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VGL920

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**THE HUMAN ROLE IN SPACE
(THURIS)**





THE HUMAN ROLE IN SPACE

VGG374

Three Factors to Consider

- Performance —
 - Where Along the Continuum From Direct Human Intervention, to Teleoperators, to Remotely Actuated and Controlled Systems, to Independently Actuating/Self-Healing Operations, Can The System Requirements Best Be Met?

- Cost —
 - If Alternative Implementation Concepts Are Feasible, Which Is the Most Cost Effective?

- Risk —
 - What is the Success Probability, or Conversely, What Is the Risk or Impact of System Failure?



PRESENCE OF CREW WAS ESSENTIAL TO SKYLAB MISSION SUCCESS

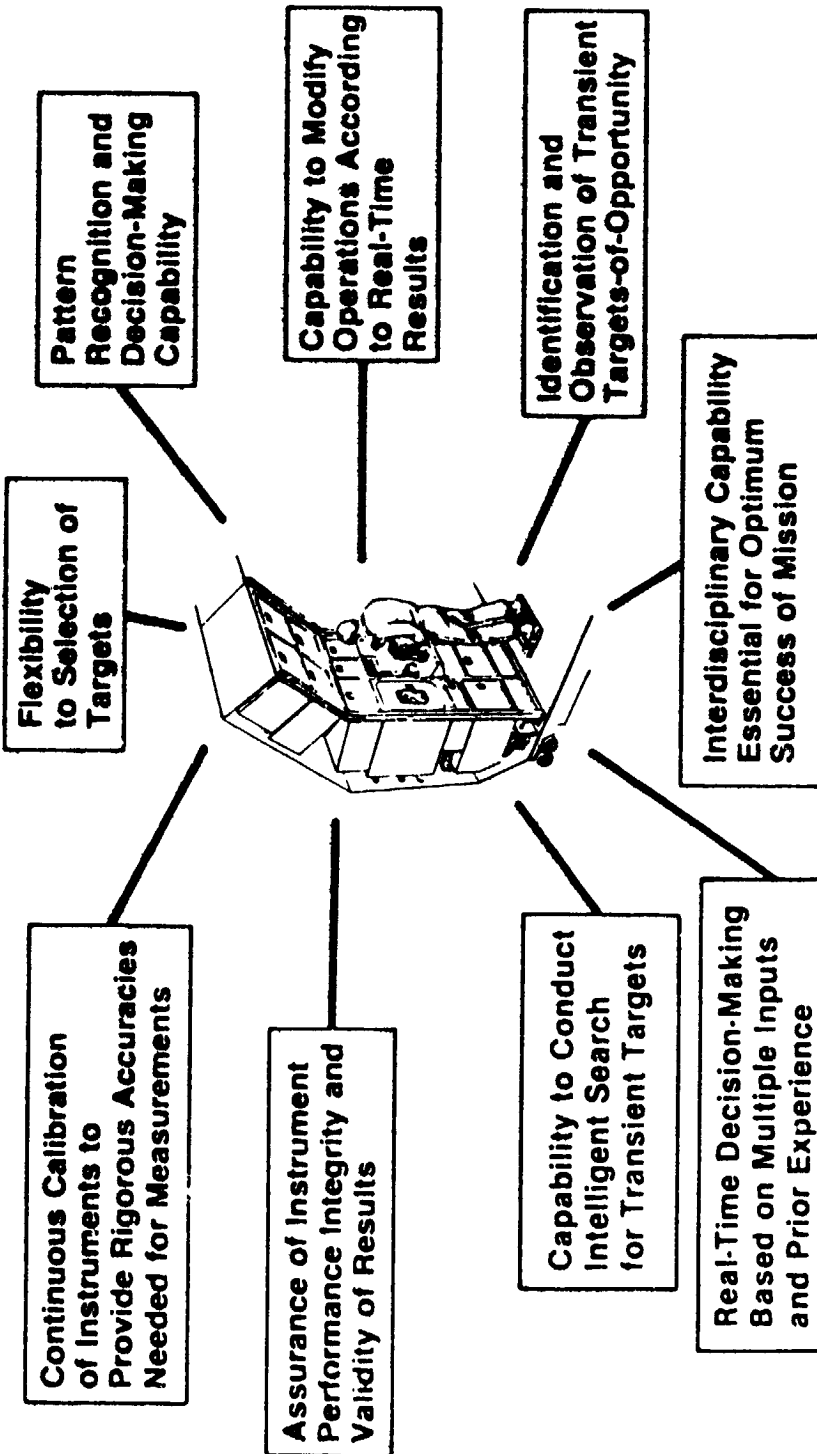
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- Assembled and Set Up Equipment
- Conducted Pre-Operations Tests (Checkout) of Experiment Equipment
- Performed Interactive Operations — Real-Time Display and Data Analysis to Determine Next Operation
- Management — Changed Ops Plans Due to “Surprises”
- Conducted Malfunction Tests
- Maintained and Repaired Subsystems
- Modified Instruments
- Analyzed and Interpreted Results
- Conducted Ground/Space Cooperative Tests
- Made Visual Observations — Discrimination
- Developed “Work-Arounds” — Heat Shield, Solar Array Deployment
- Recovered Payloads
- Assembled Large Experiments/Equipment From Parts
- Recovered Film



CAPABILITIES PROVIDED BY MAN

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SAR IMAGE — SANTA BARBARA CHANNEL





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OCEANOGRAPHIC EFFECTS DISCOVERED FIRST FROM MANNED SPACECRAFT

EDDIES

- Existence at Coastal Boundaries (Gemini)
- Size Variability in Confined Seas (Apollo)
- Distribution Along Current Edges (Skylab)
- Kelvin-Helmholtz and Von Karman Vortices — Island Wakes (Apollo and Skylab)
- Scale Variability (Skylab)
- Surface Manifestation of Warm and Cold Core Eddies (Skylab and ASTP)
- Coalescence (Skylab)
- Associated Cloud Formations (Skylab)

FRONTS

- Surface Manifestations of Fronts (Gemini — ASTP)
- Fronts and Thermal Boundaries (ASTP)
- Mesoscale Turbulence at Frontal Boundaries (Skylab)
- Plankton Distribution (Skylab)
- Wave/Front Interaction (Skylab)



OCEANOGRAPHIC EFFECTS DISCOVERED FIRST FROM MANNED SPACECRAFT

VG376

INTERNAL WAVES

- Distribution Along Shelf Break (Apollo 6)
- Configuration Over Shelf (Apollo 6)
- Existence In the Open Ocean (Skylab)
- Extent and Configuration Along Ocean Fronts (Skylab)

OCEAN SWELL

- Refraction and Absorption at Current Boundaries (Skylab)
- Refraction In Fjords (Skylab)
- Dissipation at Upwelling Boundaries (Skylab)

UPWELLING

- Configuration of Upwelling Boundaries (Apollo, Skylab)

CURRENTS

- Current Confluence and Retention of Identity (Skylab)



VFX882

BENEFITS OF MAN IN ORBIT

Scientist/Observer

- **Real-Time Data Analysis**
- **Multiple Sensor Use**
- **Sensor Mode/Parameter Selection**
- **Cooperation With Principal Investigator**

Target Selection Development Engineer

- **Sensor Operation**
- **Sensor Evaluation**
- **Component Testing**

Technical Operations Specialist

- **Equipment Setup, Checkout, Maintenance, Calibration**
- **Servicing of Sensor and Equipment Consumables**



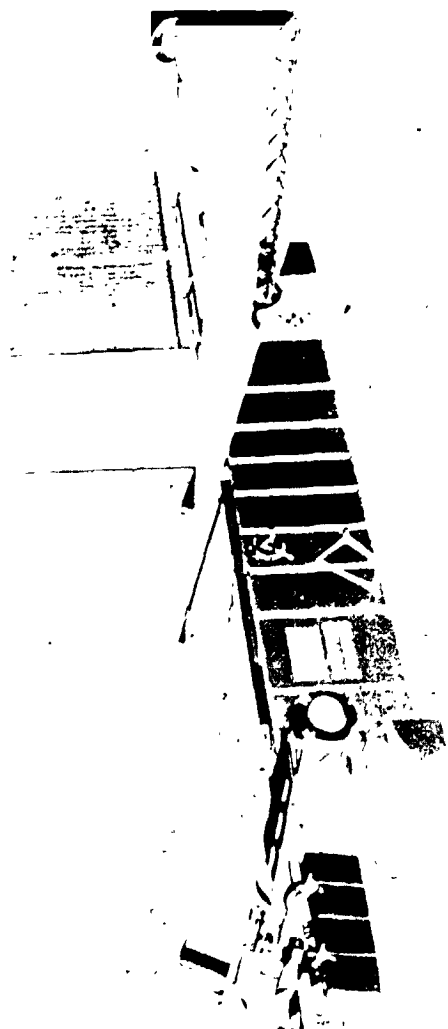
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CONCERNS OF MAN IN ORBIT

Safety of Flight

- External Environment
 - Physiological Limits
 - Psychological Stress
 - Onboard Safety
- ## Performance Degradation
- Acceleration Disturbances
 - Effluent Release
 - Repetitive Duty Cycles

