DEPLOYABLE PLATFORM SYSTEMS DEVELOPMENT

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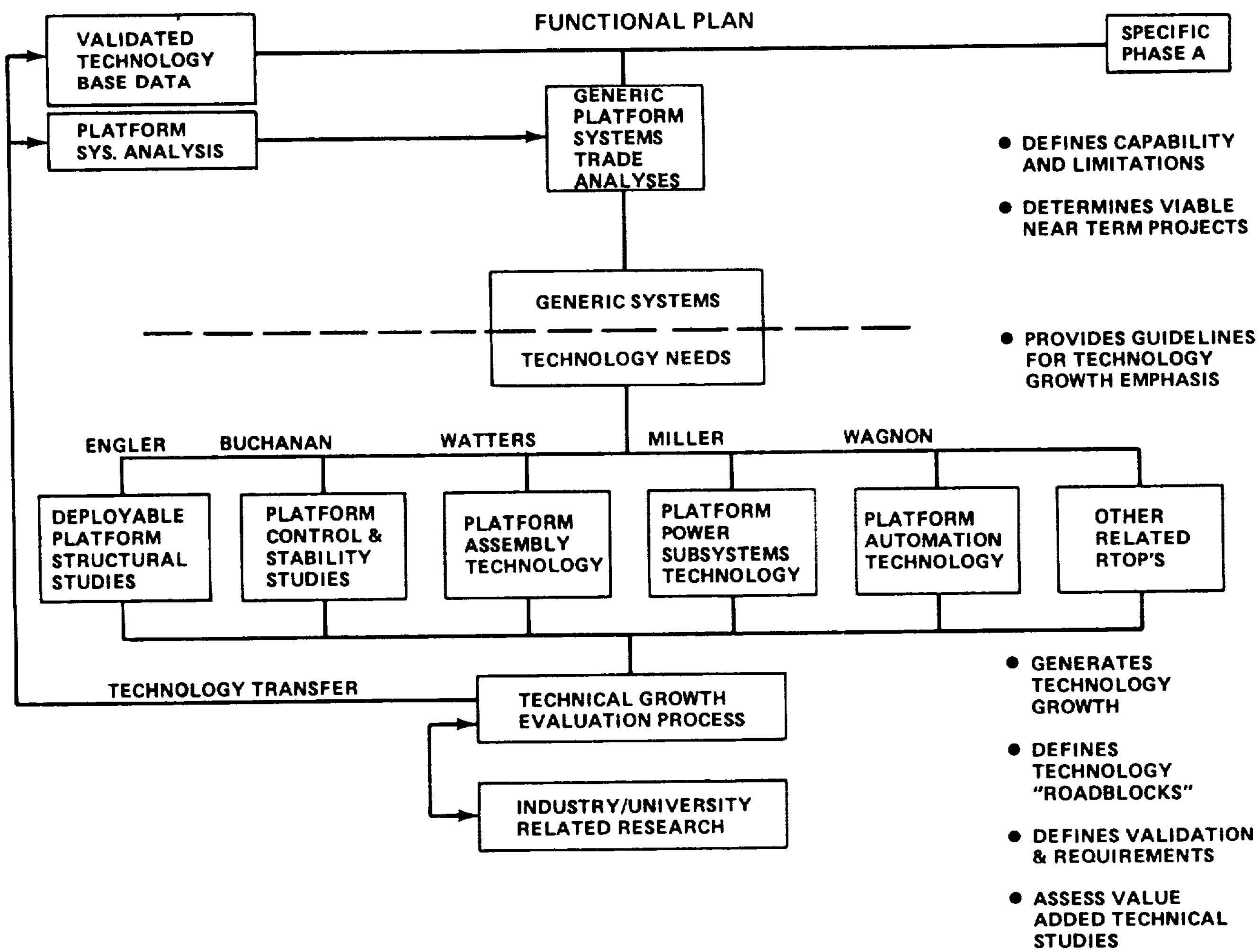
FUNCTIONAL PLAN

The flow chart shows the interaction between the different aspects of platform systems technology. In order to perform technology in the different discipline areas, shown below the dashed line, generic platform systems must be established and used as reference in defining and executing technology work in the discipline areas shown. Specific outputs of the activity are indicated to the right of the chart.



