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SPACE STATION FREEDOM AS AN ENGINEERING EXPERIMENT STATION: AN OVERVIEW

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ABSTRACT

It is one of NASA's missions to provide the technological underpinnings for space flight, be it manned or unmanned. As a consequence, the relevant technologies such as power, propulsion, life support and materials technologies are investigated throughout the space community. The results of these investigations quite often produce laboratory prototypes which are sometimes an order of magnitude better than the technology employed in the currently flying spacecraft. Attempts to bring these developments to the point where they will readily be used by spacecraft designers invariably stumbles on the issue of space qualification. The process to do this is long and, while terrestrial simulation can give confidence, nothing suffices for full qualification like time in space.

In this presentation, the premise that Space Station Freedom has great utility as an engineering experiment station will be explored. There are several modes in which it can be used for this purpose. The most obvious are space qualification, process development, in space satellite repair, and materials engineering. The range of engineering experiments which can be done at Space Station Freedom run the gamut from small process oriented experiments to full exploratory development models. A sampling of typical engineering experiments are discussed in this session. First and foremost, Space Station Freedom is an elaborate experiment itself which, if properly instrumented, will provide engineering guidelines for even larger structures which must surely be built if mankind is truly "outward bound". Secondly, there is the test, evaluation and space qualification of advanced electric thruster concepts, advanced power technology and protective coatings which must of necessity be tested in the vacuum of space. The current approach to testing these technologies is to do exhaustive laboratory simulation followed by shuttle or unmanned flights. Third, the advanced development models of life support systems intended for future space stations, manned mars missions, and lunar colonies can be tested for operation in a low gravity environment. Fourth, it will be necessary to develop new protective coatings, establish construction techniques, evaluate new materials to be used in the upgrading and repair of Space Station Freedom. Finally, the industrial sector, if it is ever to build facilities for the production of commercial products must have all the engineering aspects of the process evaluated in space prior to a commitment to such a facility.

The necessity for EVA, an engineering laboratory, and the appropriate compliment of instrumentation will be discussed in terms of what is now planned for Space Station Freedom and what would ideally be needed. The link with transportation will be discussed in terms of cost, lift capability and current state of the art.

SPACE STATION FREEDOM UTILIZATION CONFERENCE

SPACE STATION FREEDOM AS AN ENGINEERING EXPERIMENT STATION

AN OVERVIEW

PRESENTED TO
SPACE STATION FREEDOM UTILIZATION CONFERENCE
AUGUST 3 - 6, 1992

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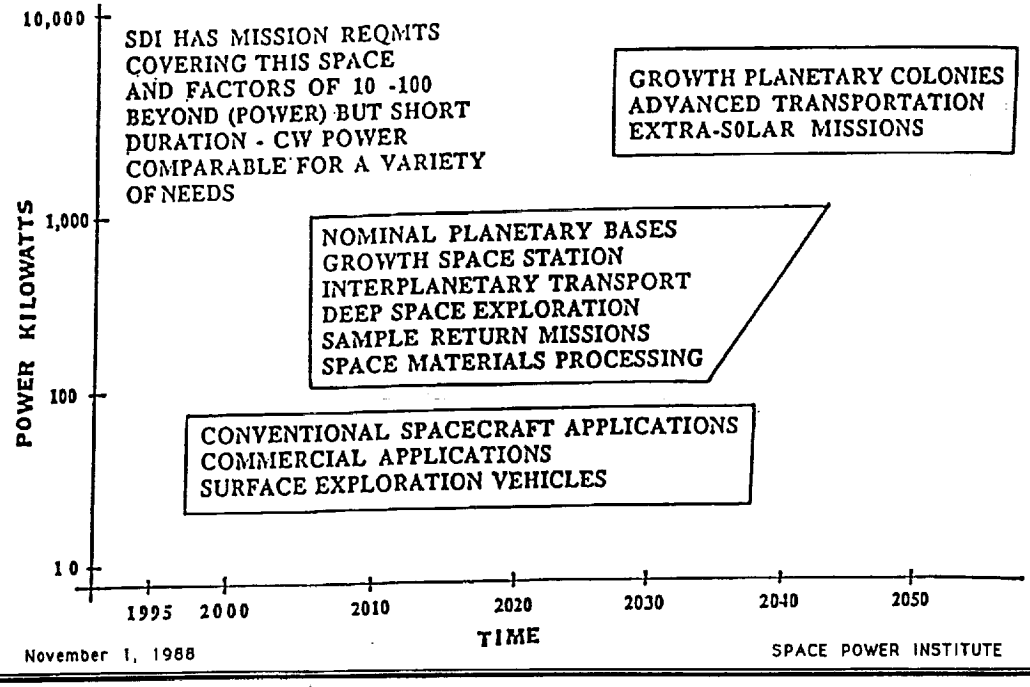
231 LEACH CENTER
AUBURN UNIVERSITY, AL

