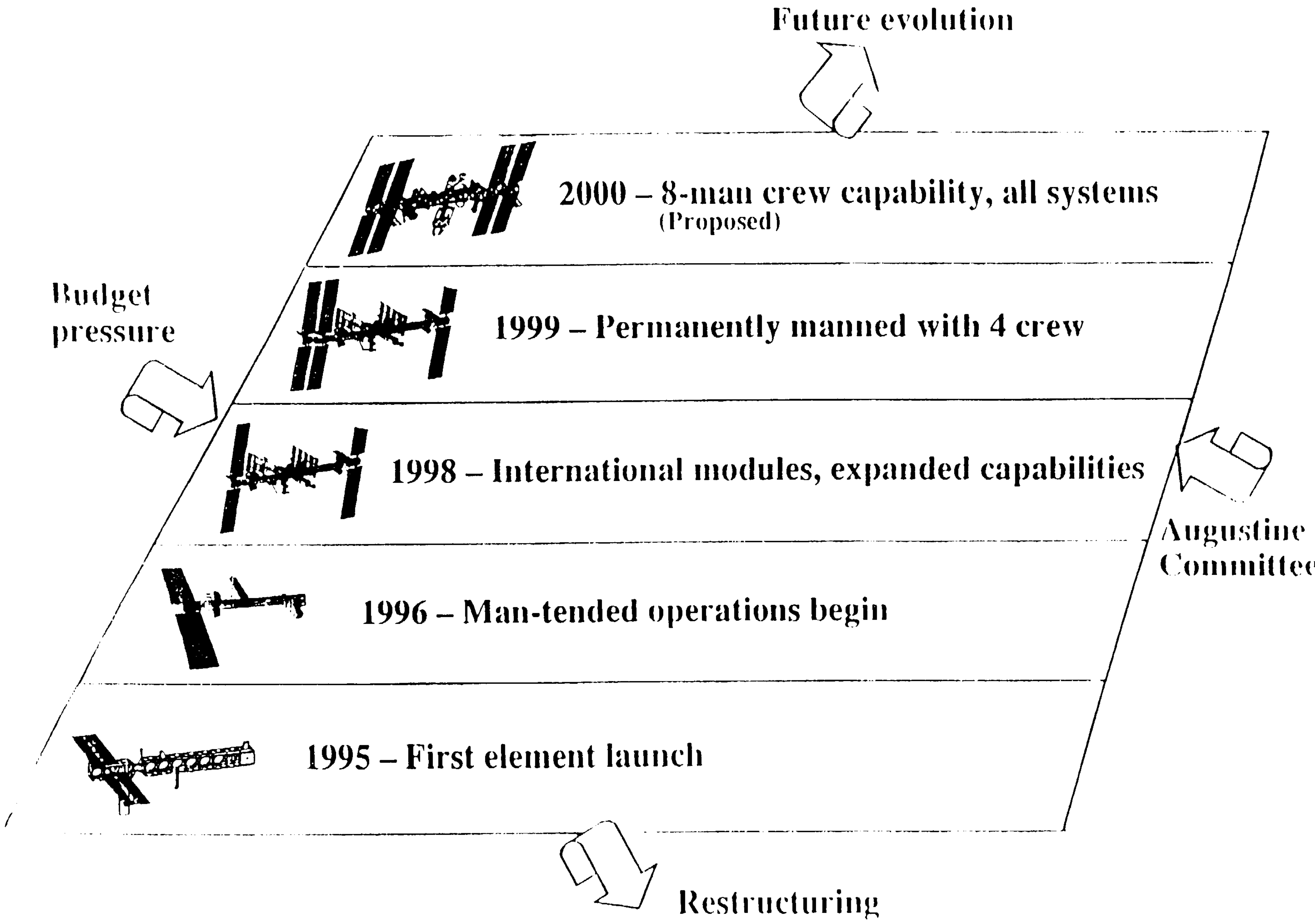
BALANCED COMMERCIAL ACCESS TO SPACE
EVOLUTIONARY APPROACH

- Drop Tubes/Towers (MSFC, LeRC)
- Microgravity Aircraft (KC 135)
- Suborbital Sounding Rockets (Joust, Consort)
- Orbital Rockets (COMET)
- Shuttle - Based Facilities (Middeck, SPACEHAB, Wakeshield)
- Space Station Freedom