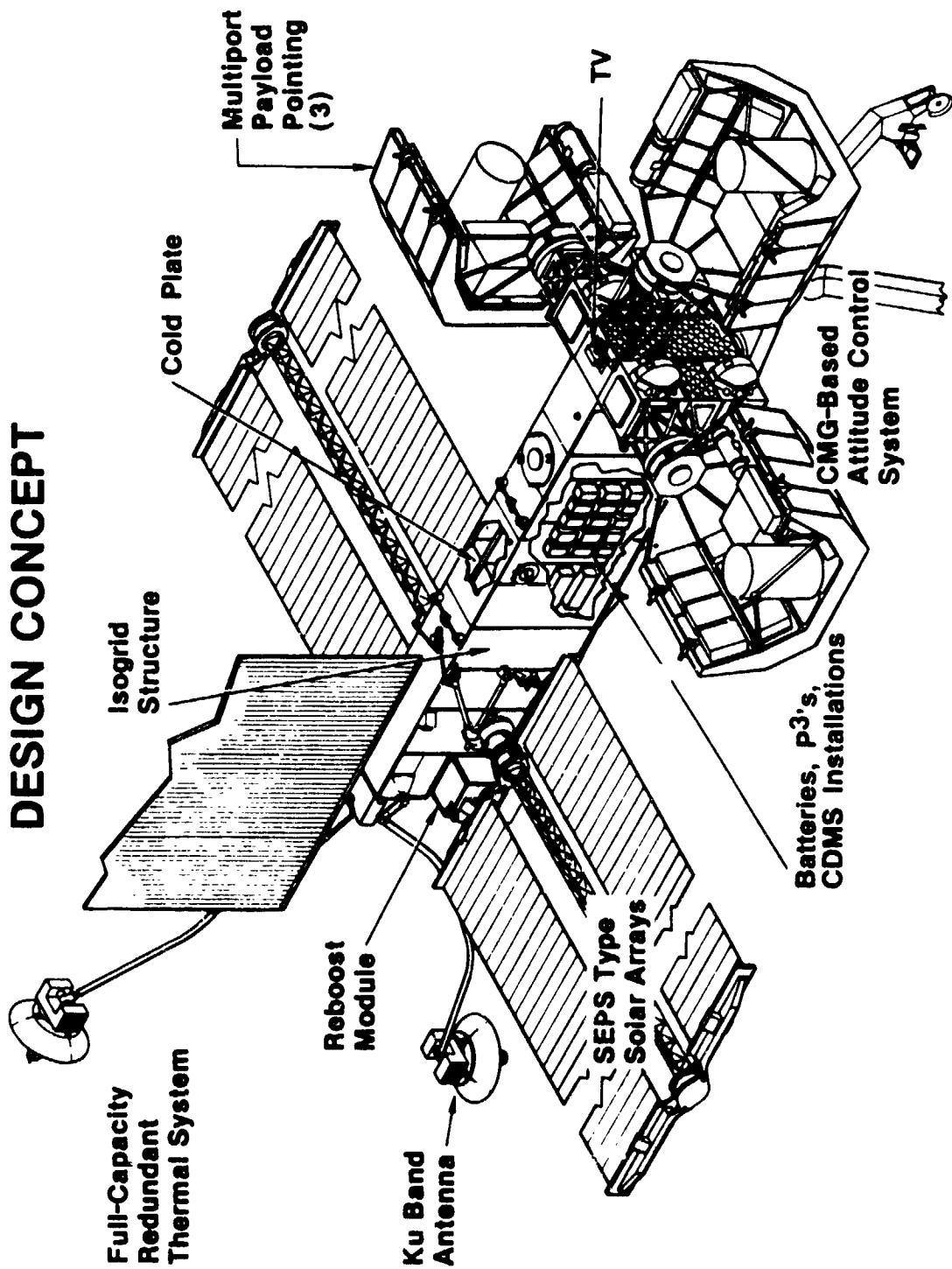
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SPACE PLATFORM SYSTEM DESIGN CONCEPT

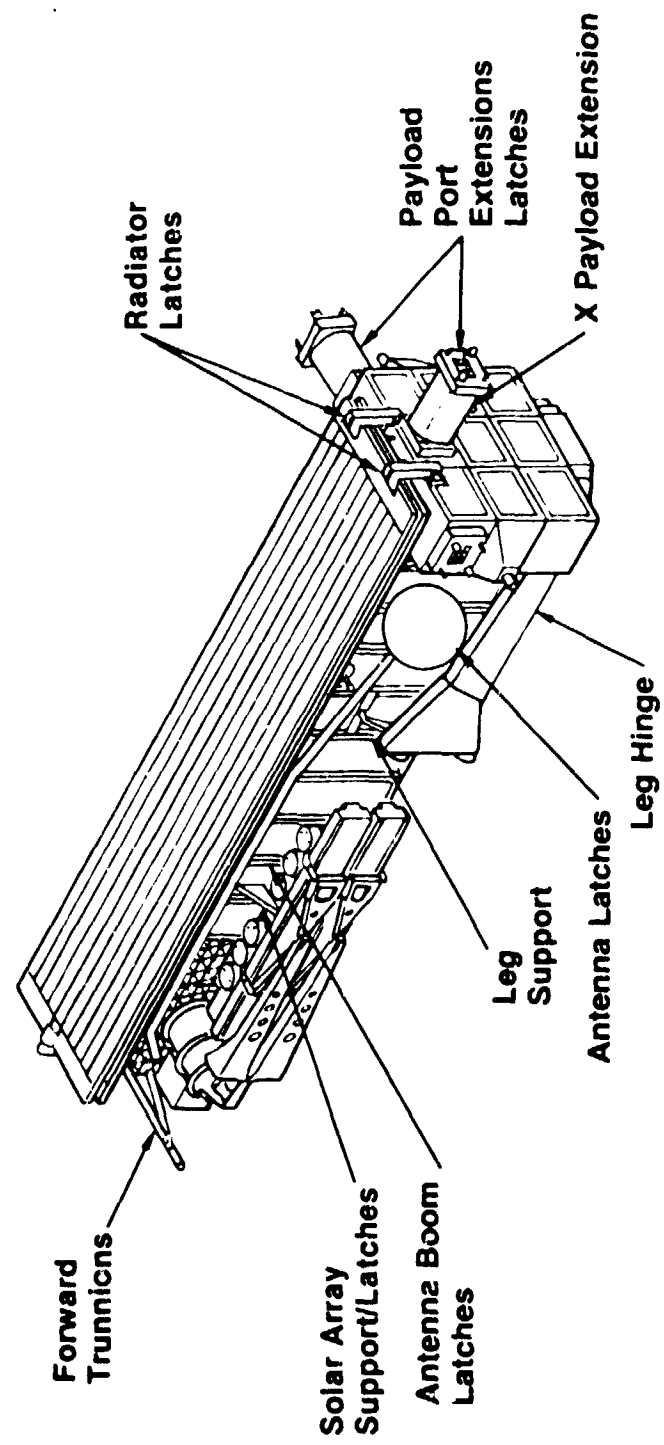
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CANDIDATES FOR EVA ACTIVATION

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- Latches/Supports Required for Ascent/Descent Only
- Costs — EVA Versus Mechanisms

EVA VERSUS MECHANISMS

- **Initial Survey Found 15 Candidate Mechanisms That Could be Done by an EVA Crewman**

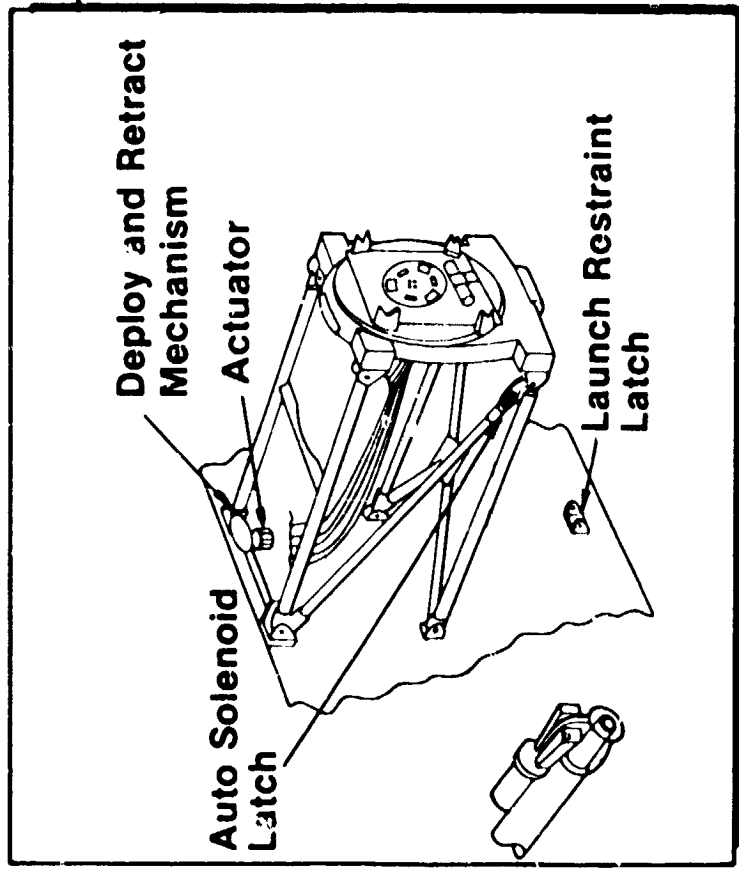
- **Survey Criteria:**
 - **Low Activation Cycles**
 - **No Free-Flight Activation Requirement**
 - **EVA Activation is Safe**

- **Candidates:**
 - **Forward Launch Supports (1 Total)**
 - **Solar Array Launch Latches (2 Total)**
 - **Radiator Latches (3 Total)**
 - **+ Y and - Y Berthing Ports (4 Total)**
 - **Aft Berthing Port (3 Total)**
 - **Ku Band Antenna (2 Total)**

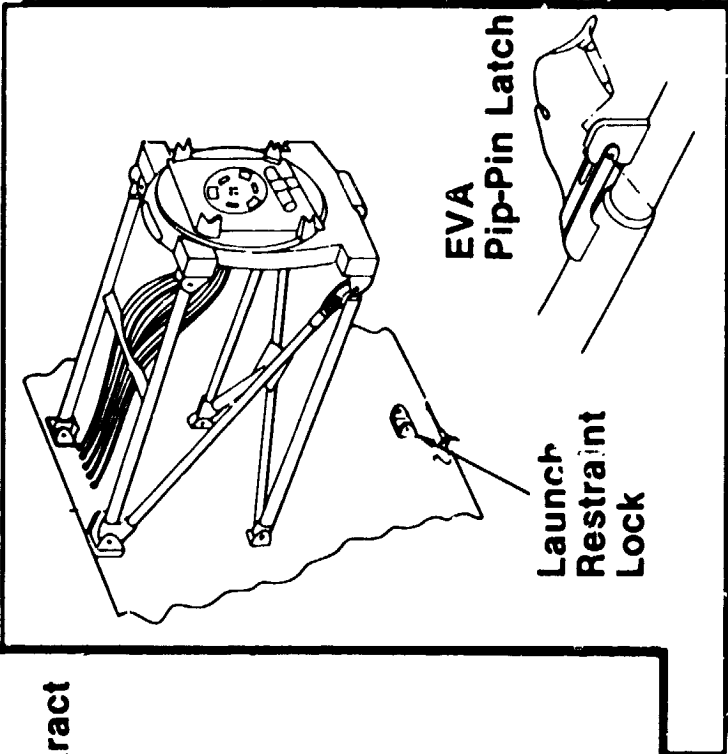
PAYLOAD BERTHING PORT (X-AXIS)

