RY 23/002 58-14
39610
P-21

Rockwell-Downey Mission Support Room (MSR) and Data Display & Review (DDR) Room Upgrade

Ground Support System Methodology

and Architecture

for Control Center Conference
University of Houston, Clear Lake
June 18, 1991

P. D. Schoen

Rockwell International SSD Downey
Aerospace Simulation and Systems Test Center
(213) 922-2534

Rockwell International
Space Systems Division

RI-SSD

6/14/91

P. D. Schoen

1

Synergistic Approach to Systems Test and Support

P. D. Schoen

2

Rockwell International
Space Systems Division
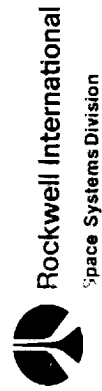
Building Block Architecture Provides Transportability of Data, Procedures and Knowledge

DATA

OPERATIONAL SUPPORT SYSTEM

LRU/SRU DEPOT

PRODUCTION TEST SYSTEM

TEST DATA
TEST PROCEDURES
TEST REPEATABILITY
FAILURE REPLICATION

OPERATIONAL ENVIRONMENT

DEVELOPMENT ENVIRONMENT

INTEGRATION LABORATORY

MANUFACTURER'S SUPPORT EQUIPMENT

REQUIREMENTS
LOGISTICS & ENGINEERING

SYSTEM LEVEL TESTER

Rockwell International
Space Systems Division
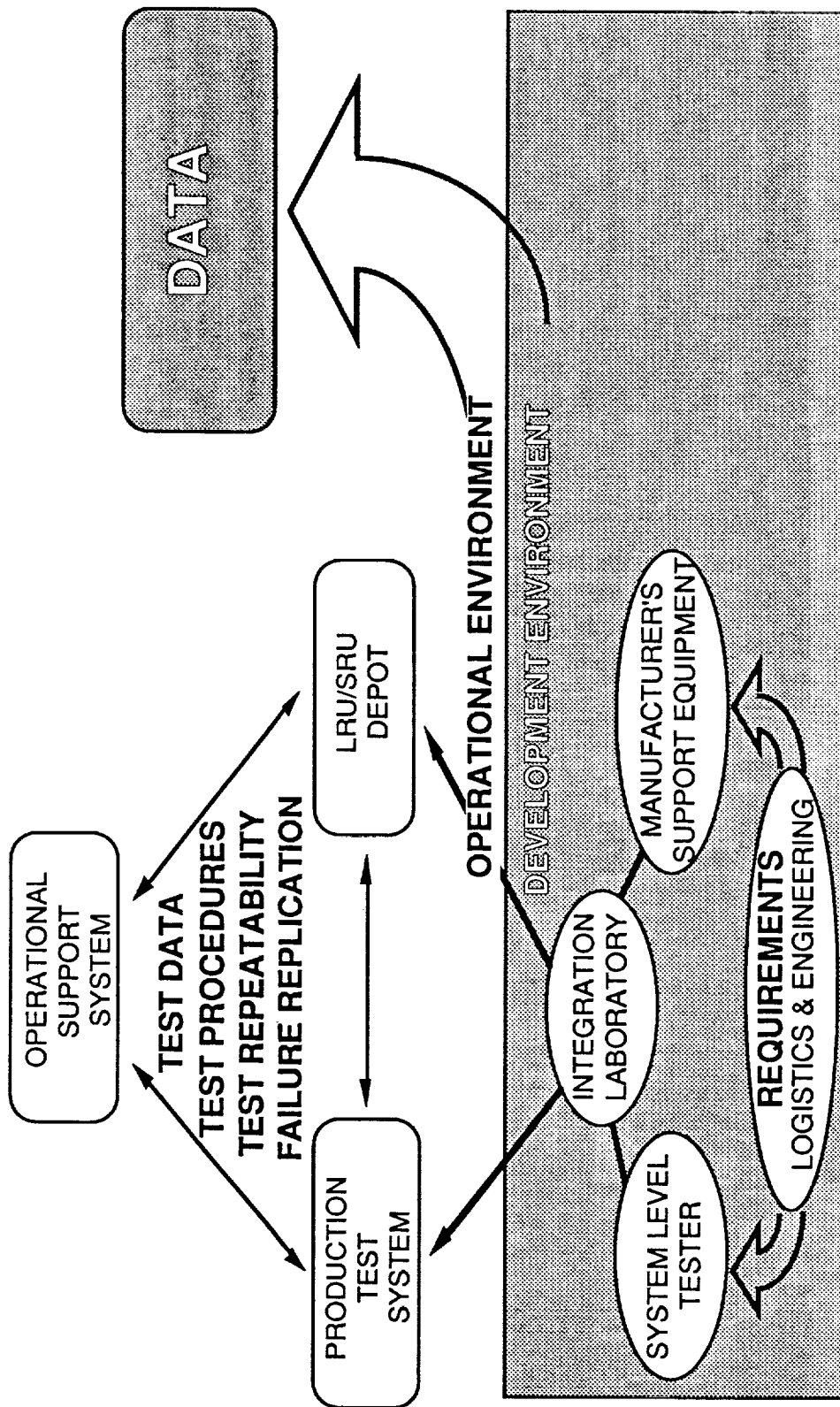
Synergistic Approach Lowers Cost and Risk for Life Cycle of a Program