LONG RANGE OBJECTIVE

The long range objective is to achieve technology readiness for one or more deployable platform systems by 1986. All technology areas required for deployable platform structures will be identified and worked.

APPROACH

A two-phase program is planned to insure attainment of the development objective. In Phase I, engineering studies are performed to identify various deployable platform structures concepts, and based on established selection criteria, one or two viable concepts are chosen for a follow-on concept design effort. Generic platform design requirements are used in this effort. Phase II will expand the technology work into hardware verification of the selected deployable structure concept(s). In an incremental program, an orderly progression from component to subsystem development and finally to an overall system verification will take place. Flight experiments required to augment the ground test will be identified during this program phase.

LONG RANGE OBJECTIVE

- DEVELOP TO TECHNOLOGY READINESS ONE OR MORE DEPLOYABLE PLATFORM SYSTEM CONCEPTS BY 1986

APPROACH

- EXECUTE TWO PHASED PROGRAM TO INSURE ATTAINMENT OF DEVELOPMENT OBJECTIVE

PHASE I ENGINEERING STUDY ACTIVITY

- CONCEPT DEVELOPMENT AND SELECTION
- CONCEPT DESIGN

PHASE II HARDWARE DEVELOPMENT, TEST AND EVALUATION

- COMPONENTS AND SUBSYSTEMS
- SYSTEMS
- FLIGHT EXPERIMENT DEFINITION

OVERALL STUDY GUIDELINES

The goal of the Deployable Platform System Technology program is to perform an integrated program with demonstrated technology readiness in 1986 through test proven hardware on the system level. In order to achieve versatility, point design of the system is avoided, and a generic platform, incorporating features of presently conceived platforms (LEO and GEO), is utilized. Other applied major guidelines include the adaptation of a building block approach with self-contained automatic deployed modules and minimum EVA for assembly and maintenance. The basic launch vehicle is assumed to be the Space Shuttle (STS).

- FY 1986 TECHNOLOGY READINESS
    - TEST PROVEN HARDWARE
- COMPLETE SYSTEM - NOT JUST A STRUCTURE
- GENERIC - NOT A BASEPOINT DESIGN
- VERSATILITY
    - CAN BE USED TO BUILD PLATFORMS OF DIFFERENT CONFIGURATIONS
    - "BUILDING BLOCK" APPROACH - SELF-CONTAINED MODULES
- DISTINCTION BETWEEN LEO AND GEO DESIGNS
- ADAPTABLE FOR A WIDE RANGE OF PAYLOADS
- AUTOMATIC DEPLOYMENT
    - MINIMUM EVA
- BASED ON STS CAPABILITIES