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Remotely Actuated
Deployment Mechanism



Manually Actuated (EVA)
Deployment Process

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EVA VS MECHANISMS

- Reduction of Automatic Mechanisms
 - Forward Launch Support \$133K
 - Solar Array Launch Latches 1051K
 - Radiator Launch Restraints 401K
 - + Y and - Y Berthing Port Mechanisms 266K
 - Aft Berthing Port Mechanisms 344K
 - Antenna Launch Latch 211K

TOTAL COSTS FOR 15 MECHANISMS = \$2406K

- Manual Activation to Perform the Functions of the Above-
Stated Mechanisms Involves 2 EVA Crewman Approximately
2.5 Hours Which is Well Within the Capability of
EVA Operations

EVA Costs (Per EVA Crewman) = \$60K-100K, Depending
on EVA Support Equipment*

\$60K X 2 Crewman = \$120K \$100K X 2 CREWMAN = \$200K

*Per MMU Users Guide, Martin Marietta Report MCR-78-517
(Contract NAS9-14593)

**CRITERIA FOR SELECTING
COMMERCIAL MISSIONS**

VG8376

- **High Market Value**
- **High Value Per Pound**
- **Not Labor Intensive**
- **Requires Unique Properties of Space**
- **Low Probability of Rapid Technological
Obsolescence**

CANDIDATE PHARMACEUTICAL PRODUCTS

12 TYPICAL

Typical Products	Beneficial Medical Application	Function/Status	Annual Patients (USA)
α_1 Antitrypsin	Emphysema	Research Quantities Only Now	100,000
Antihemophilic Factors VIII and IX	Hemophilia	100% Terminal by Age 40	20,000
Beta Cells	Diabetes	Possible Single-Dose Cure	600,000
Epidermal Growth Factors	Burns	Replacement Skin Grafting	150,000
Erythropoietin	Anemia	Replacement Transplants/Transfusions	1,600,000
Immune Serum	Viral Infections	EOS Provides Higher Purity	185,000
Interferon	Viral Infections	Potential May Be Unlimited	> 10,000,000
Granulocyte Stimulating Factor	Wounds	Research Quantities Only Now	2,000,000
Lymphocytes	Antibody Production	Replace Antibiotics/Chemotherapy	600,000
Pituitary Cells	Dwarfism	Currently Not Jurable	850,000
Transfer Factor	Leprosy/Multiple Sclerosis	Potential for Other Applications	550,000
Urokinase	Blood Clots	Low Development Costs	1,000,000

ELECTROPHORESIS OPERATIONS IN SPACE

VFY053

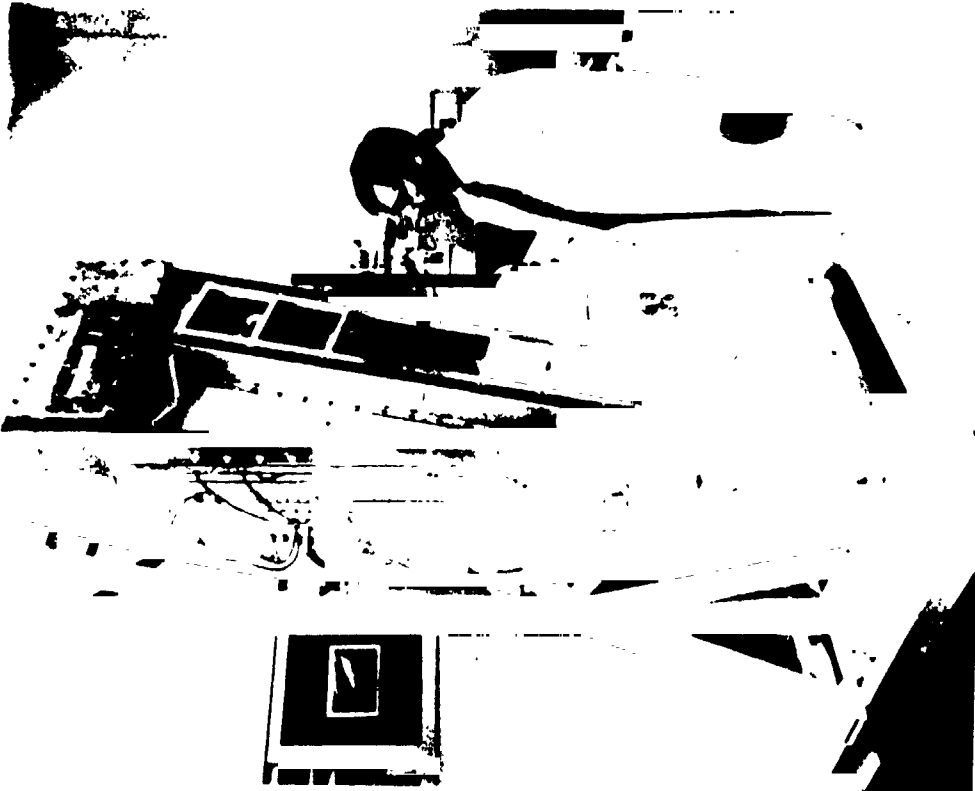
Flight Dates Under Joint Endeavor Agreement

STS 4	JUN	1982
STS 6	APR	1983
STS 7	JUNE	1983
STS 8	AUG	1983
STS 14	JUN	1984
STS 19	OCT	1984

Results From First STS Flights

1. 700 Times Increase in Yield
2. Quantitatively Repeatable Separation
3. Validated Design Concepts
4. Value of Manned Participation Confirmed

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STS-4 EOS OPERATIONS SUMMARY

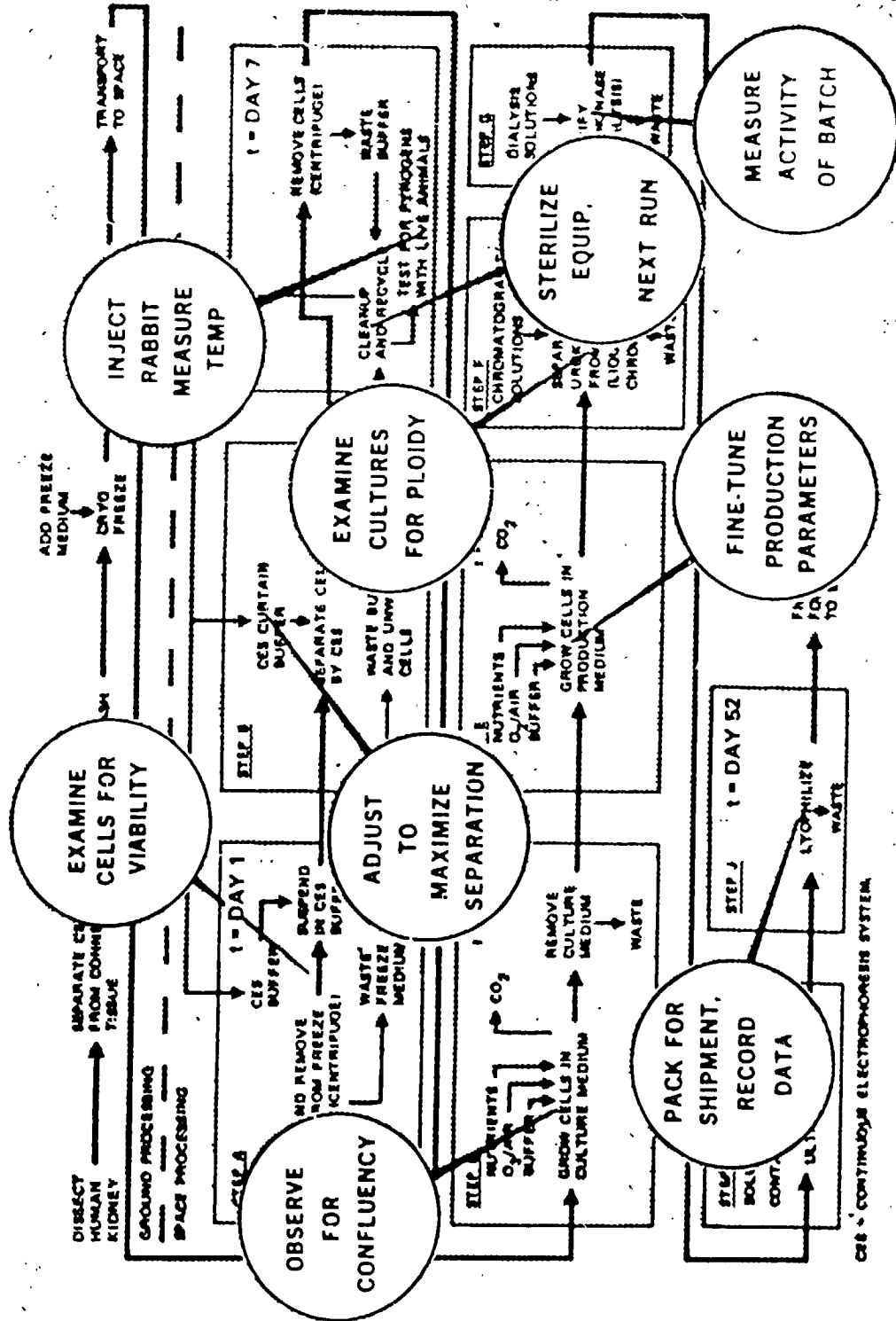
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	28 June 1982	30 June 1982
Raw Parameters	6.5 Hours	8 Hours
Total Operating Time		
Total Number of CPU Operator Calls	27	28
Scheduled Calls	19	22
Unscheduled Calls	8	6
Total Number of Key-Board Inputs Required	99	83
Scheduled Calls	48	72
Unscheduled Calls	51	11
Averaged parameters		
Operator Calls/Hour	4	3
Scheduled Calls	3	3
Unscheduled Calls	1	1
Keyboard Inputs/Hour	15	10
Scheduled Calls	3	3
Unscheduled Calls	6	2
Operator Call Response Time	27 Sec	43.7 Sec