Life Cycle Elements

OPERATIONS
- Ground
- In-Flight
- Post Flight

MANUFACTURING & SYSTEMS INTEGRATION

BREADBOARD BRASSBOARD

DESIGN

REQUIREMENTS DEFINITION

MISSION MONITOR

MISSION CONTROL

SYSTEM INTEGRATOR

COMPONENT TESTER

SIMULATION DATA REDUCTION

DATA DISPLAY POST-PROCESSING QUICK-LOOK REAL-TIME

MANUAL INTERACTION

APPLICATIONS EXECUTION

RANGE

UPLINK

TELEMETRY

RE-TRANSMISSION

Determination of Design Errors at the Earliest Phase Reduces Cost of Vehicle Ownership

P. D. Schoen

4

Rockwell International
Space Systems Division

RI-SSD

6/15/91

284 C-4

Distributed Scaleable Architecture is Based on Industry Standards Maximizing Transparency and Maintainability

⇧ Data Base Driven

⇧ Commercial Off-the-Shelf Hardware and Software

⇧ Integrated Vehicle and Launch Architecture Synergism

⇧ Distributed, Remote Processing

⇧ Compatible with Emerging Government and Industry Systems

⇧ Distributed, Networked and Real-Time Systems

⇧ Expert Systems Applications to Real-Time and Ground Systems

Rockwell International
Space Systems Division

P. D. Schoen

RI-SSD

6/14/91

5

285

Autonomous Control Structure Provides for Distributed and Segmented Systems

User I/F

Sub Server N

Sub Server 0

User I/F

User I/F

Sub Server 1

User I/F

Data/ Info Server # N

Master Server

Data/ Info Server # 1

INFORMATION & CONTROL BUS

SUB SYSTEM DATA BUS

FRONT END

FEP Function Boards

FEP

FEP Function Boards

FEP Function Boards

Data Source 1

Data Source 2

Data Source 3

FEP Front End Processor

System is Completely Core Compatible

P. D. Schoen

6

Rockwell International
Space Systems Division

RI-SSD

6/14/91

286

Control of Interfaces Maximizes Compatibility and Re-Use Reducing Long-Term Program Cost

Data
Content & Architecture

Test Bed

UUT

Interface Test Adapter

Hardware Interface

CPU
Non-Specific

Simulators

Operations Environment (System Language)