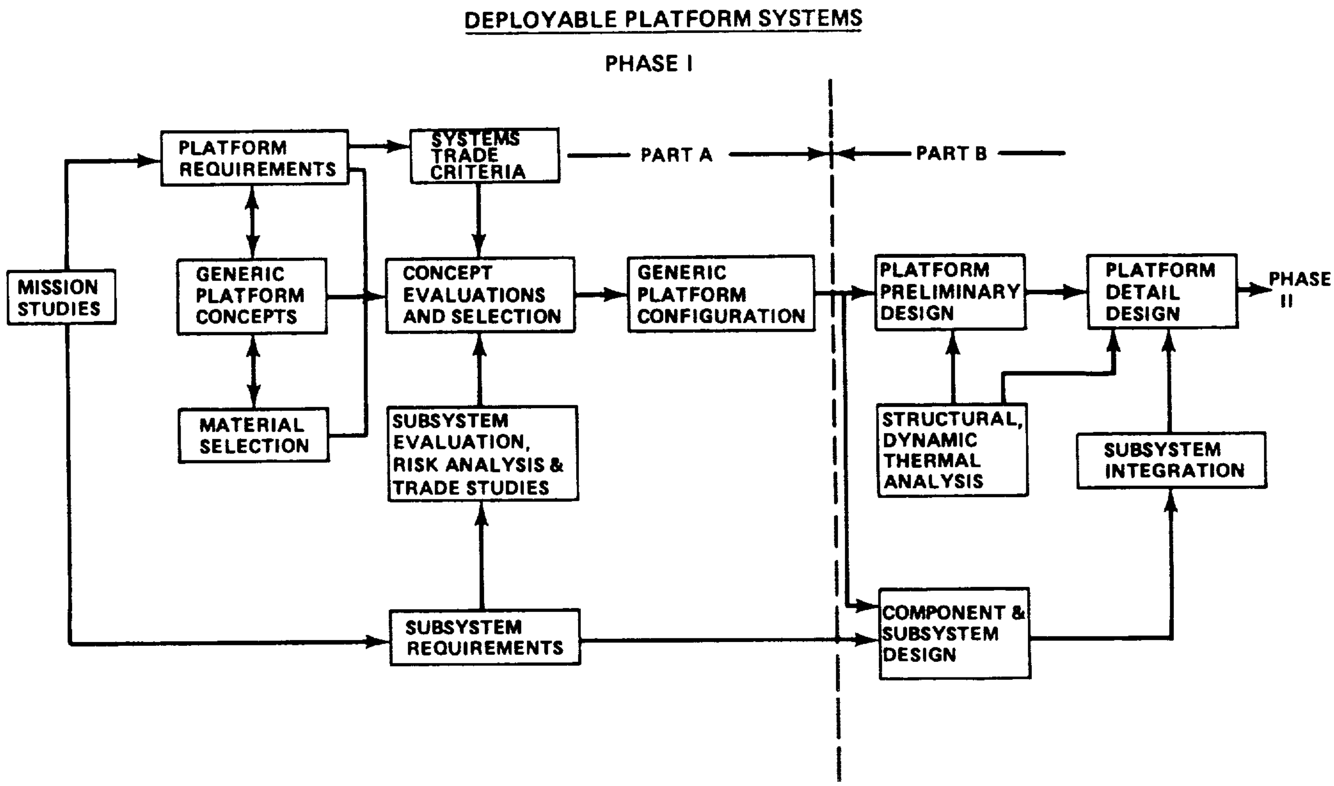
MAJOR TECHNICAL CONCERNS

A listing of major technical concerns, which will be addressed in the technology program, is shown. Special emphasis will be given to the areas indicated.

- √ ● DEPLOYMENT METHODS
- ● STRUCTURAL CONCEPTS
- √ ● UTILITIES INTEGRATION
- ● STRUCTURAL PERFORMANCE
- √ ● COMPATIBILITY WITH ENVIRONMENTS
- ● DESIGN FLEXIBILITY
- ● CONTROL SYSTEM HARDWARE INTEGRATION
- ● CONTROL SYSTEM/STRUCTURAL SYSTEM INTERACTION
- √ ● PACKAGING EFFICIENCY
- ● DEPLOYMENT ASSEMBLY
- ● POWER AND THERMAL SYSTEM INTEGRATION
- ● PROPULSION SYSTEM INTERACTION & INTEGRATION
- √ ● SPACECRAFT OPERATIONS AND SERVICING
- √ ● PAYLOAD INTEGRATION
- ● MATERIAL SELECTION
- ● COST TRADES

DEPLOYABLE PLATFORM SYSTEMS, PHASE I

This schematic depicts the study flow for the first phase of the technology program. No hardware tests are planned during this segment of the effort which is performed in two parts.