Space Station Freedom



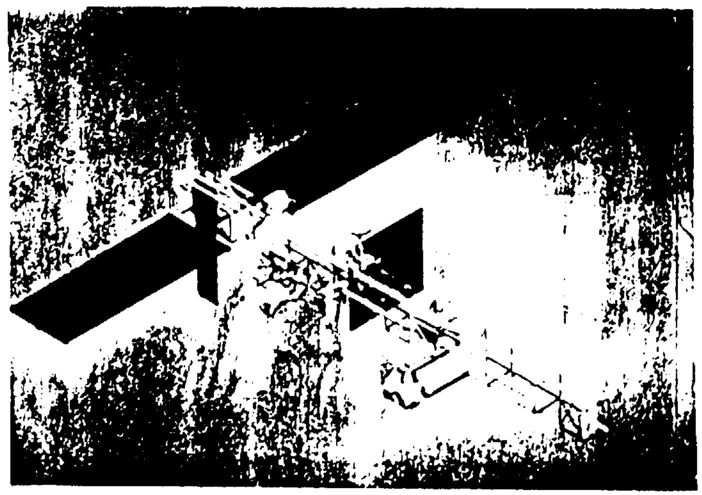
Phased Space Station Freedom Program



Man-Tended Capability

Science mode like Spacelab with equipment on orbit all year

Shuttle-based crew operates experiments during two 2-week visits per year



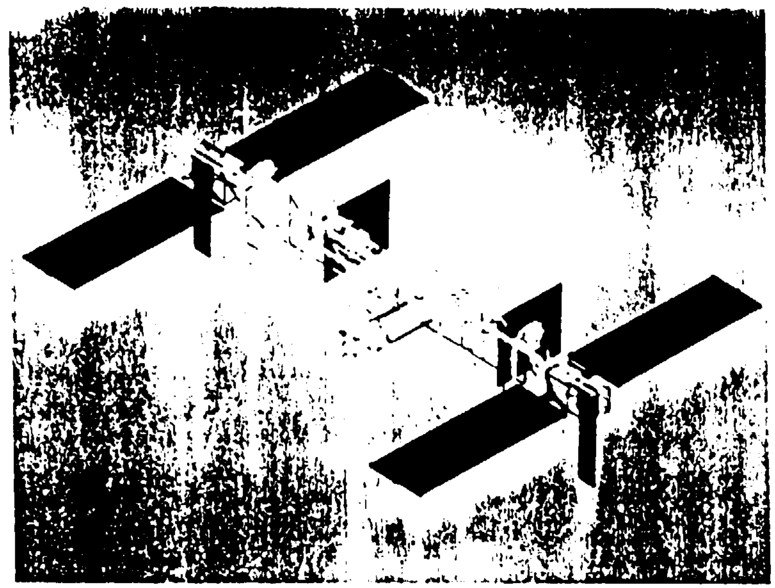
	Spacelab	Man-Tended Capability Station
User racks on orbit	6	15
Days/year of operation	39	365
Available crew	6	6
Average user power (kW)	2.5-3.5	12-45

Add power, truss, logistics, and international modules during this phase

Permanently Manned Capability

Science mode like Skylab or Mir with more power, international laboratories, and logistics