User

Controlled Interfaces

System Allows for Use of Multiple Vendor Hardware Platforms

P. D. Schoen

7
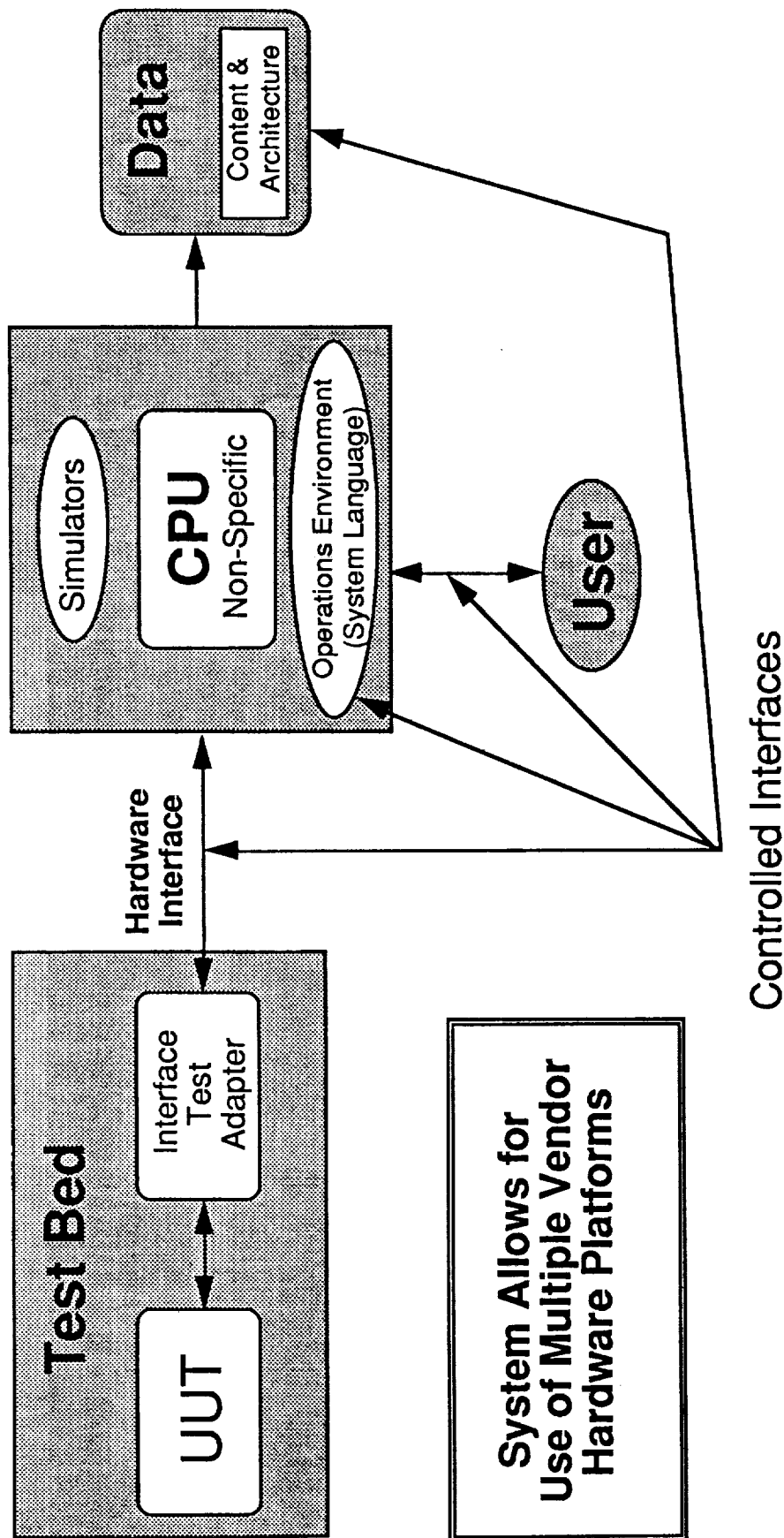
Intelligent Data Management Architecture Reduces Analysis Time and Cost (Automation)

Ground Data Processing
- Data Stream
- Raw Data

Data Acquisition Processing
- Data Acquisition
  - Real-Time Data Monitor
  - Real-Time Data Collector
- Data Supplier
- Data Reduction

Graphics Processing
- Plots & Tables

Automated Data Mgmt
- Acquisition & Reduction Control
- DBMS

Expert System
- Performance Assessment
- Multi-Level Trend Analysis

- Control
- Data
- Report Generation
- User
- Document

Archival Data System

Data
- Manufacturing
- Integration
- Test Operations
- Operational Support
- Simulation

P. D. Schoen

8

Rockwell International
Space Systems Division

RI-SSD

6/14/91

288

RI-ASSTC is Putting the System Architecture to Action

NLS

SSTO

AF/EWTS

CEE Team

LSA

RAAF F-111

X-31 Pilots Associate

FUTURE BUSINESS

SIM
- SABIR Phase 0
- Shuttle
- GPS User Eq.

SPACE BASED INTERCEPTOR (SABIR)
- HSV/MSE
- GUNSHIP
- X-31
- GTS
- SDI

FACTORY
- B1-B

GROUND
- Automated Factory

OPERATIONS
- DDR/MSR
- B1-B

SYSTEMS
- DDR/MSR
- GUNSHIP
- X-31
- ASDC

PAYLOADS
- PRIS
- CAS
- PITS

- GTS
- CAS II

Advanced Avionics Test System (AATS)

I R & D

Advanced Integrated Test System (AITS)