GENERIC DEPLOYABLE PLATFORM REQUIREMENTS

A matrix of requirements will be established to direct the design of the generic spacecraft configuration and the development of concepts for the platform design. Information will be extracted from the MSFC summary document of the three focus missions. Other sources of requirements are JSC 0770, Vol. XIV, Space Shuttle System Payload Accommodations, and CR-160861, Shuttle Considerations for the Design of Large Space Structures. The matrix will distinguish between LEO and GEO requirements, where pertinent, and will include structural strength and stiffness; payloads masses and sizes; materials environments and temperatures; utilities quantity, sizes, and function; orbiter integration; space operations functions and mission equipment, such as TT&C, solar arrays, batteries, and control system components.

GENERIC DEPLOYABLE PLATFORM REQUIREMENTS

STRUCTURAL

- SUITABLE FOR EITHER AREA OR LINEAR PLATFORM
- STRUCTURAL ELEMENT SIZE:
- STRUCTURAL FREQUENCY
- STRENGTH OF BEAM
- STIFFNESS OF BEAM
- MATERIAL

DEPLOYMENT/STOWAGE/RETRACTION

- MUST DEPLOY AUTOMATICALLY
- SHOULD BE ABLE TO RETRACT
- PACKAGING RATIO 10 TO 30:1 (DEPLOYED/STOWED)
- MUST OBSERVE SHUTTLE ORBITER PAYLOAD BAY CONSTRAINTS

UTILITY INTEGRATION AND INTERFACES

- POWER RANGE
- DATA RATE
- THERMAL CONTROL
- UTILITIES CABLES, AND LINES, MUST BE FULLY INTEGRATED INTO THE DEPLOYED TRUSS WORK
- UNIVERSAL INTERFACE HARDWARE ADAPTER CAPABILITY AS A GOAL

GENERIC PLATFORM REQUIREMENTS
(CONT'D)

SUBSYSTEM INTEGRATION

- POWER SYSTEM SOLAR ARRAYS : AUTOMATICALLY DEPLOYED
- PROPULSION SYSTEM : ALTITUDE/ATTITUDE CONTROL/REBOOST
- THERMAL CONTROL : AUTOMATICALLY DEPLOYED OR MOUNTED ON DEPLOYED STRUCTURE

PAYLOAD INTEGRATION

- PAYLOAD MASS AND POSITION SENSITIVITY
- ACCESSABILITY/SERVICEABILITY REQ'TS

OPERATIONS AND SERVICING

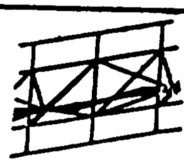
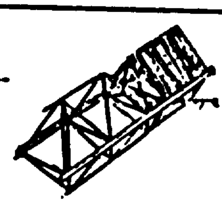
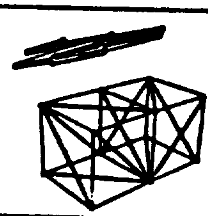
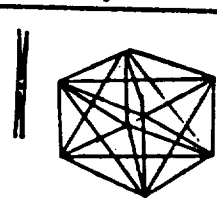
- PLATFORM MUST BE COMPATIBLE WITH ORBITER DOCKING AND BERTHING METHODS AND HARDWARE

MISSION

- PRIMARY ORBIT : LOW EARTH ORBIT (400 TO 600 km) WITH GEOSYNCHRONOUS ACCESS.
- ORBITAL MANEUVERS : ALTITUDE CHANGES
  ORBIT REBOOST
- 30 YEAR LIFE : LONG TERM ENV. EFFECTS, MATERIALS & SUBSYSTEMS