4-person crew rotates every 2 to 3 months



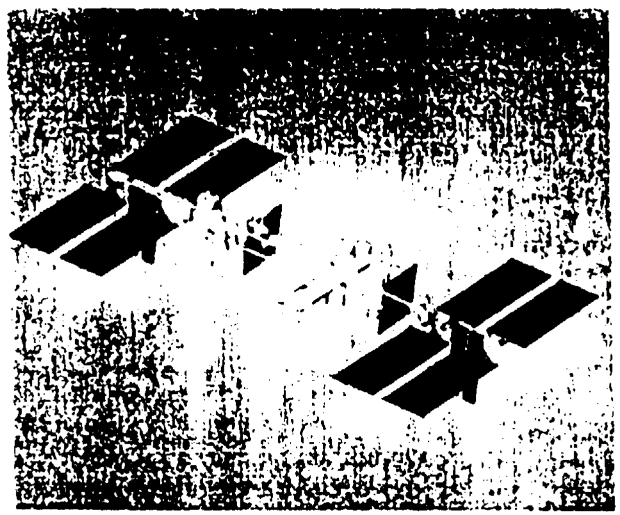
	Skylab	Mir* (estimated)	Permanently Manned Capability Station
User racks on orbit	295 m^3 workshop	10-25	14-45
Available crew	2-3	2-3	2-3
Average user power (kW)	7.5	5-10	31-54

Add habitation modules, environmental control systems, and user systems during this phase

Eight-Man Crew Capability

Full power and three laboratories with 8-person international crew

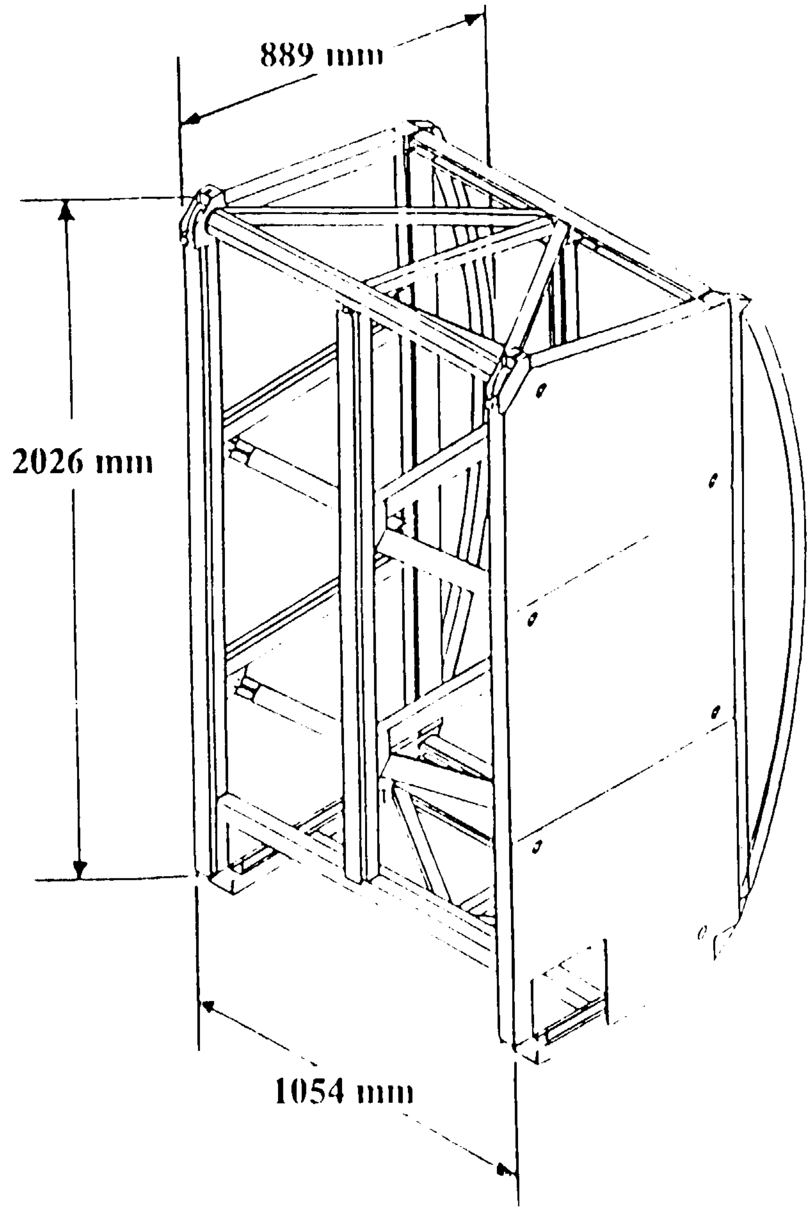
8-person crew rotates every 2 to 3 months