P. D. Schoen

9
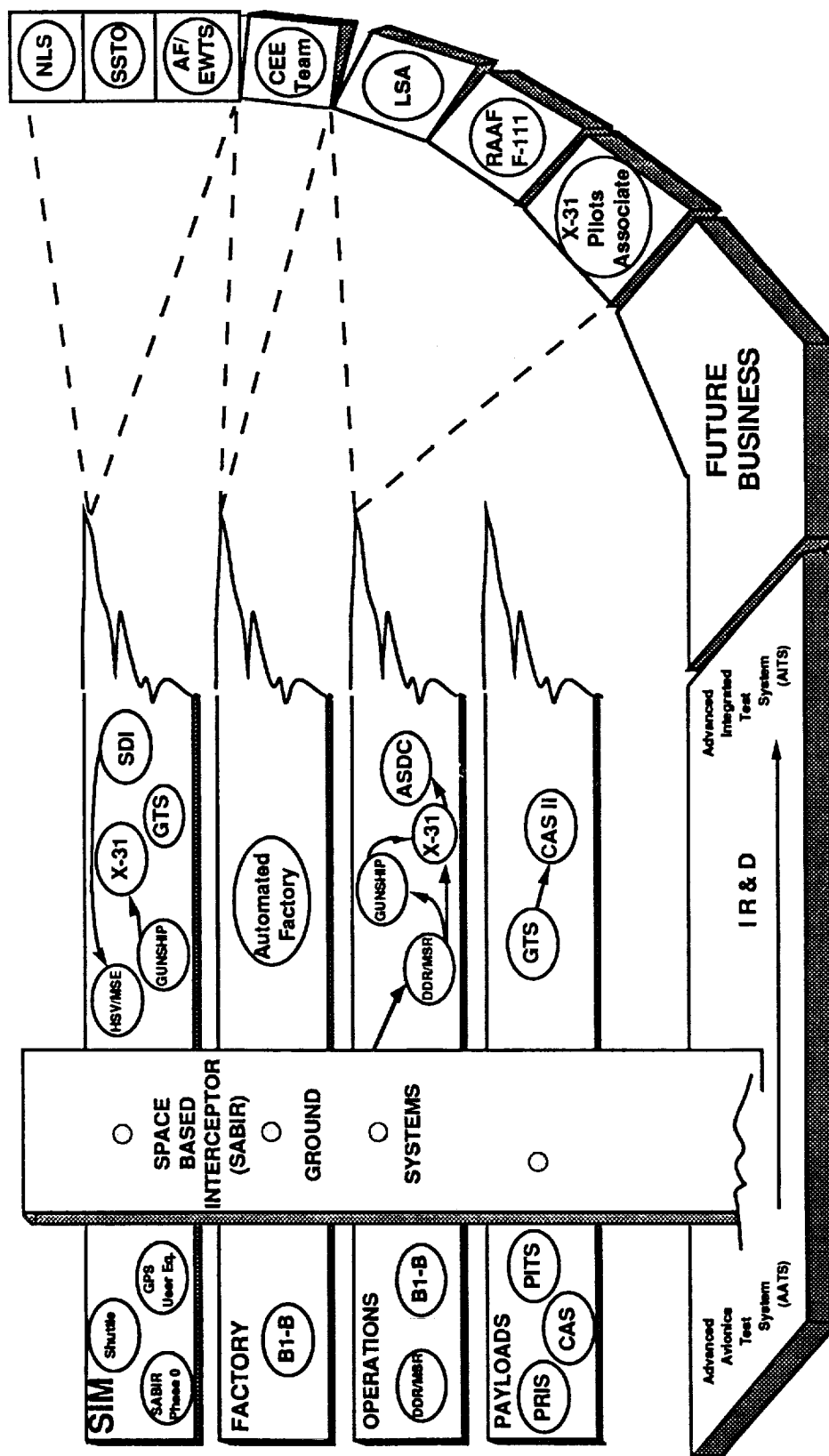
RI-SSD

6/14/91

289

Shuttle Mission Support Room (MSR)
Data Display and Review (DDR) Room