Manned Presence Essential to Reduce Risk of Failure

ROLE OF MAN IN UROKINASE PROCESS DEVELOPMENT AND OPTIMIZATION

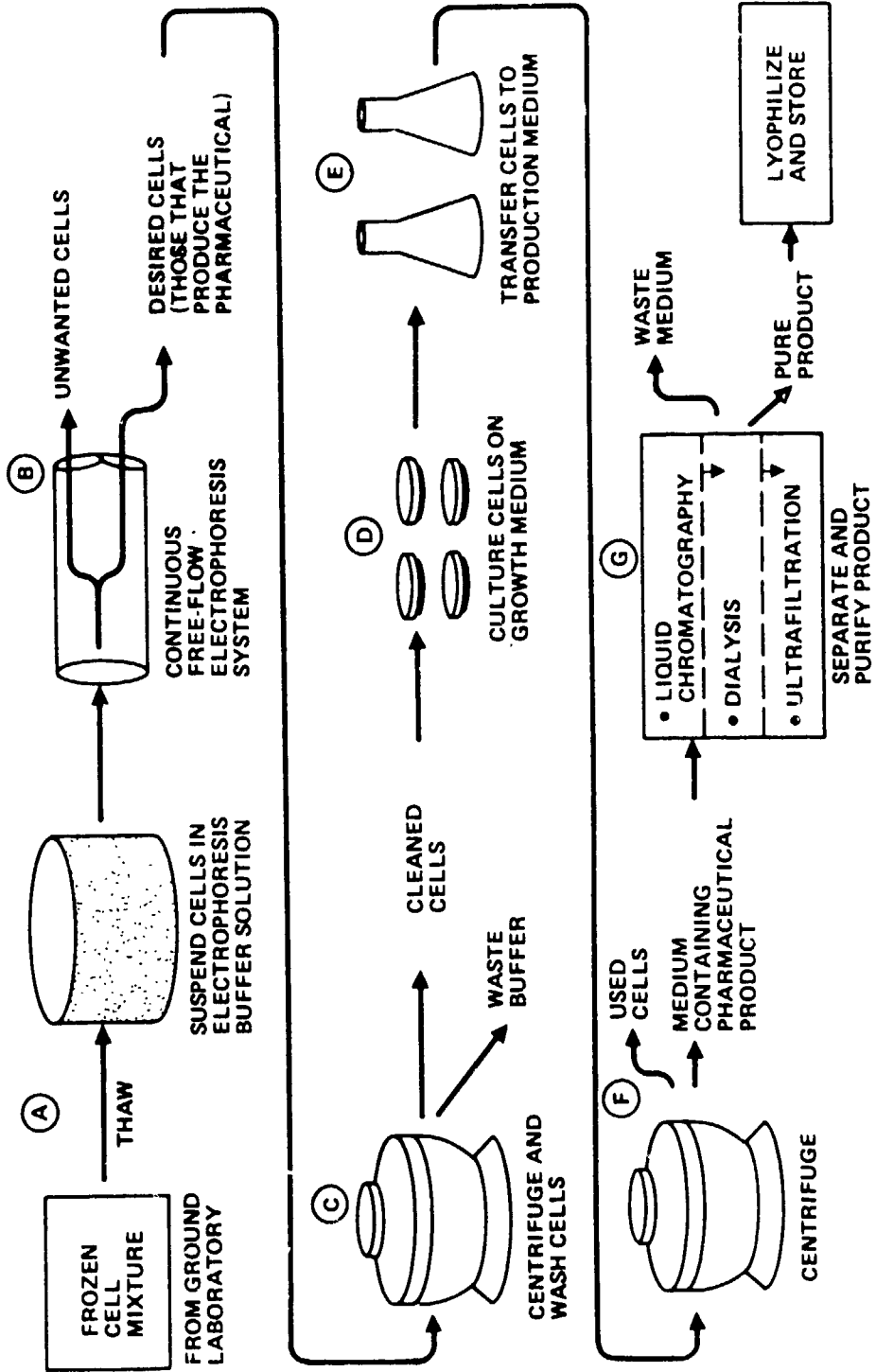
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TYPICAL SPACE PHARMACEUTICAL PILOT PLANT

(Manned Involvement: Circled Letters)

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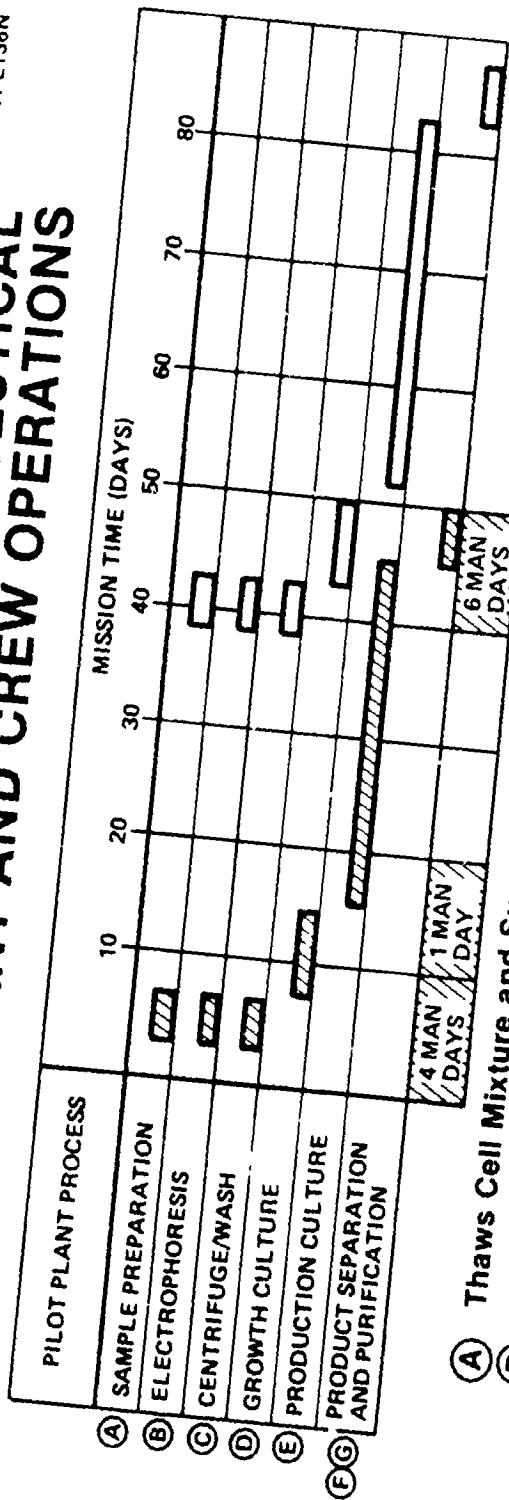


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TYPICAL TIMELINE PHARMACEUTICAL PILOT PLANT AND CREW OPERATIONS

VFL136N



- (A) Thaws Cell Mixture and Suspends in Electrophoresis Buffer Solution
- (B) Introduces Cell Suspension Into Electrophoresis Unit and Collects Separated Products
- (C) Discards Unwanted Products. Centrifuges Wanted Cells a Number of Times — Resuspending Cells in Fresh Wash Water Between Centrifugations
- (D) Prepares Cell Cultures on Growth Medium in Culture Plates
- (E) Transfers Cell Colonies to Production Medium and, After Approximately 30 Days, Removes Cells by Centrifugation
- (F) Separates Pharmaceutical From Production Medium Via Successive Processes (e.g., Liquid Chromatography, Dialysis, and Ultrafiltration)
- (G) Lyophilizes Pure Pharmaceutical and Stores

ATTRIBUTES OF A MANNED SPACE STATION

VGB708

- Schedule Compression — Reduced Cost and Risk
- Combines Best Features of Unmanned Free-Flyer and Sortie Mission, e.g.,
 - Onboard Step-by-Step Development Sequence
 - Less Automation
 - Reduced Cost — No Free-Flyer Support Subsystems, Fewer Shuttle Launches
 - Common Support Equipment
 - Unlimited Data Gathering — Test Conduct Time — Flexibility
 - Infrequent Event — Seasonal Coverage
- Flight Crew Capabilities —
Modifications/Repair/Replacement/Assembly
 - Visual Observations
 - Real-Time Sensor Adjustments
 - Analyzing Data
 - Pointing Control
 - Targets of Opportunity
 - Failure Diagnosis/Repair
 - EVA for Structural Assembly — Equipment Adjustments
 - Iterative Operations
 - Learning Curve Benefits
- Contribution of Man in Space is Historical Fact