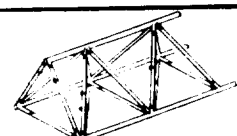
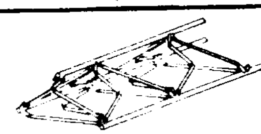
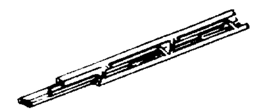
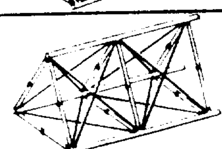
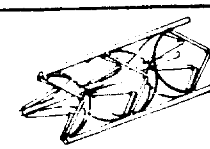
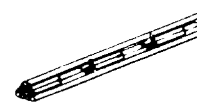
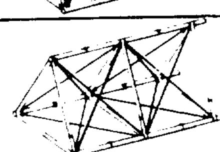
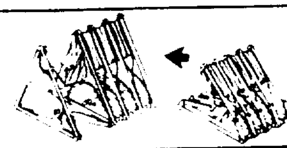
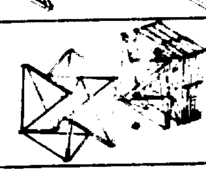
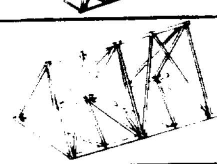
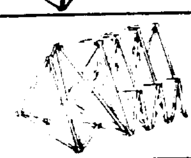
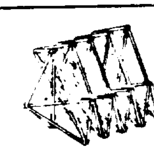
MATURED STRUCTURAL CONCEPTS

Applicable structural concepts will be compiled for structures system selection. Both new and mature concepts, as shown, will be investigated.

CONCEPT	DEVELOPMENT STATUS	MATERIALS
(1) CONTINUOUS LONGERON MAST 	SPACE-PROVEN, WITH INSTALLATION OF SMALL ELECTRICAL LINES	FUTURE USE OF LOW CTE COULD BE PROBLEM
(2) ARTICULATED LONGERON MAST	DEMONSTRATION MODELS WITHOUT PREINSTALLED UTILITIES	FUTURE DESIGN COULD USE LOW CTE MATERIALS
(3) EXTENDIBLE SUPPORT STRUCTURE FOR SEASAT 	SPACE-PROVEN, BUT WITHOUT UTILITIES INSTALLATION—5 FT x 35 FT LONG	TITANIUM, BUT CAN BE LOW CTE
(4) DIAMOND-SHAPED BEAM 	DEMONSTRATED AUTOMATIC DEPLOYMENT OF FIVE-BAY STRUCTURE—SMALL UTILITIES INCLUDED—MODEL 5 x 7.5 FT CROSS-SECTION	LOW CTE MATERIAL WITH ALUMINUM FITTINGS
(5) DOUBLE-CELL, DOUBLE-FOLD TRUSS 	DEMONSTRATED DEPLOYMENT IN MSFC BUOYANCY TANK WITH 4 WIRE BUNDLES—EXTERNALLY APPLIED FORCES—SIZE, 3 M x 3 M x 6 M LONG	ALUMINUM, BUT CAN EMPLOY LOW CTE MATERIALS
(6) BOX TRUSS WITH X-BRACING 	DEMONSTRATION MODEL WITHOUT UTILITIES	LOW CTE MATERIAL

ADDITIONAL DEPLOYABLE STRUCTURES CONCEPTS

Applicable structural concepts will be compiled for structures system selection. Both new and mature concepts, as shown, will be investigated.

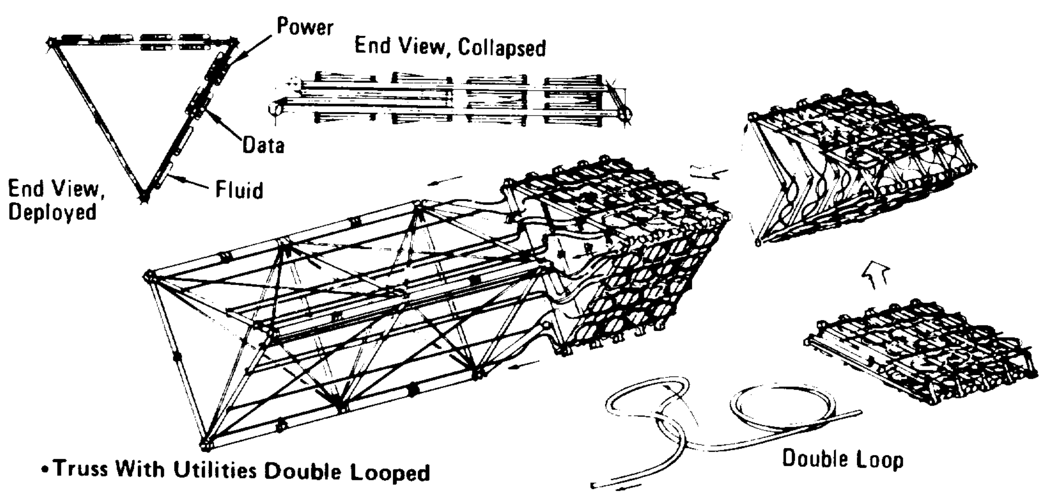
Type	Deployed	Partially Deployed	Packaged
(1) Warren Truss – Transverse Fold			
(2) Cable Cross-Braced – Transverse Fold			
(3) Cable Cross-Braced – Transverse and Longitudinal Fold			
(4) K Brace – Longitudinal Fold			
(5) K Brace – Longitudinal Fold			