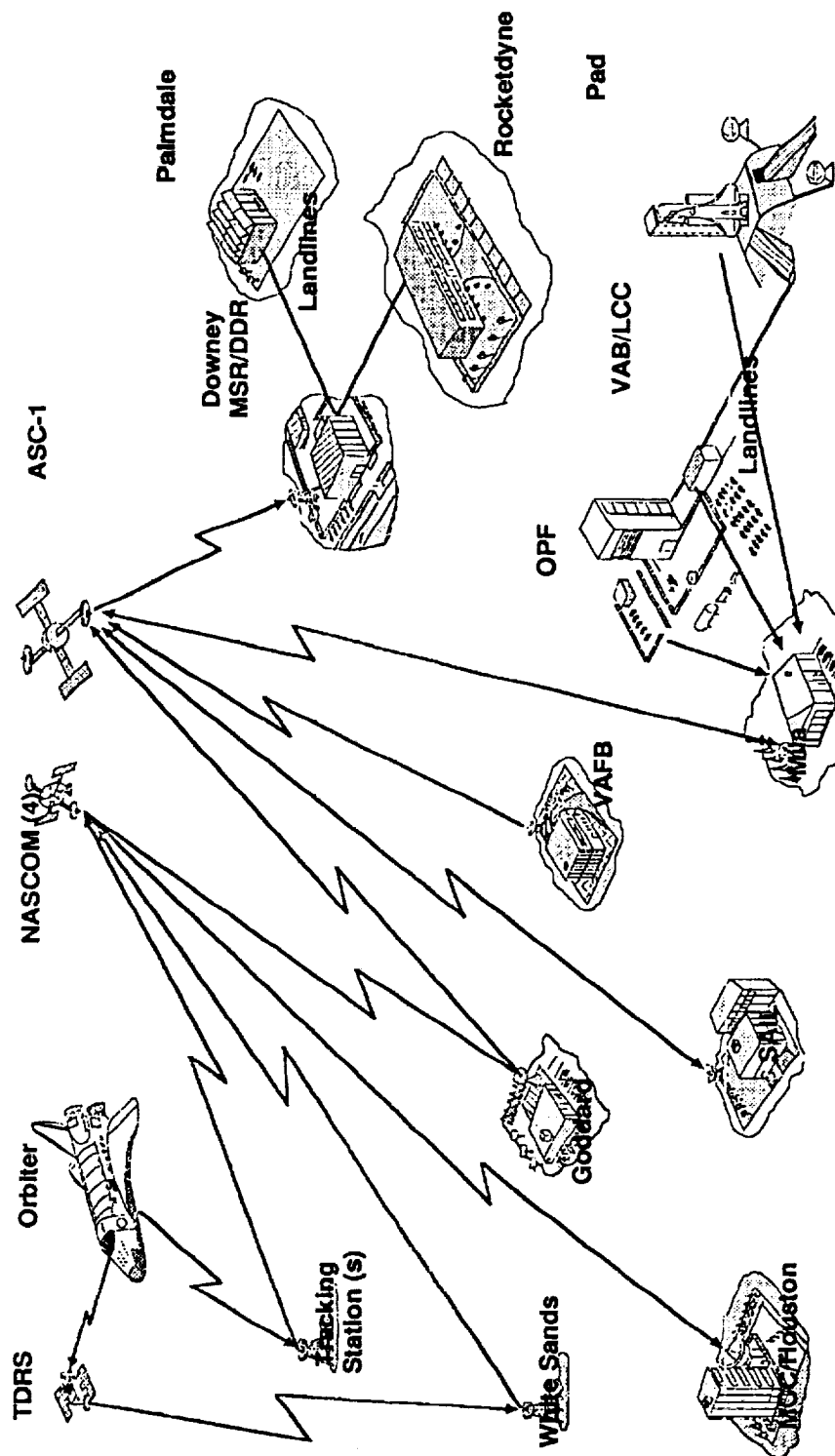
Rockwell International
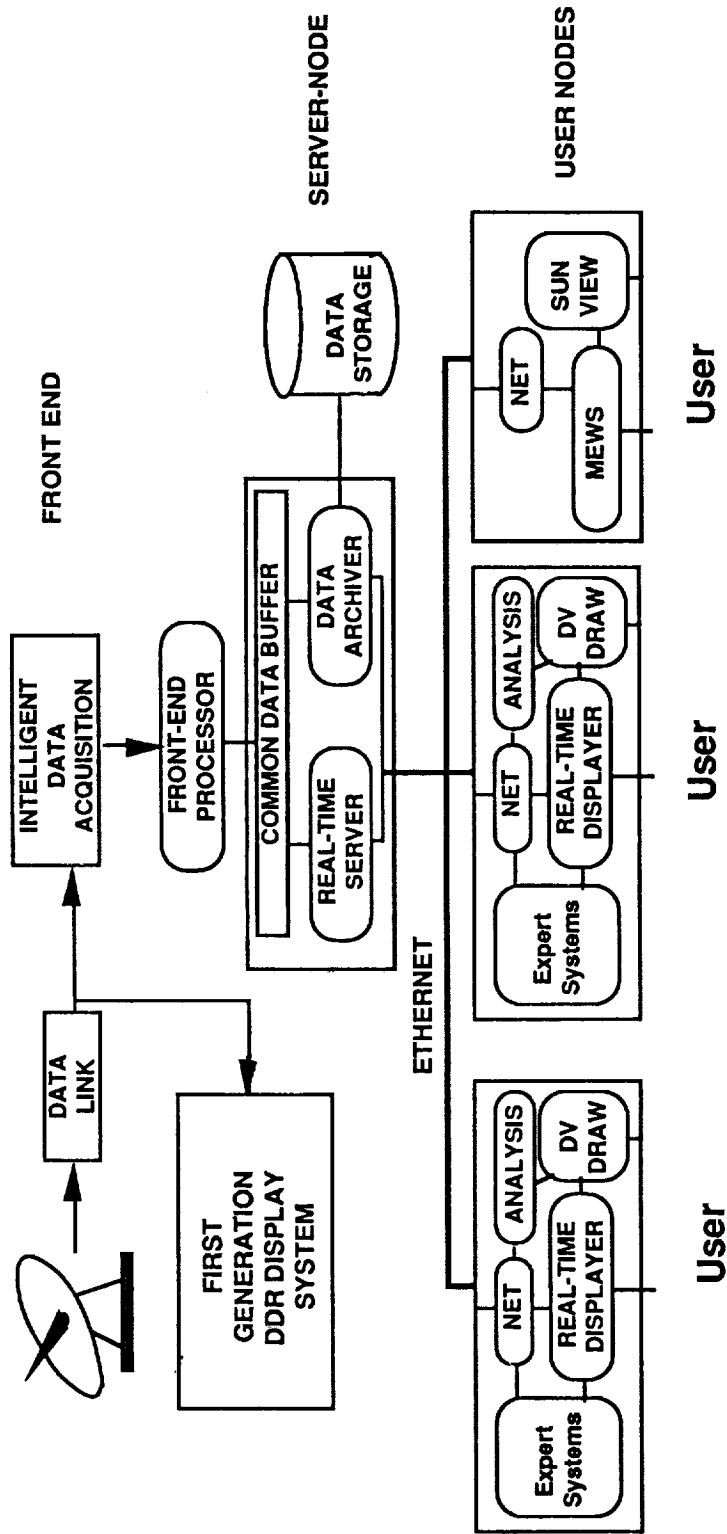Space Systems Division