	Mir* (estimated)	Freedom Station
User racks	10-25	60
Available crew	2-3	6
Average user power (kW)	5-10	30

- Ready for growth missions
  - Commercial processing
  - Life sciences
  - Missions from planet Earth

Standard Payload Rack Dimensions



Resource Capabilities

	Man Tended	Permanently Manned	Eight-Man Crew
Crew Size	7 with Orbiter docked	4	8
Power, kW	18.75	56.25	75
Pressurized Volume, m^3	100	600	800
User Racks	15	46	60
Thermal Control	3°C	3°C and 17°C	3°C and 17°C
Process Fluids	Vacuum vent	Vacuum vent	Vacuum + Ultrapure water
Pressurized Logistics Modules	8-rack	8-rack + 20-rack	8-rack + 20-rack

BOEING COMMERCIAL PROJECT

(JOINT ENDEAVOR AGREEMENT)

CRYSTALS BY VAPOR TRANSPORT EXPERIMENT (CVTE)

- Joint Endeavor Agreement signed with NASA - May 1986
  - Entitles Boeing to three Shuttle experiment flights and options for two more
  - Quid pro quo entitles NASA to samples in CVTE furnaces
- Purpose of CVTE is to investigate materials processing technologies in microgravity
  - Build and integrate hardware
  - Initial investigations focus on vapor transport processing of electro-optic matierials
  - Assess commercial viability of materials processing
- First flight scheduled for STS-49 - April 1992
- Program challenges
  - Integration to a manned flight system
  - Interface requirements and schedule changes

CVTE – A Cooperative Venture

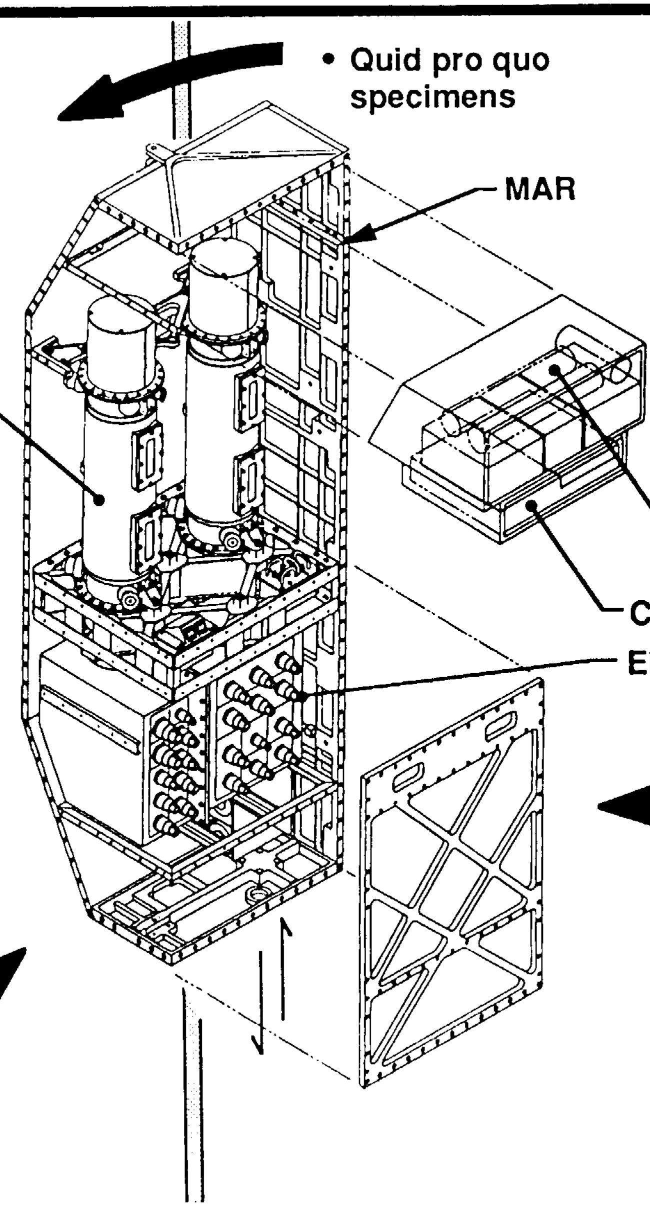
CCDSs

- Science/research support
- Material samples

Boeing

- Design, test, performance and safety of CVTE payload
- Specimen processing
- Integration and mission support
- MAR/CVTE ICD certification
- Flight data recording
- Post flight report