UTILITIES INTEGRATED WITH STRUCTURE

The overall spacecraft design will be broken down into separate design areas, and several concepts will be developed for each area. The areas which will be developed are:

- Folding/deployable structural trusses--including the existing diamond truss and double-cell, double-fold.
- Deployable methods and mechanisms.
- Installation, attachment, and deployment of utilities.
- Expansion/contraction in fluid lines.
- Interfaces between structure and modules (payloads, control module, RCS, etc.).
- Interfaces between utilities and modules.

A typical design problem, integrated utilities, is depicted in this picture.

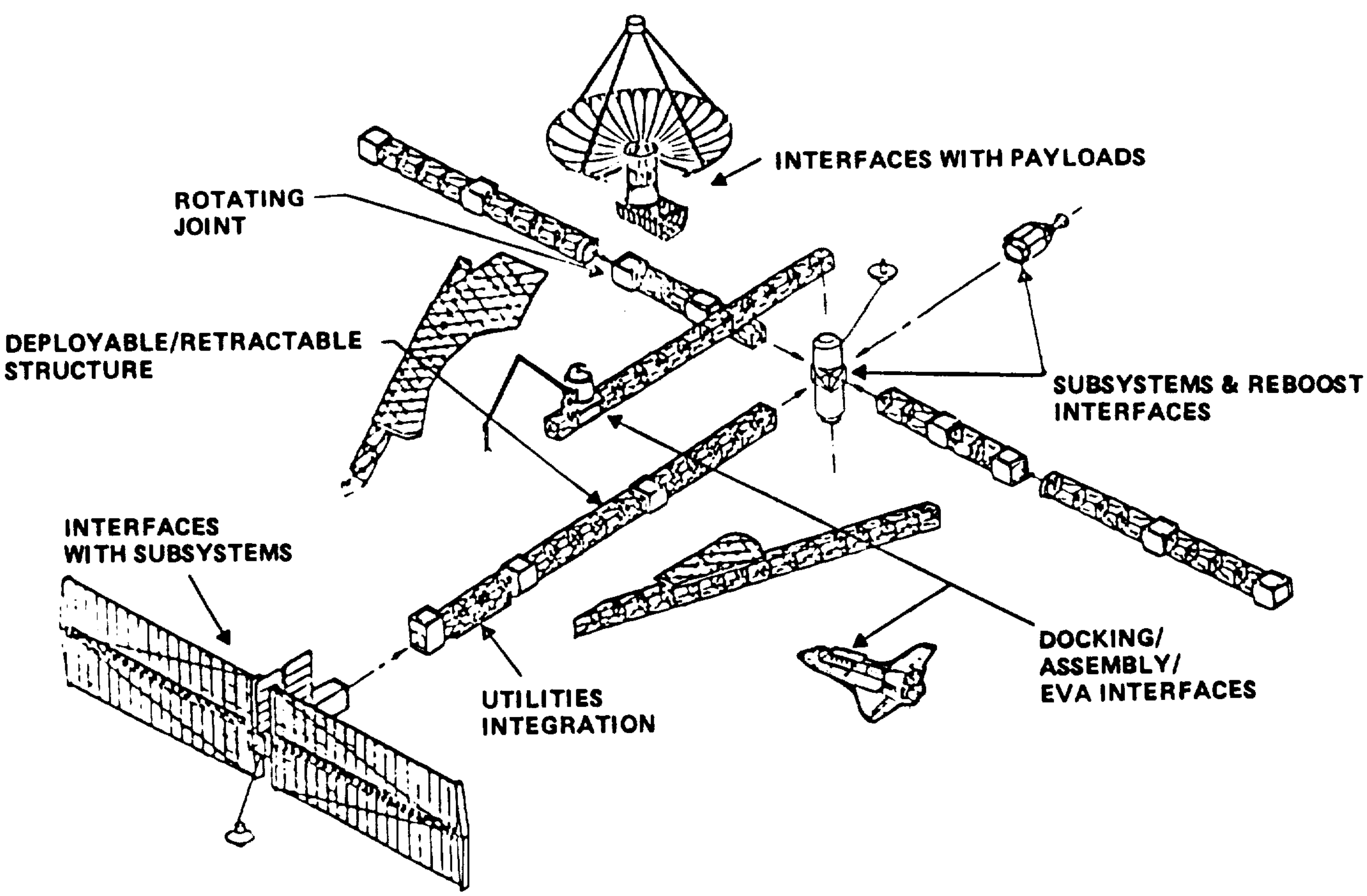


•Truss With Utilities Double Looped

ELEMENTS OF DEPLOYABLE PLATFORM SYSTEM