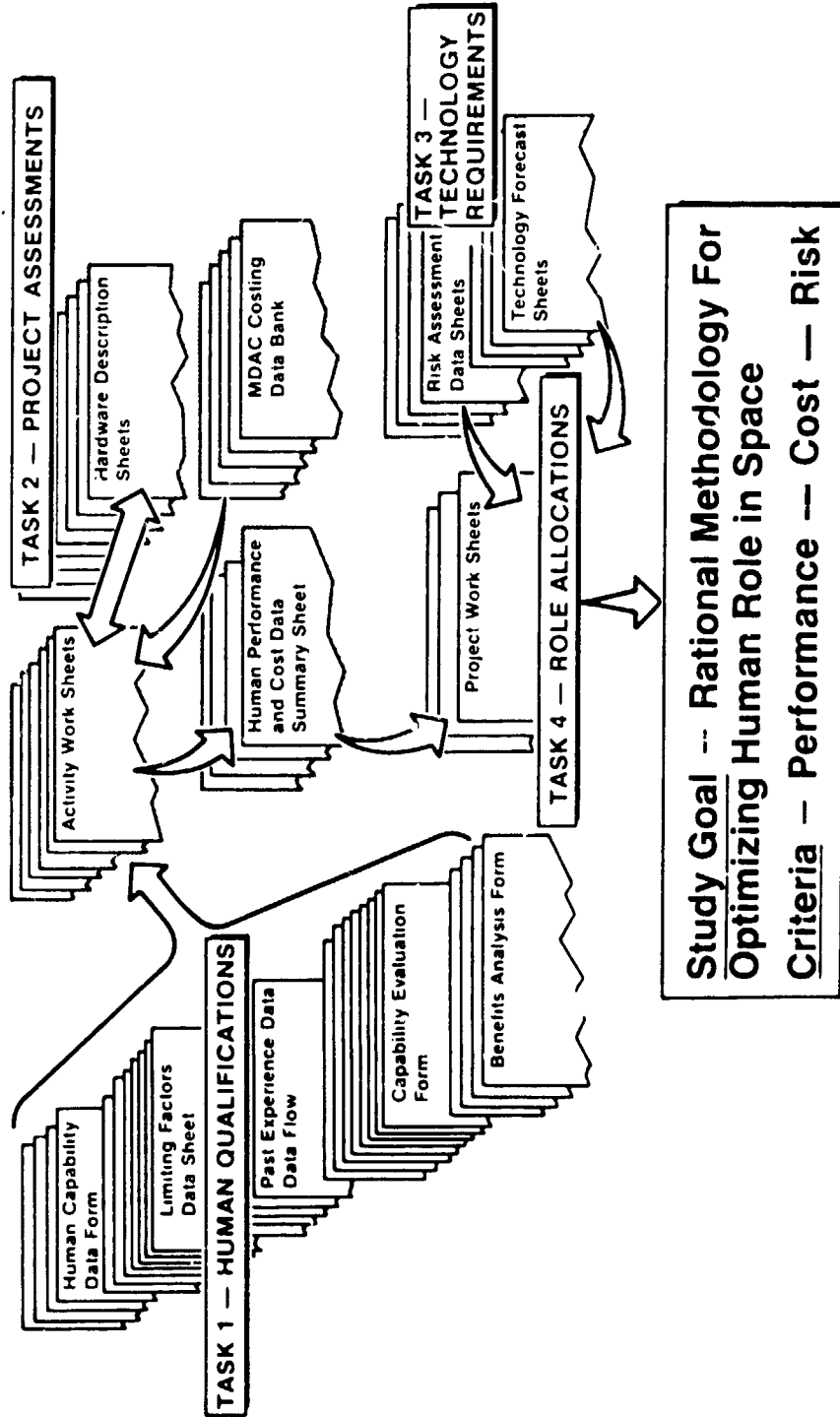
Man Responds Creatively as
Unanticipated Events or
Problems Arise



VGG338

STUDY METHODOLOGY

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THURIS STUDY SCHEDULE

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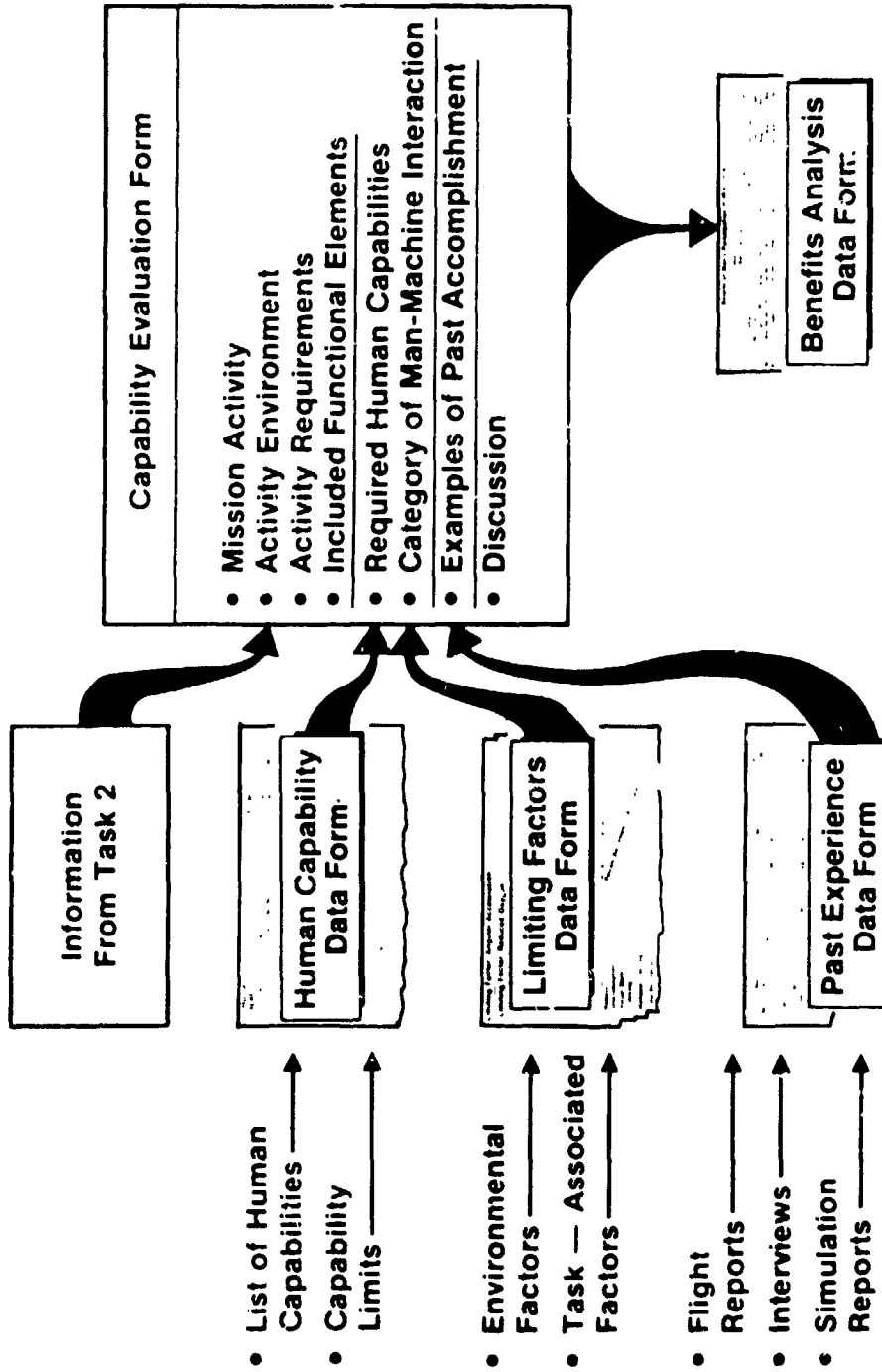
Study Tasks	Study Months												Total Man-Months	
	1	2	3	4	5	6	7	8	9	10	11	12		
1.0 Human Qualifications	1	1												2
2.0 Specific Project Assessments	2	2	2	2	2	2	2							14
2.1 Project Analysis														
2.2 Mission Time Lines														
2.3 Support Requirements														
2.4 Econometrics														
2.5 Evaluation														
3.0 Technology Requirements								2						2
4.0 Human Roles in Space									2					2
Study Documentation										2	1	1		4
Totals (Contract Funds)	3	3	2	2	2	2	2	2	2	2	1	1		24
Milestones														
ATP														
Midterm Briefing														
Final Briefing														
Final Reports														



TASK I — HUMAN QUALIFICATIONS FOR SPACE ACTIVITIES

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TYPICAL LIST OF BASIC HUMAN CAPABILITIES

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A. Sensory/Perceptual

- Visual acuity
- Detection and discrimination of brightness
- Color detection and discrimination
- Depth perception at close range
- Static depth perception at a distance
- Peripheral visual detection and discrimination
- Visual accommodation
- Detection and discrimination of tone
- Detection and discrimination of sound intensity
- Localization of sound
- Detection of tone duration
- Auditory detection and discrimination of motion
- Discrimination of tone patterns
- Detection of light touch
- Tactile recognition
- Discrimination of texture
- Detection and discrimination of force against limb
- Recognition of location of limb
- Detection and discrimination of movement of limb
- Detection and discrimination of angular acceleration
- Detection and discrimination of linear acceleration
- Detection and discrimination of vibration
- Detection of heat and cold
- Perception of pain
- Olfaction

B. Cognitive

- Decision-making
- Problem solving (invention)
- Association (long- and short-term memory)
- Deduction
- Induction
- Guided performance
- Learned procedure
- Perceptual set
- Reading
- Speaking
- Writing
- Speech perception
- Recording
- Time perception
- Assessment of volume of space
- Discrimination of complex pattern
- Complex visual generalization and discrimination

C. Psychomotor

- Arm/hand/finger control of force
- Arm/hand/finger control of speed of motion (including reaction time)
- Leg control of force
- Control of mass in motion (loop behavior)
- Damped tracking (visual)
- Visual-motor tracking

D. Motor

- Arm/hand/finger manipulation
- Body positioning



VGL395

HUMAN CAPABILITY

CATEGORY - SENSORY/PERCEPTUAL CAPABILITIES				
SENSORY MODALITY - VISION				
HUMAN CAPABILITY	DEFINITION	CHARACTERISTICS	LIMITING FACTORS	REFERENCES
BRIGHTNESS DETECTION AND DISCRIMINATION (CONT)	HUE DISCRIMINATION - THE ABILITY TO DETECT THE SMALLEST DIFFERENCE IN WAVELENGTH OF TWO TEST FIELDS BRIGHTNESS DISCRIMINATION - DEFINED ABOVE SATURATION DISCRIMINATION - THE ABILITY TO DETECT SMALL DIFFERENCES IN THE PERCENTAGE OF WHITE LIGHT IN TWO FIELDS OF IDENTICAL HUES	BLUE - 2.5 nm GREEN - 1.0 nm YELLOW - 3.3 nm ORANGE - 1.5 nm RED - 20.0 nm TOO DIFFICULT TO MEASURE FOR ACCURATE THRESHOLDS	- REGION OF RETINA STIMULATED - LEVEL OF ILLUMINATION ON TEST • COLOR OF LIGHT SOURCE • COLOR OF LIGHT REFLECTED FROM NEARBY SURFACES • LEVEL OF ILLUMINATION • SURFACE REFLECTIVITY CHARACTERISTICS	1, 6, 11, 15, 17
DEPTH PERCEPTION AND DISCRIMINATION	THE ESTIMATE OF THE DISTANCE OF AN OBJECT FROM THE OBSERVER, OR THE RELATIVE DISTANCE OF TWO OR MORE OBJECTS, OR THE DIFFERENCE IN PARALLAX CORRESPONDING TO THE MINIMUM DISTANCE TWO OBJECTS CAN BE DISPLACED ALONG THE LINE OF SIGHT AND STILL BE RECOGNIZED AS BEING AT DIFFERENT DISTANCES	JUDGMENT OF ABSOLUTE DISTANCE IS VERY INACCURATE JUDGMENT OF RELATIVE DISTANCE IS VERY ACCURATE ANGULAR DIFFERENCES AS SMALL AS 2 sec OF PARALLAX CAN BE DETECTED EFFECTIVE USE OF UNAIDED STEREOPSIS (BINOCULAR DISPARITY) IN DEPTH PERCEPTION LIMITED TO A DISTANCE OF 15 TO 20 ft. BEYOND 20 ft. JUDGMENT OF DEPTH OR DISTANCE IS PRIMARILY DEPENDENT ON MONOCULAR CUES	• DISTANCE OF OBJECTS FROM THE EYE • ABSENCE OF OBJECTS OF KNOWN SIZE FOR COMPARISON • ATMOSPHERIC CONDITIONS • ILLUMINATION INTENSITY • STIMULUS SIZE • MONOCULAR VERSUS BINOCULAR CUES	6, 13, 17, 18