P. D. Schoen

10

MSR and DDR Applying Systems Concepts To Shuttle Support

○ **Member of Emergency Mission Control Center (EMCC)**
  - MILA Data Link Independent from JSC

○ **Real-Time Monitoring of the Vehicle During Mission & Pre/Post-Launch**
  - Provides Subsystem Engineers Visibility on Vehicle Performance
  - Processing of Two Vehicles Simultaneously
  - Real-time Data Processing and Displays
  - Post Processing

○ **Currently Upgrading Workstation Architecture**
  - Architecture has Front End Processor, Server, and User Workstations
  - Rehost of MEWS Software from MER on Sun 4 for Use in Downey
  - Dataview Display Builder for User Configurable Displays

Rockwell International
Space Systems Division

Shuttle Checkout and Mission Support Datalink Provides Real-Time Integrated Satellite/Ground Systems

Palmdale

Rocketdyne

Pad

Downey
MSR/DDR

Landlines

ASC-1

VAB/LCC

OPF

Landlines

NASCOM (4)

VAFB

Orbiter

Goddard

SAIL

TDRS

Tracking
Station (s)

White Sands

MCC/Houston

MSR/DDR Upgrade System Architecture Enables Greater Mission Support Capabilities

FRONT END

SERVER-NODE

USER NODES

INTELLIGENT DATA ACQUISITION

FRONT-END PROCESSOR

DATA LINK

FIRST GENERATION DDR DISPLAY SYSTEM

COMMON DATA BUFFER

DATA ARCHIVER

REAL-TIME SERVER

DATA STORAGE

ETHERNET

NET

SUN VIEW

MEWS

User

ANALYSIS

DV DRAW

NET

REAL-TIME DISPLAYER

Expert Systems

User

ANALYSIS

DV DRAW

NET

REAL-TIME DISPLAYER

Expert Systems

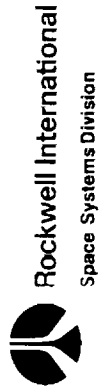User

P. D. Schoen

13

RI-SSD

6/15/91

Expert Systems Enhance the DD&R Room Flight Support

- ○ **Improves Effectiveness of Subsystem Engineers**

- ○ **Faster, More Accurate Malfuncton Diagnosis**

- ○ **Increased Safety**

- ○ **Expert Knowledge Captured and On-Line**

- ○ **Reduced Training Costs**
  - Both Expert and Trainee
  - Rockwell OMS Ground Estimates 50% Savings