A generic linear and area shaped deployable spacecraft configuration will be developed from the requirement established. The purpose of the spacecraft configurations is not to freeze the design, but to help understand and solve the localized problems which will be encountered, i.e., to see the forest in addition to seeing the trees. The spacecraft configuration will be configured to support the reference payload group (selected from the three focus missions) for LEO or GEO applications. The drawing of the generic deployable spacecraft configuration shows the following typical elements:

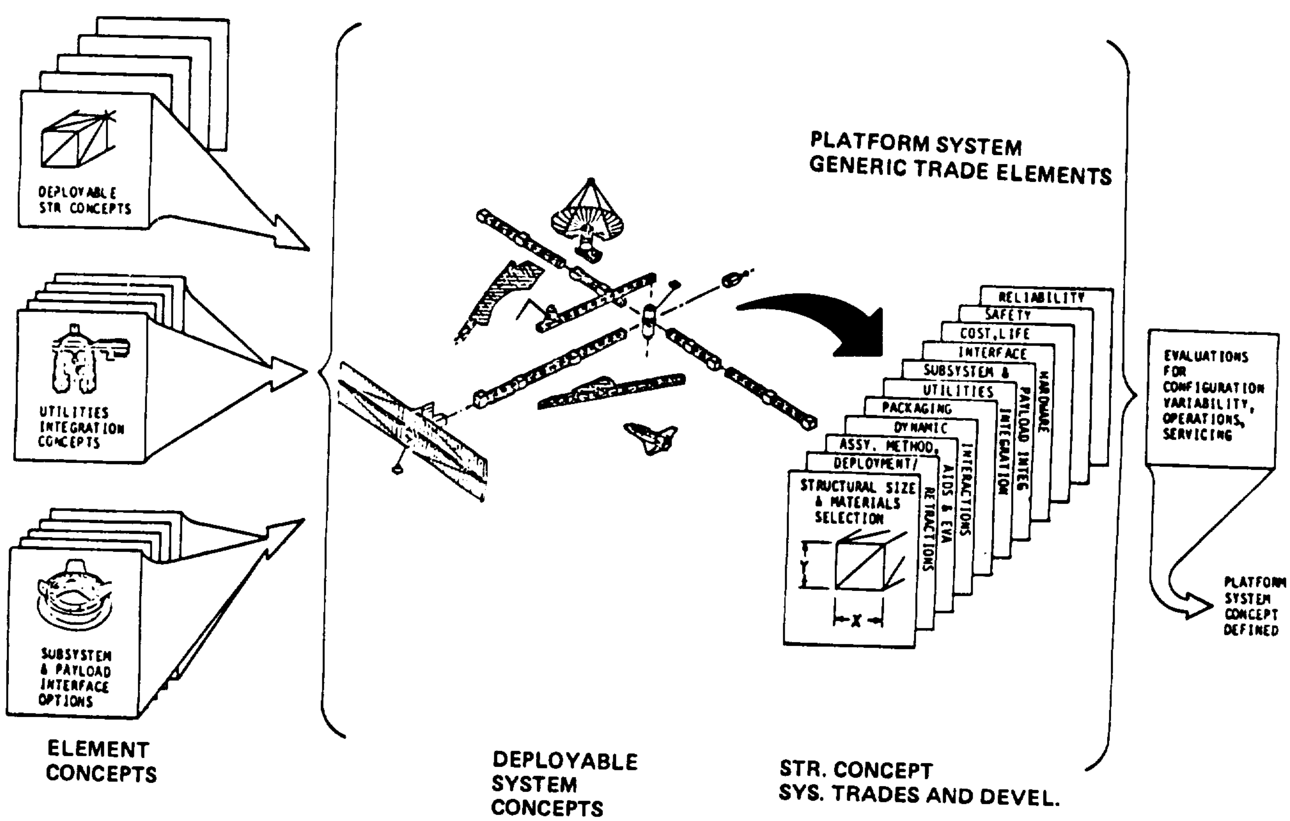
- Structure
- Control module
- Propulsion system
- RCS--distributed thrusters
- Solar array
- Electric power distribution
- Docking/berthing provisions
- Payloads--the reference payload group
- Radiators
- Interfaces between structure and modules/payload/RCS
- Module-to-module interface
- Fluid line routing