LIMITING FACTORS

VG-0023

Stress Factor: Space Adaptation Syndrome (Exposure to Weightlessness)							
Human Capabilities Impacted	Duration of Exposure						
	Less Than 3 Hours	3-12 Hours	12-24 Hours	24-48 Hours	48-72 Hours	72-96 Hours	More Than 96 Hours
Threat to Life or Consciousness	None	None	None	Neg	Neg	Neg	None
Visual Acuity	None	Mod	Neg	Neg	Neg	None	None
Depth Perception	None	Mod	Neg	Neg	Neg	None	None
Visual Accommodation	None	Mod	Mod	Neg	Neg	None	None
Tactual Discrimination	None	Mod	Mod	Neg	Neg	None	None
Discrimination of Angular Acceleration	Neg	Mod	Sig	Sig	Sig	Sig	Sig
Cognition	None	Sig	Sig	Mod	Neg	Neg	None
Memory	None	Neg	Neg	None	None	None	None
Evaluation	None	Mod	Sig	Mod	Neg	None	None
Arm/Hand/Finger/Control of Force and Speed of Motion	Mod	Sig	Sig	Sig	Mod	Neg	None
Visual-Motor Tracking	Mod	Sig	Sig	Mod	Neg	Neg	None
Arm/Hand/Finger Manipulation	None	Sig	Sig	Mod	Mod	Neg	None
Body Positioning	Mod	Sig	Sig	Mod	Mod	Neg	None

Impact Code (Decrease in Observed Capability)
None (None)
Negligible (Neg)
Moderate (Mod)
Significant (Sig)



MANNED SPACEFLIGHT EXPERIENCE

VGL398

MISSION ACTIVITY	GENERIC ACTIVITIES INCLUDED	COMMENTS	DOCUMENT
<ul style="list-style-type: none"> • OVERRIDE CONTROL ACTIVATED TO OPEN SHUTTER ON STAR TRACKER 	<ul style="list-style-type: none"> • IDENTIFY ABNORMALITIES • ANALYZE DATA • DEFINE PROCEDURES/SCHEDULES • IMPLEMENT PROCEDURES/SCHEDULES • MEDIATIONAL PROCESSING 	<ul style="list-style-type: none"> • STAR TRACKER SHUTTERS NOT CYCLING OPEN AND CLOSED AS EXPECTED • CREW ANALYZED PROBLEM, SHUTTER NOT RESPONDING TO AUTO CONTROL • MANUAL OVERRIDE OF SHUTTER BY CREW SOLVED PROBLEM 	<p>STS-1 ORBITER MISSION REPORT JSC 17378 AUGUST 1981</p>
<ul style="list-style-type: none"> • RESET OPEN RMS TV CIRCUIT BREAKER 	<ul style="list-style-type: none"> • ACTIVATE/INITIATE SYSTEM OPERATION • OPERATE SYSTEM • INSPECT/OBSERVE • CONNECT ELECTRICAL INTERFACE • INSPECT/OBSERVE • ANALYZE DATA 	<ul style="list-style-type: none"> • DURING DAY 2 RMS OPERATIONS, THE RMS WRIST/ELBOW TV CAMERA CIRCUIT BREAKER OPENED • CREW RESET BREAKER • RESETTING BREAKER DID NOT SOLVE PROBLEM • TROUBLESHOOTING ISOLATED PROBLEM TO EXCESSIVE CURRENT DRAW BY ELBOW TV CAMERA 	<p>STS-2 ORBITER MISSION REPORT JSC 17959 FEBRUARY 1982</p>
<ul style="list-style-type: none"> • METRIC CAMERA (GERMAN EXPERIMENT) FAILED ON STS-9/SL-2 • SECOND CASSETTE JAMMED ON 25TH FRAME OF 400 • DATA LINK BETWEEN JSC, CAMERA FIRM IN GERMANY, AND FLIGHT CREW SET UP • JSC GROUND CREW DEvised, FIXED AND WALKED FLIGHT CREW THROUGH PROCEDURES TO REPAIR JAM • CAMERA PUT BACK ON LINE BY FLIGHT CREW 	<ul style="list-style-type: none"> • IDENTIFY ABNORMALITIES • DEACTIVATE/TERMINATE SYSTEM OPERATION • RELEASE LATCH • REMOVE/OPEN COVERING • INSPECT/OBSERVE • COMMUNICATE INFORMATION • CORRELATE DATA • GATHER TOOLS/EQUIPMENT • RESOLVE ABNORMALITIES • REPLACE/CLOSE COVERING • CLOSE LATCH • ACTIVATE/INITIATE SYSTEM OPERATION • REPLACE TOOLS/EQUIPMENT 	<ul style="list-style-type: none"> • STS-9/SL-1 • METRIC CAMERA (GERMAN) SECOND FILM CASSETTE JAMMED • JSC GROUND LINKED TO ZEISS CAMERA IN GERMANY AND TO STS-9/SL-1 CREW • REPAIR PROCEDURES WORKED OUT IN REAL TIME AT JSC • RELAYED TO CREW TO EFFECT REPAIR 	<p>AVIATION WEEK AND SPACE TECHNOLOGY DECEMBER 19, 1983</p>
<ul style="list-style-type: none"> • SOYUZ 23 (OCT. 1976) AUTOMATIC DOCKING FRUSTRATED • SOYUZ 23 (FEB 1977) MANUAL DOCKING ACHIEVED 	<ul style="list-style-type: none"> • ADJUST/ALIGN ELEMENTS • CONFIRM/VERIFY PROCEDURES/SCHEDULES • CORRELATE DATA • DETECT CHANGE IN STATE OR CONDITION • TRACKING (CONTINUOUS ADJUSTMENT) • INSPECT/OBSERVE 	<ul style="list-style-type: none"> • SOYUZ 24 DOCKED MANUALLY WITH SALLYUT 5 • SOYUZ 23 WAS "FRUSTRATED" (FAILED) WITH ITS AUTOMATIC DOCKING SYSTEM IN EARLIER ATTEMPT 	<p>SPACEFLIGHT VOL 19, NO. 5 MAY 1977</p>