- ○ **Generic Architecture Can Support Multiple Programs**
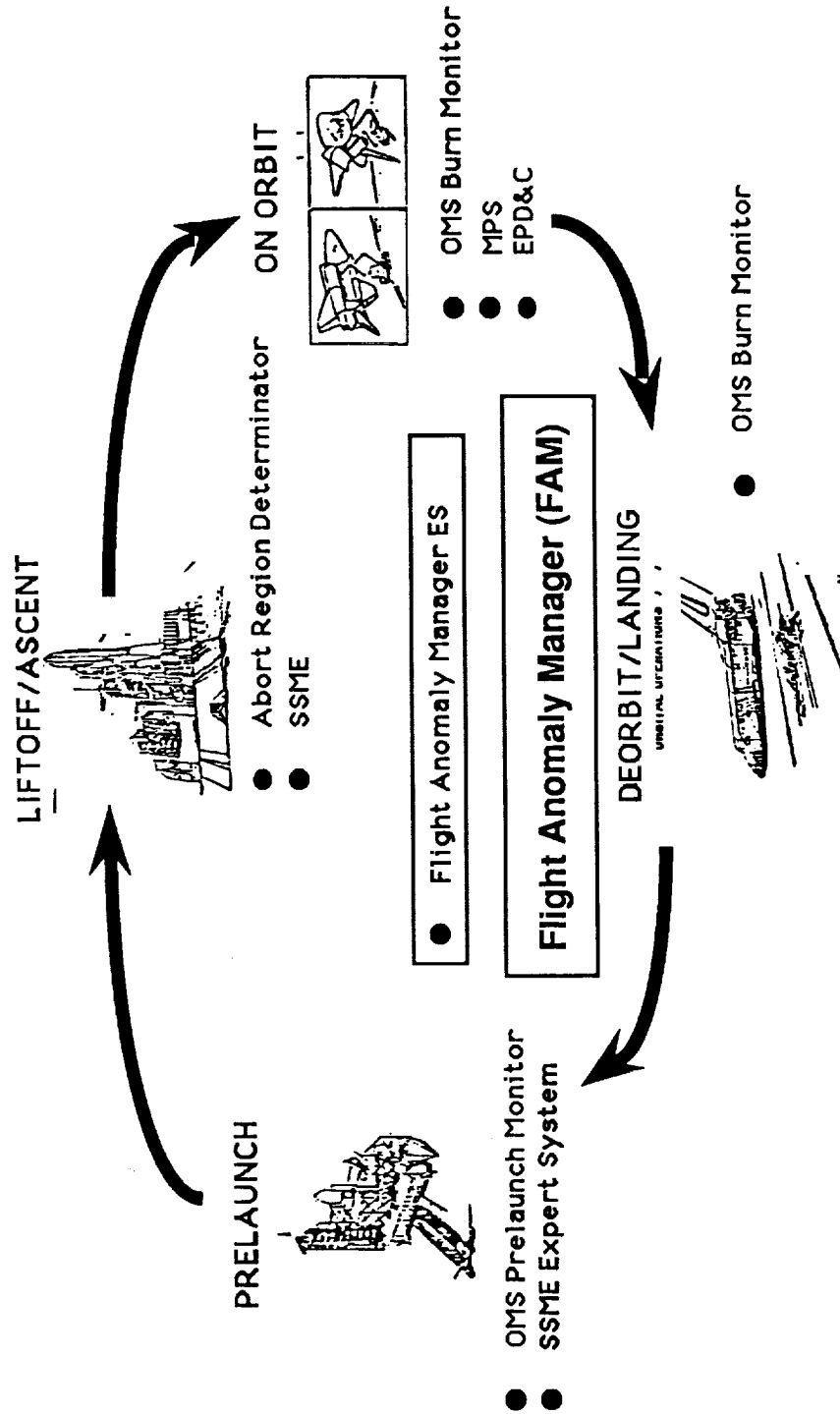
- ○ **Has been Used and Demonstrated to be Effective**

Rockwell International
Space Systems Division

P. D. Schoen

14

ASSTC is Applying ES Technology to Mission Support

LIFTOFF/ASCENT

- Abort Region Determinator
- SSME

ON ORBIT

- OMS Burn Monitor
- MPS
- EPD&C

PRELAUNCH

- OMS Prelaunch Monitor
- SSME Expert System

- Flight Anomaly Manager ES

Flight Anomaly Manager (FAM)