POWER LEVEL GROWTH



November 1, 1988

ASSUMPTIONS

- MAN IN SPACE IS INEVITABLE AND WILL BE A PARTNERSHIP WITH HIS MACHINES
- COLONIZATION AND SCIENTIFIC OUTPOSTS ON THE MOON AND MARS WILL OCCUR
- "COMMERCIALIZATION" OF SPACE WILL OCCUR

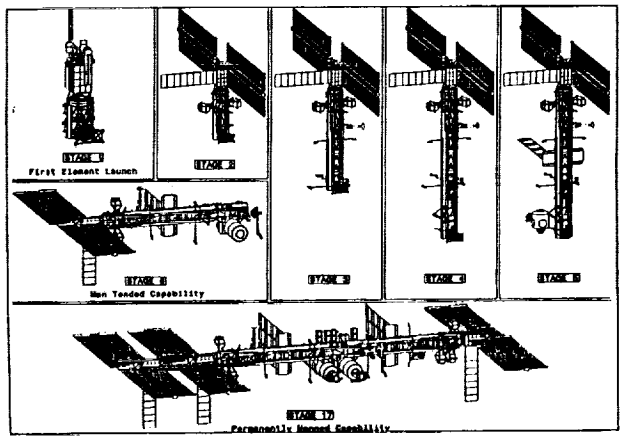
CONSEQUENCES

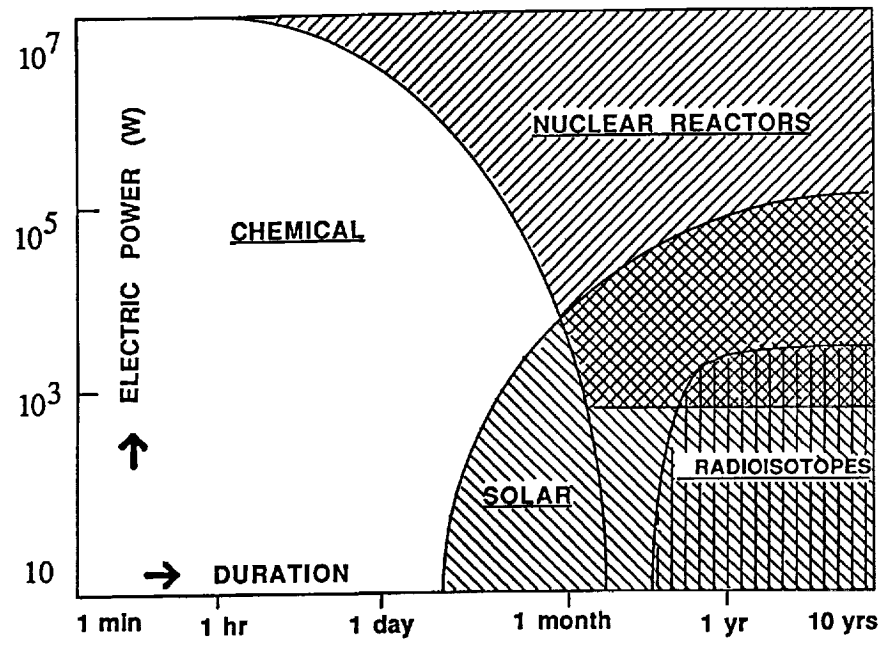
- SCIENTIFIC LABORATORIES TO STUDY FUNDAMENTAL PHENOMENA UNIQUE TO THE SPACE ENVIRONMENT
- ENGINEERING LABORATORIES TO SPACE QUALIFY AND "PROOF"TEST ADVANCED SYSTEMS/COMPONENTS FOR EXPLORATION AND COMMERCE
- MUST HAVE A SPACE STATION - NOTHING SPACE QUALIFIES LIKE TIME IN SPACE