SYSTEM LEVEL CONCEPT DEVELOPMENT TRADES

The concepts for separate components or subsystems will be screened and then matched to each other to form integrated platform systems. For example, each foldable truss will be matched with the type deployment mechanism to which it is best suited. Similarly, the various concepts of utilities installation will be matched with structures and deployment methods. The objective is to produce integrated systems, each capable of deploying a structural truss complete with (as far as possible) all of the utilities, plus interfaces and interconnects for payloads and modules. The emphasis is placed on the system, not individual pieces or subsystems. A subsystem, however ingenious it may be, will be discarded if it cannot perform its role as part of the integrated system. An integrated system forms the basis of a series of building blocks which can be assembled to construct deployable platforms of various configurations. The integrated process will be supported by analyses in all of the pertinent areas:

- o Deployment methods/mechanisms--external mechanisms, strain energy.
- o Structures--strength, stiffness, member shape and size, attachments.
- o Utilities installation--cable bend radii, flexing, fatigue.
- o Materials--aluminum, composites, structures, utilities.



SYSTEM LEVEL CONCEPT DEVELOPMENT TRADES (Cont'd)

The criteria for selection of a deployable platform system will encompass basic structure performance, subsystem accommodation, space assembly operations, orbiter integration implications, and development cost. With these categories, the specific criteria will be developed; for example, such structures performance criteria as thermal stability, weight, packaging efficiency, etc. For each set of criteria, the methodology to be used in the screening process involving a combination of numerical data (where feasible) and engineering judgments to apply a point rating scheme and summary comparisons will be developed. For each type of criteria, a written definition of what constitutes acceptable numerical or qualitative limits will be prepared. Detailed engineering data from the concept characteristics matrix will be combined to form a set of overall ratings, based on the selection criteria. The sum of possible points and total costs for each concept will then be compared on summary screening charts, and one or two structural concepts selected for design and analysis to complete Phase I of the Technology program.

DEPLOYABLE PLATFORM SYSTEM TECHNOLOGY SCHEDULE

The schedule shows the overall program consisting of two phases. Phase I was discussed in detail. Phase II effort will deal in component, subsystem, and system development. Extensive hardware design, fabrication, and validation effort is planned to achieve the demonstrated technology readiness by 1986.