BENEFIT OF MAN'S PARTICIPATION IN MISSION ACTIVITIES

VGL577 1

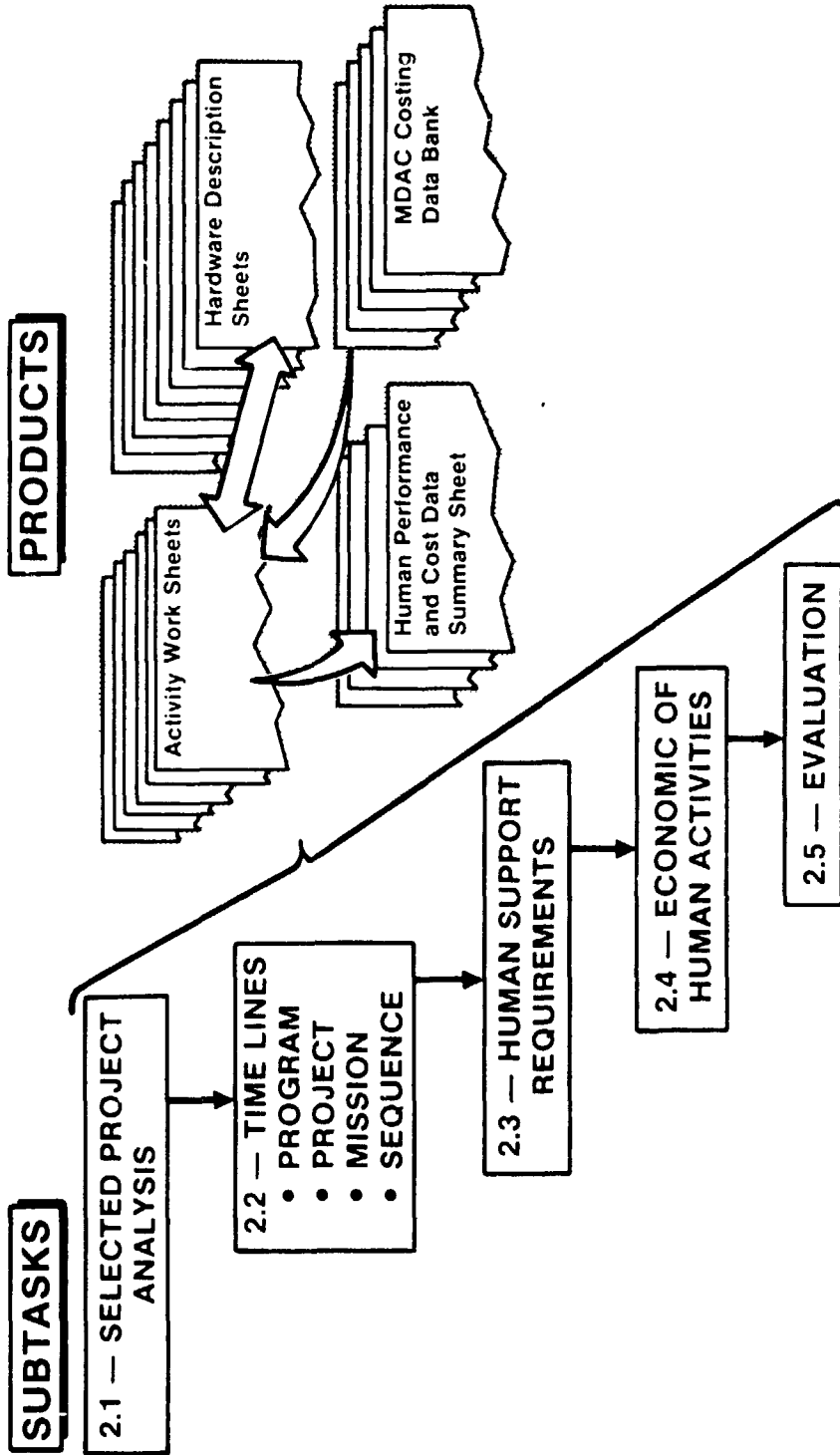
Life Science Mission Activities	Recommended Man/Machine Category	Evaluation of the Benefit of Man's Participation			Assessment of Onboard Participation	Skill Type and Level Required for Man's Participation	Reasons for Conclusions Regarding Benefits of Man's Participation
		Equipment Can Be Eliminated	Performance of Activity Is Improved	Probability of Mission Success is Improved			
Monitor Rat Colony	Supported	●	●	●	Beneficial	Biological Technician	Man Onboard Can Treat Sickness and Remedy Malfunctions
Replenish Supplies	Manual	●	—	●	Beneficial	Minimal Training	Equipment Mass and Volume Significantly Increased by Automation
Remove and Process Urine Samples	Supported	●	—	●	Beneficial	Biological Technician	Increase in Equipment Mass and Complexity If Samples Automatically Processed
Measure Mass of Rat	Augmented	●	●	●	Essential	Minimal Training	Extremely Difficult to Design Intra-Habitat Mass Measurement System
Acquire, Process, and Store Rat Blood Samples	Augmented	—	●	●	Essential	Biological Technician	No Feasible Method Is Available for Blood Sample Acquisition Without Man
Sacrifice Rats and Acquire Tissue Samples	Supported	—	●	●	Essential	Skilled Scientist/Technician	Exposure of Rats in Habitats to Lethal Chemical Preservative Not Realistic Alternative



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TASK 2 — SPECIFIC PROJECT ASSESSMENT

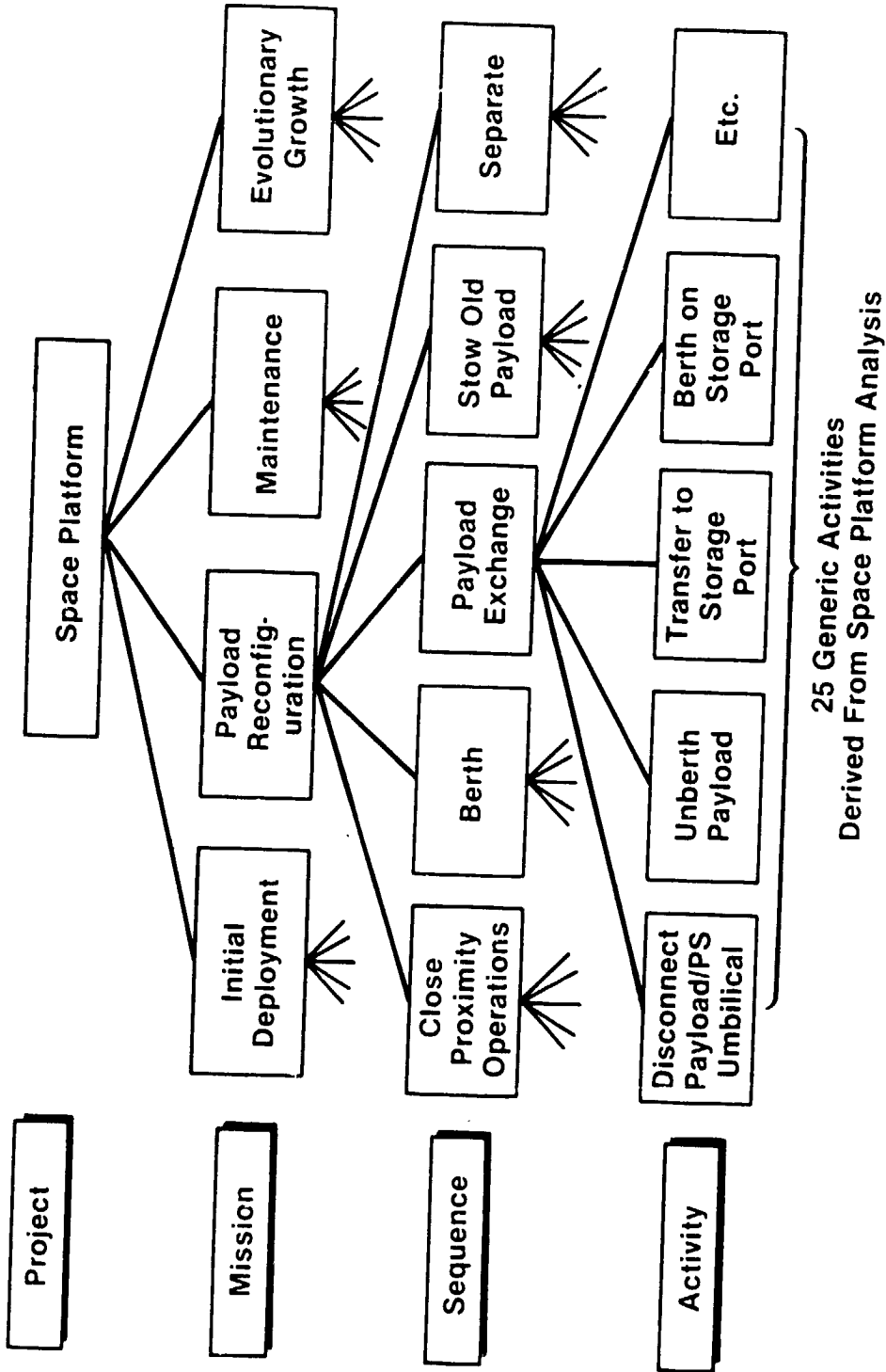
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SPACE PLATFORM PROJECT ANALYSIS

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GENERIC SPACE ACTIVITIES

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1. Activate/Initiate System Operation
2. Adjust/Align Elements
3. Allocate/Assign/Distribute
4. Analyze/Compute Data
5. Apply Biomedical Sensor
6. Communicate Information
7. Confirm/Verify
Procedures/Schedules/Operations
8. Connect/Disconnect Electrical Interface
9. Connect/Disconnect Fluid Interface
10. Correlate Data
11. Deactivate/Terminate System Operation
12. Decode Data
13. Define
Procedures/Schedules/Operations
14. Deploy Appendage
15. Detect Change in State or Condition
16. Display Data
17. Encode Data
18. Extract Data
19. Gather Tools/Equipment
20. Handle/Inspect/Examine Living Organisms
21. Identify Abnormalities
22. Implement Procedures/Schedules
23. Inspect/Observe
24. Measure (Scale) Physical Dimensions
25. Mediatlional Processing
26. Perform Fine Motor Manipulations
27. Plot Data
28. Position Module
29. Release/Secure Mechanical Interface
30. Remove/Open Covering
31. Remove Biomedical Sensor
32. Remove Module
33. Replace/Close Covering
34. Replace/Clean Surface Coatings
35. Replace Tools/Equipment
36. Replenish Materials
37. Retract Appendage
38. Store/Record Data
39. Tracking (Continuous Adjustment)
40. Transport Loaded
41. Transport Unloaded

VGL919

GENERIC SPACE ACTIVITIES (CONT)

Activities	Source					
	AXAF	(1) Skylab	(2) Space Platform	Space Station	(3) Arms Study (MIT)	Life Sciences Laboratory
1. Activate/Initiate System Ops	•	•	•	•	•	•
2. Adjust/Align Elements		•		•	•	•
3. Allocate/Assign/Distribute		•	•	•	•	•
4. Analyze/Compute Data		•	•	•	•	•
5. Apply Biomedical Sensor		•	•	•	•	•
6. Communicate Information	•	•	•	•	•	•
7. Confirm/Verify Proced/Sched/Ops		•	•	•	•	•
8. Connect/Disconnect Elec Interface		•	•	•	•	•
9. Connect/Disconnect Fluid Interface		•	•	•	•	•
10. Correlate Data		•	•	•	•	•
11. Deactivate/Terminate Sys Ops	•	•	•	•	•	•
12. Decode Data			•	•	•	•
13. Define Proced/Sched/Ops		•	•	•	•	•
14. Deploy Appendage	•	•	•	•	•	•
15. Detect Change in State or Cond		•	•	•	•	•
16. Display Data		•	•	•	•	•
17. Encode Data			•	•	•	•
18. Extract Data			•	•	•	•
19. Gather Tools/Equipment	•	•	•	•	•	•
20. Handle/Inspect/Examine			•	•	•	•
21. Identify Abnormalities		•	•	•	•	•

(1) Includes EREP and ATM Activities
 (2) Includes Activities Derived From the Analysis of Space Platform GroundSystem Data Management Study
 (3) Includes 330 Generic Functional Elements Derived From the Geosynchronous Platform, Advanced X-Ray Astrophysics Facility, Telescope Operator Maneuvering System and Space Station