SPACE STATION FREEDOM IS ANOTHER NASA FIELD STATION WITH THE SAME COMPLIMENT OF TASKS AS EXISTING CENTERS - ONLY 300 MILES FROM FOGGY BOTTOM. UNFORTUNATELY IT IS UP-HILL BOTH WAYS

SSF AS AN ENGINEERING EXPERIMENT

ONLY COUNTRY IN THE WORLD WHO WILL KNOW HOW TO BUILD LARGE SPACE STRUCTURES - IMPORTANT TO COMMERCIALIZATION AND EXPLORATION





Space power technologies as related to mission duration

SPACE STRUCTURES TECHNOLOGY

- EFFICIENT RELIABLE POWER - SSF REPRESENTS A MAJOR EXPERIMENT IN POWER FOR FUTURE FACILITIES
- MATERIALS AND THEIR INTERACTION WITH THE SPACE ENVIRONMENT
  - THOSE ON THE STATION
  - NEW MATERIALS FOR NEXT GENERATION
- THERMAL MANAGEMENT FOR LARGE STRUCTURE
- PROPULSION AND STATION KEEPING
- EFFECTS OF OPERATIONS
- DYNAMICS OF THE STRUCTURE

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ENGINEERING EXPERIMENT STATION

- EVALUATE NEW LIFE SUPPORT SYSTEM CONCEPTS, COMPONENTS AND SYSTEMS
- MANS ABILITY TO FUNCTION AND PROSPER IN THE SPACE ENVIRONMENT
  - HUMAN FACTORS
  - PRODUCTIVITY
  - MAN - MACHINE TEAMS
- SPACE QUALIFY
  - POWER
  - PROPULSION
  - ELECTRONICS
  - MATERIALS
- ASSEMBLY AND REPAIR OF COMPLEX SPACECRAFT
  - NODE IN THE LUNAR AND MARS MISSIONS
  - REFURBISH AND REPAIR SATELLITES ALONG THE LINES OF THE SHUTTLE CREW EXPERIENCE

ASSEMBLE, TEST, SPACE QUALIFY COMPONENTS, SYSTEMS, ETC INTENDED FOR COMMERCIAL OPERATIONS

AERONAUTICS AND SPACE TECHNOLOGY
CODE - R

- RESPONSIBLE FOR DEVELOPING THE TECHNOLOGICAL UNDERPINNINGS OF ANY FUTURE SPACE ENDEAVOUR
- HAS DEVELOPED MANY COMPONENT TECHNOLOGIES WHICH REPRESENT SIGNIFICANT IMPROVEMENTS OVER FLIGHT HARDWARE
- NEEDS TO ADVANCE TO TECHNOLOGY DEMONSTRATORS
  - TERRESTRIAL
  - SPACE DEMONSTRATOR
- SPACE QUALIFY AND TRANSFER TO THE AEROSPACE COMMUNITY

SPACE STATION FREEDOM SHOULD BE THE LABORATORY FOR TRANSITIONING CODE - R TECHNOLOGY TO THE SPACE FLEET

• Conclusion: OAST has an enormous spectrum of science and technology which must form the basis of a permanent space infrastructure. SSF's greatest value to OAST is as an engineering experiment station where advanced technologies can be researched, developed and space qualified, SEI hardware space tested, engineering guidelines for future space hardware determined, and commercial prototyping established.