- Quid pro quo specimens



Code C – JEA

- Three experimentation flights
- Two optional commercial prototype flights

JSC

- Integration and mission management
- Crew support

MSFC

- JEA management
- Science support

Integration and crew

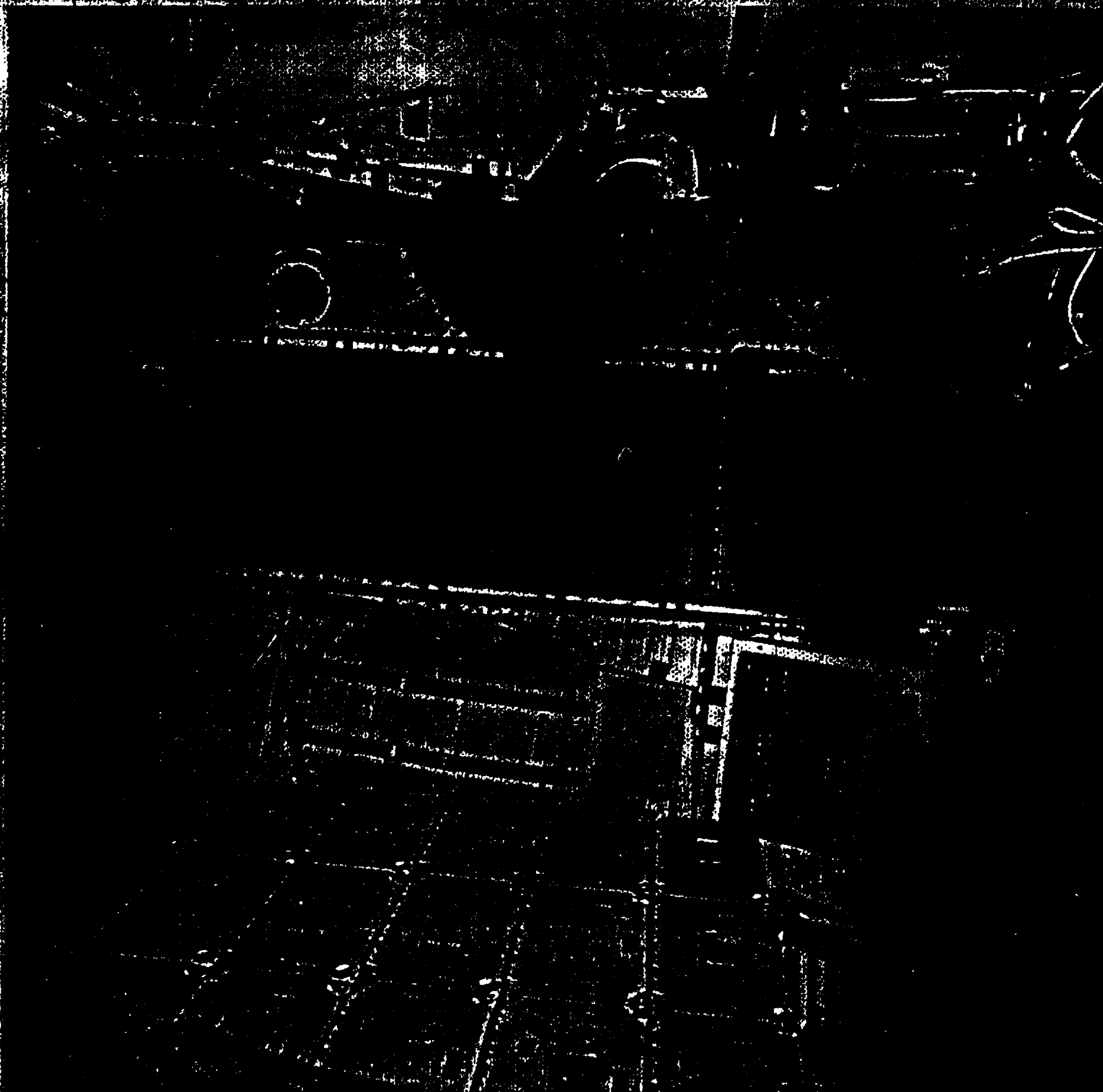
KSC

- Final assembly, installation, and checkout

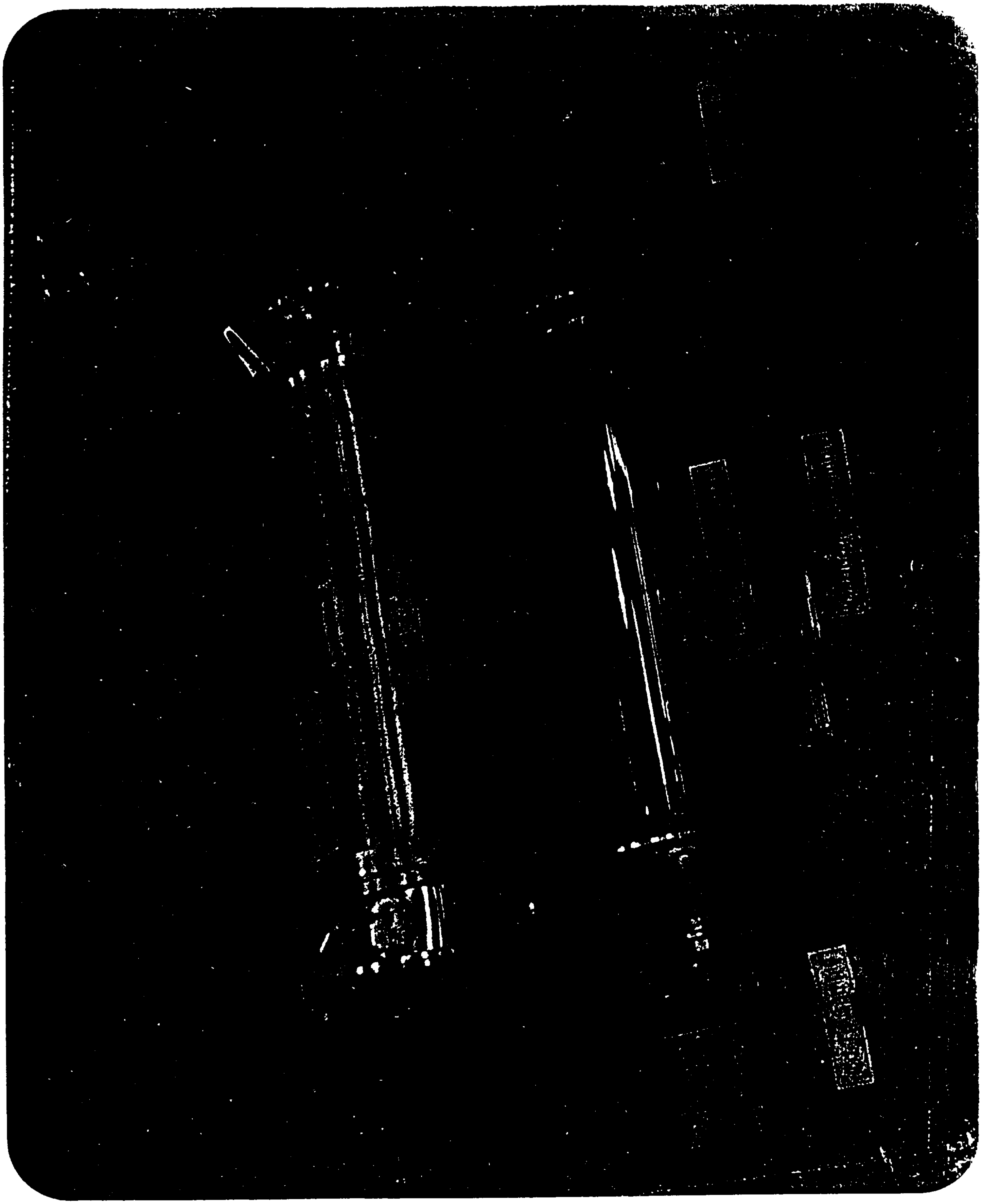
NASA National Aeronautics and Space Administration