GENERIC SPACE ACTIVITIES

VGL918

Activities	Source					
	AXAF	(1) Skylab	(2) Space Platform	Space Station	(3) Arms Study (MIT)	Life Sciences Laboratory
22. Implement Proeced/Sched		•	•	•	•	•
23. Inspect/Observe		•	•	•	•	•
24. Measure (Scale)		•			•	
25. Mediatlonaal Processing		•		•		•
26. Perform Fine Motor Manip		•		•		•
27. Plot Data		•	•	•		•
28. Position Module	•	•	•	•	•	•
29. Release/Secure Mech Interface	•	•	•	•	•	•
30. Remove/Open Covering		•	•	•	•	•
31. Remove Biomedical Sensor		•		•	•	•
32. Remove Module	•	•	•	•	•	•
33. Replace/Close Covering		•	•	•	•	•
34. Replace/Clean Surf. Coat.	•		•			•
35. Replace Tools/Equipment	•	•	•	•	•	•
36. Replenish Materials	•	•	•	•	•	•
37. Retract Appendage	•	•	•	•	•	
38. Store/Record Data		•	•	•	•	•
39. Tracking (Cont Adjust.)				•	•	•
40. Transport Loaded	•	•	•	•	•	•
41. Transport Unloaded	•	•	•	•	•	•

- (1) Includes EREP and ATM Activities
- (2) Includes Activities Derived From the Analysis of Space Platform GroundSystem Data Management Study
- (3) Includes 330 Generic Functional Elements Derived From the Geosynchronous Platform, Advanced X-Ray Astrophysics Facility, Telescope Operator Maneuvering System and Space Station



CATEGORIES OF MAN-MACHINE INTERACTION

VGL403

MANUAL	Unaided IVA/EVA, With Simple (Unpowered) Hand Tools
SUPPORTED	Requires use of Supporting Machinery or Facilities to Accomplish Assigned Tasks (e.g., Manned Maneuvering Units and Foot Restraint Devices)
AUGMENTED	Amplification of Human Sensory-Motor Capabilities (Powered Tools, Exo-Skeletons, etc)
TELEOPERATED	Use of Remotely Controlled Sensors and Actuators Allowing the Human Presence to Be Removed From the Work Site (Remote Manipulator Systems, Teleoperators, Telefactors)
SUPERVISED	Replacement of Direct Manual Control of System Operation With Computer Directed Functions Although Maintaining Humans in Supervisory Control From <u>Ground-Based or Orbital Based</u> Work Stations
INDEPENDENT	Basically Independent Self Actuating, Self-Healing Operations but Requiring Human Intervention Occasionally (Automation and Artificial Intelligence)

DEPLOY APPENDAGE

Man-Machine Categories	TIME SCALE		Crew Req	Skill Level*	Prob of Success	Freq per Mission
	Seconds	Minutes				
Manual	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1-2	Norm	99%	2
Supported	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1-2	Norm	99%	2
Augmented	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1-2	Norm	95%	2
Teleoperated	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	—	—	—	—
Supervised Ground	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1	Norm	95%	5
Supervised On-Orbit	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1	Norm	95%	5
Independent	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80	10 20 30 40 50 60 70 80	1	Norm	95%	4

* Skill Level

Normal Skills (Norm) — Task Falls Within the Realm of Standard Training/Basic Knowledge

Specialized Skills (Spec) — Task Requires Special Training or Specific Knowledge of the Activity



REFERENCE SOURCES

- ① McDonnell Douglas Astronautics Company, Alternative System Design Concept Study (Space Platform/Power System), Contract NAS8-33955, DR Numbers 1-16, July, 1982
- ② Space Platform Ground System Study — Final Report, 7/21/82, Ford Aerospace and Communications Corporation. (Subcontract to MDAC Under NAS8-33955)
- ③ Space Station Program Description Document — Book Number 6, Appendix B, Operations Studies, Second Level White Pages, 8/83, Space Station Operations Working Group, NASA-KSC
- ⑦ Space Maintenance and Contingency Operations Simulation Neutral Buoyancy Testing (NB-51) — Final Report, MDC H0190, MDAC-HB, 5/83
- ⑧ McDonnell Douglas Astronautics Company Engineering Estimate
- ⑨ National Aeronautics and Space Administration, Johnson Space Center, Mission Planning and Analysis Division, The 25-Kilowatt Power System — Baseline Reference Mission, JSC 17066, February 1981



COST FACTOR ASSIGNMENT TO MAN-MACHINE INTERACTION CATEGORIES

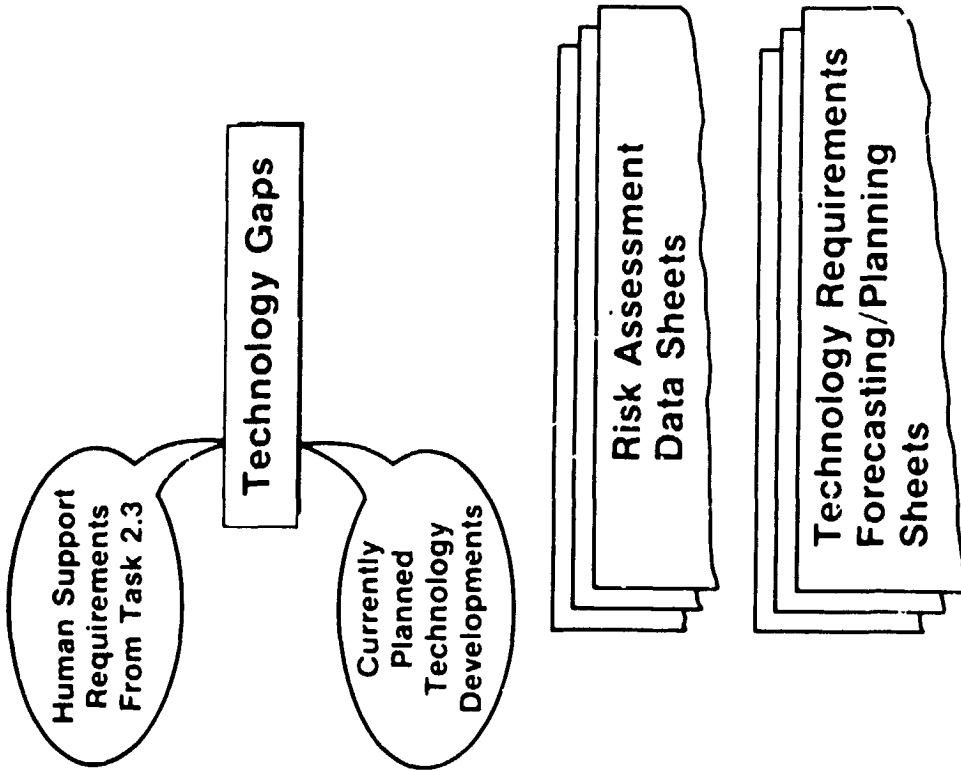
VGL401

Cost Factors	Categories of Man-Machine Interaction					
	Manual	Supported	Augmented	Teleoperated	Supervised	Independent
1. Prorated Facility Costs	•	•	•	•	•	•
2. Prorated Transp Costs	•	•	•	•	•	•
3. Orbital Supt Equip Costs	•	•	•	•	•	•
4. Automated Equip Costs				•	•	•
5. Gnd Supt Equip Costs				•	•	•
6. Gnd Supt Operations				•	•	•
7. Training Requirements	•	•	•	•	•	•
8. Software Support Costs			•	•	•	•
9. Crew Rotation Rates	•	•	•	•	•	•
10. Duty Cycles	•	•	•	•	•	•
11. Operation Times	•	•	•	•	•	•
12. Logistics Requirements	•	•	•	•	•	•
13. Emergency Provisioning	•	•	•	•	•	•
14. Hazardous Ovs Provisioning	•	•	•	•	•	•



VG363

TASK 3 — TECHNOLOGY REQUIREMENTS



- Technology Gaps

- Technology Risk Assessment

- Technology Plan



TASK 4 — ROLE ALLOCATIONS

VGG339

Generic Activity	Failure Effect*	Categories of Man-Machine Interactions																				
		Manual			Supported			Augmented			Tele-operated			Supervised			Independent					
		\$	T	C	\$	T	C	\$	T	C	\$	T	C	\$	T	C	\$	T	C			
A — Deploy Appendage	1																					
B — Position Module	2																					
C — Connect Electrical Interface	1																					

3-174

- *Failure Effect Rating
- 1 = Mission Loss
 - 2 = Minimal Data Return
 - 3 = Significant Data Return
 - 4 = Minor Effect



Select Lowest Expected Cost Path

- Compute $(\$)(T)/(C)$
- Test: $T \leq T_{max}$, $C \geq C_{min}$

- \$ — Cost Per Unit of Time (From Task 2)
- T — Estimated Time For Activity (From Task 2)
- C — Confidence of Estimate (Risk) — (From Task 3)

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VGL394

STUDY ACCOMPLISHMENTS TO DATE

106 Reference Documents Reviewed to Date

Task 1 — Completed

- Documentation of Human Capabilities/Limitations
- Historical Precedents and Operational Experiences

Task 2 — In Process

- Six Space Project Areas Reviewed
- Generic List of 41 Basic Activities Developed
- Timeline Profiles and Mission Impact Factors Established for 20 of 41 Activities
- Preliminary Listing of Human Support Equipment Completed
- Early Start on Economic Assessment of Human Activities in Space
- Fourteen Factors Impacting Costs Identified
- Philosophy for Allocating Costs Established

Tasks 3 and 4 — No Work Scheduled as yet per Study Plan

THURSDAY

		Page
Overview	M. Cohen	4-1 to 4-27
A Preliminary Human Factors Planning and Design Outline of Parameters Related to Space Station Windows and CCTV Monitoring	R. Haines	4-28 to 4-40
View graphs re SS Windows	R. Haines	4-41 to 4-59
Johnson Space Center Configurations	J. Lewis	4-60 to 4-72
Man Machine Trade-Off Study	A. Feinberg	4-73 to 4-82
Some Ideas and Questions Regarding Space Station Design	S. S. Kolnick	4-83 to 4-91
Underseas Habitat Design	T. Taylor and J. Spencer	4-92 to 4-107
Considerations for SS Interior Architecture	B. Griffin	4-108 to 4-170
ECLSS Module Concept	C. Poythress	4-171 to 4-184
Habitability Sleep Accommodations	H. Fisher	4-186 to 4-197
Design of Confined Environments	M. Kalil	4-198
Customer and Mission Influences on Space Station Architecture	F. Runge	4-199 to 4-215