Recommendation: OAST should promote this interpretation of SSF insisting that SSF is much more than a platform for life sciences and microgravity materials R&D. OAST should coordinate with Code C to actively promote a joint constituency. OAST should constantly negotiate with SSF to insure maximum man in the loop experimentation aboard SSF and obtain NASA administrator support for this.

• Conclusion: The SSF planning cycle for experimental access is estimated to be greater than 5 years and needs to be streamlined and made user friendly.

Recommendation: OAST should insist on standardization of procedures and equipment, reduction of "paperwork", and the establishment of a field center office whose function is to guide and expedite the process of "getting an experiment through the system". In general, it should push for a time line of 1-3 years. Rapid response SARR type payloads should be minimal time response with large complicated experiments taking no more than four years.

--- OAST SECURE A MANDATE FROM THE NASA ADMINISTRATOR TO HEAVILY USE SSF TO PURSUE THE RELEVANT SCIENCE, ESTABLISH ENGINEERING GUIDELINES, SPACE QUALIFY PROMISING TECHNOLOGIES AND TEST PROTOTYPE SYSTEMS INTENDED FOR COMMERCIAL ENTERPRISES AND MAN'S INEVITABLE PERMANENT PRESENCE IN SPACE—

August 3, 1992

KEY ISSUES
ENGINEERING EXPERIMENT STATION

- WILL THE SSF AS FINALLY BUILT BE ADEQUATE
  - WORK SPACE
  - EQUIPMENT COMPLIMENT
  - PERSONNEL
- CAN PROCEDURES BE STREAMLINED TO MINIMIZE TIME NEEDED TO TAKE AN EXPERIMENT TO THE STATION
- CAN EVA WORKLOAD BE SCHEDULED TO SERVICE STATION AND MAJOR EXTERNAL EXPERIMENTS
- COST OF TIME AT STATION
- COST OF TRANSPORTATION
- SUPPORT OF THE CONGRESS AND THE AMERICAN PEOPLE

It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old institution and merely lukewarm defenders in those who would gain by the new ones.

Machiavelli, "The Prince", 1513.

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SPACE STATION FREEDOM UTILIZATION CONFERENCE

8:30	Overview—Dr. M. Frank Rose
9:00	Precursor Space Station Experiments—Sherwin M. Beck, Director, Systems Analysis and Engineering, Space Station Freedom Office, NASA LaRC
	Modal Identification Experiment—Dr. Brantley Hanks, Head, Spacecraft Dynamics Office, NASA LaRC
9:40	Instrumented Space Station—Dr. Lenwood G. Clark, Acting Deputy Manager, Earth Probes Program, NASA Headquarters
	Middeck 0-g Dynamics Experiment—Professor Edwin F. Crawley, Department of Aeronautics and Astronautics, MIT
10:00	Break
10:30	Potential Attached Payloads—Don E. Avery, Space Station Utilization Office, NASA LaRC
	Spacecraft Materials & Coatings—Wayne Slemp, Applied Materials Branch, Materials Division, NASA LaRC
	Materials Experiments Opportunities—Robert Schmidt, Center for Materials & Structures, Case Western Reserve University
11:30	Potential Pressurized Payloads—Roy McIntosh, Head, Advanced Development & Flight Experiment Section, NASA Goddard Space Flight Center
	Two-Phase Thermal Flow—Roy McIntosh
	0-g Life Support & Thermal Control for Space Station—Liese A. Dall-Bauman, System Engineering Analysis Office, NASA Johnson Space Center

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