S77-29435

Lyndon B. Johnson Space Center Houston, Texas 77058

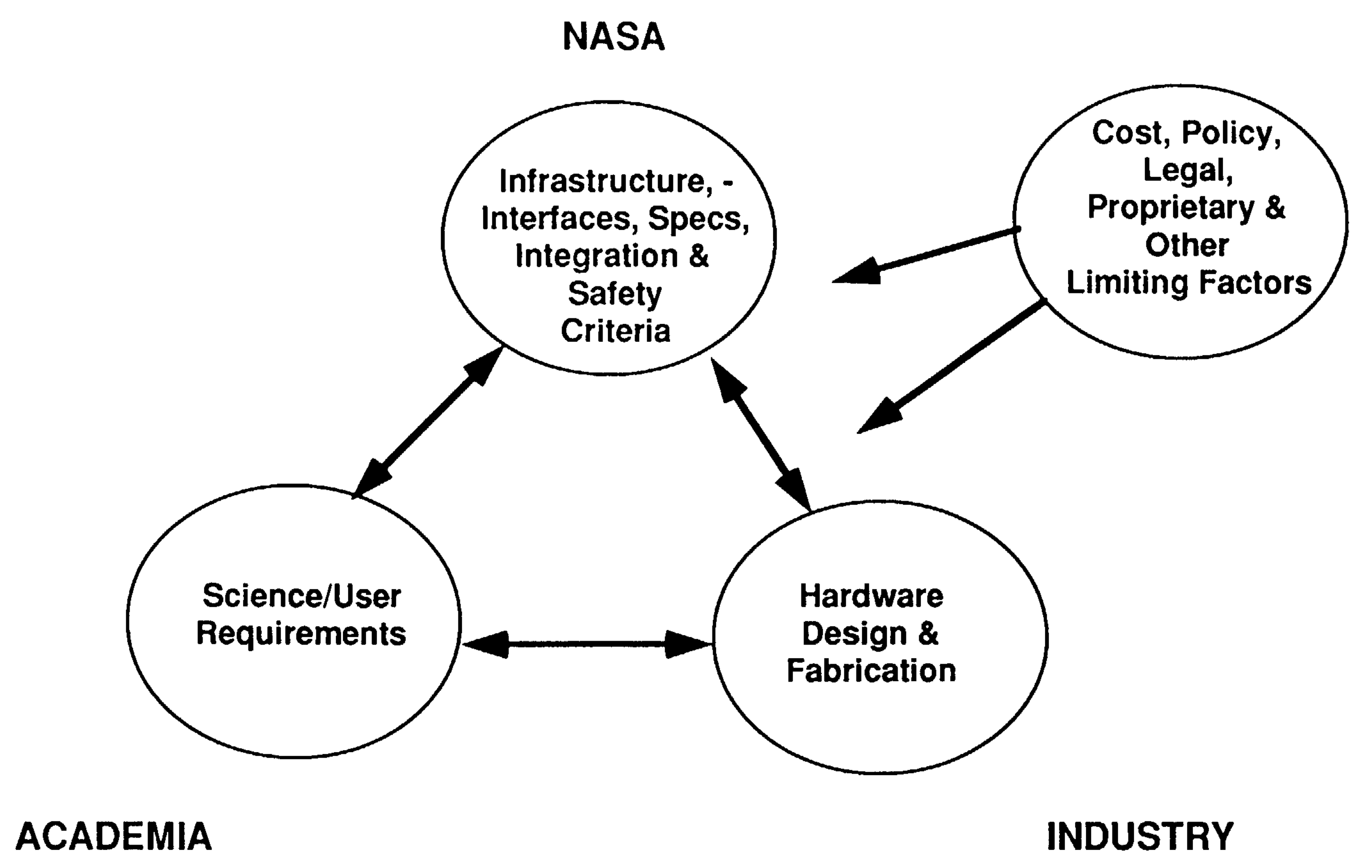


ORIGINAL PAGE IS
OF POOR QUALITY



ORIGINAL PAGE IS
OF POOR QUALITY

COMMERCIAL SPACE PROJECTS INTERFACES



LESSONS LEARNED

LESSONS LEARNED
ESSENTIAL ELEMENTS FOR SPACE STATION COMMERCIALIZATION

- Stable and Encouraging Pricing Policy
- Firm Commitments for Manifesting Payloads and Use of Infrastructure
- Established Requirements and Specifications
- Streamlined Management and Documentation
- Coordinated Interfaces Between NASA, Industry and Academia

STABLE AND ENCOURAGING PRICING POLICY

- Early establishment of pricing policy for SSF needed to permit commercial business analysis (cost/benefit)
- Pricing policy should be encouraging to commercial interests
  - Options may include initial reimbursement for direct services only, deferred payments, payments from revenue, and quid pro quo arrangements (such as used with Joint Endeavor Agreements for the Shuttle)
  - May not be able to provide long term pricing policy today, but NASA should establish "limited period" pricing policy

FIRM COMMITMENTS FOR MANIFESTING PAYLOADS AND USE OF INFRASTRUCTURE

- Important to know that you have guaranteed opportunity to fly within certain time period
  - Investment decisions based on prospective returns and payback periods
  - If opportunity to fly in space is in question, business interests will not support project
- Similarly, guaranteed access to adequate resources (eg - power, volume, time) on orbit is critical to commercialization

ESTABLISHED REQUIREMENTS AND SPECIFICATIONS

- Designers, developers and users of Space Station Freedom based hardware need baselined requirements and specifications early to efficiently take full advantage of its resources
    - Unclear or changing requirements results in inefficient and costly designs and redesigns
- Restructured Space Station Freedom presents opportunity to establish and disseminate user requirements
- Academic and industrial users need to become knowledgeable of the requirements so they scope their projects properly

STREAMLINED MANAGEMENT AND DOCUMENTATION

- Single layer of both management and requirements documents are crucial to efficient, lower cost, and timely development of commercial projects

- Interface, integration and safety documents for users prepared by multiple offices and NASA Centers causes confusion

COORDINATED INTERFACES BETWEEN NASA, INDUSTRY AND ACADEMIA

- Coordinate hardware and programmatic requirements and interfaces to optimize use of Space Station Freedom resources and economize the commercialization project are needed early
- Coordination applies to both government provided hardware projects as well as commercially developed hardware
  - In the case of government procurement programs, input from science and industrial user communities is important to meaningful capability built into hardware
  - Industry funded programs overlook important requirements due to lack of NASA incentive to communicate

RECOMMENDATIONS & SUMMARY

RECOMMENDATIONS

- NASA needs to establish early pricing policies, administrative procedures, and cooperative agreements to encourage commercialization
- System for "guaranteeing "access to Space Station Freedom needs to be developed; otherwise, business risk is too high
- Interface control documentation and payload accommodations books need to be published early to permit designers and users to properly scope their projects
- Integration management and documentation should be out of one office or Center (eg - Space Station Freedom Office) without allowing cross-referencing, duplication or modification by other offices or NASA Centers
- Coordinate and develop interface requirements, pricing policies, procedures, etc. to encourage cooperation between NASA, commercial, and academic communities

SUMMARY

- Space Station Freedom has abundant resources and can serve as important element in commercialization of space
- NASA, Industry and Academia cooperation is key to successful commercial ventures - CCDS's serve as a role model
- Lessons learned to date, by Boeing and others, ought to be incorporated into Space Station Freedom commercialization planning
- NASA can best stimulate commercialization with early pricing and use policy and early documentation of interfaces and requirements for Space Station Freedom use
- Commercial space strategy should include consideration of commercialization of Space Station Freedom systems and services