DEORBIT/LANDING

- OMS Burn Monitor

P. D. Schoen

15

Rockwell International
Space Systems Division

RI-SSD

6/14/91

295

FAM Interprets Output of Subsystem Expert System
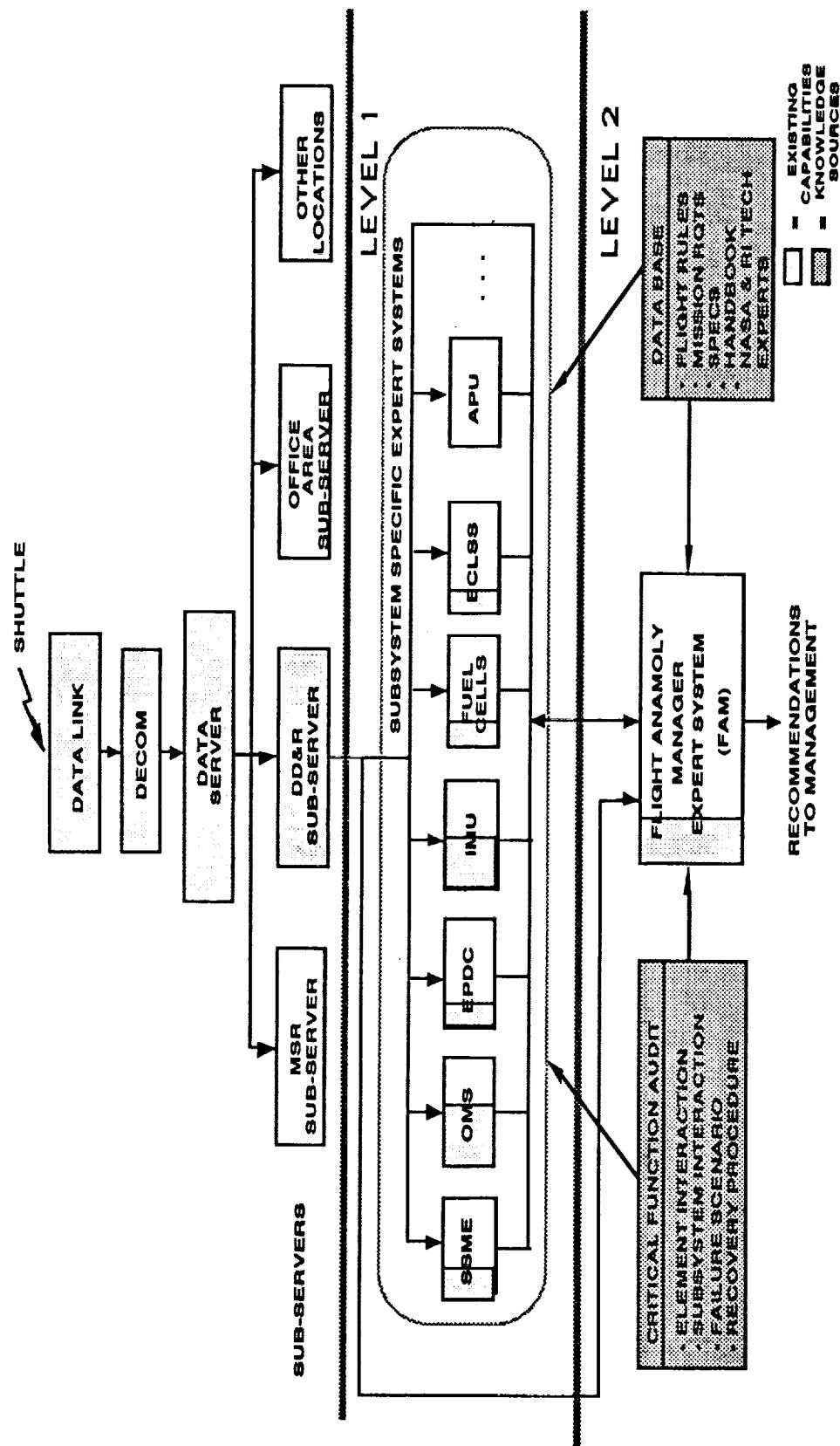
Flight Anomaly Manager

○ **Provides Mission Support Team Leader with Overall Vehicle Status**
- Knowledgeable About Subsystem to Subsystem Interactions
  - Knows the Effect of Failure on Other Subsystems
  - Provides Management Insight into Vehicle Status
  - Makes Recommendations
  - Communicates with Subsystem Specific Expert Systems

○ **Multi-Layed Implementation**
- Sun Workstation Using G2
- Communication with Subsystem Specific Expert Systems via GSI

○ **Interacts with Subsystem Specific Expert Systems**
- EPD&C
- OMS
- SSME
- Fuel Cells
- ECLSS

P. D. Schoen

17

RI-SSD

6/14/91

297

Ground Support - Summary

○ **RI-SSD has Developed and Delivered a Number of "Turn Key" Systems**

- ATE
- Simulation Support
- Factory/Flight Line
- Payload Integration
- Mission Support

○ **The Methodology being Used Allows for the Growth and Support of the System throughout the Life Cycle of a Program**

- Scaleable
- Adaptable

○ **The Ground System Architecture Provides for Data and Procedure Transportability throughout the Life Cycle**

System Architecture Provides for Generic Application to Any Program

P. D. Schoen

18

Background Material

Aerospace
Simulation & Systems Test Center

A. J. Mauceri, Director
(213) 922-4935
Comnet 372-4935

Rockwell International

Space Systems Division

ASSTC Laboratory Environments Support Technology & Market Evolution

Environment

Simulation Systems

Avionics & Payload Test

Real-Time Mission Support

Artificial Intelligence and Expert Systems

Man / Machine Interface

Automation & Robotics

Hardware/Test-System Development

Examples

Non Real-Time & Real-Time Vehicle & System, Full Mission Evaluation and Training, Man-In-The-Loop Math Model or Hardware/Software Verification System Concepts, Trade Studies & Integration

Subsystem/LRU Breadboarding, Payload Integration and Compatibility Testing

Flight Line Support and Ground Checkout Support Air-To-Ground Communications / Protocol Secure Systems

Real-Time Process Control Autonomous Robotics Adaptive Control Systems

Interactive Display and Control Development Human Engineering Studies Crew Procedures, Familiarization and Training Natural Language Interfaces

Robotics Research, Vision System Development Space-Based Construction and Servicing Man-In-The-Loop Operations

Microprocessor Systems Data Link and Telemetry Communications Hardware Simulators Avionic System Interfaces Deliverable Test Systems and Remote Checkout Systems

Rockwell International
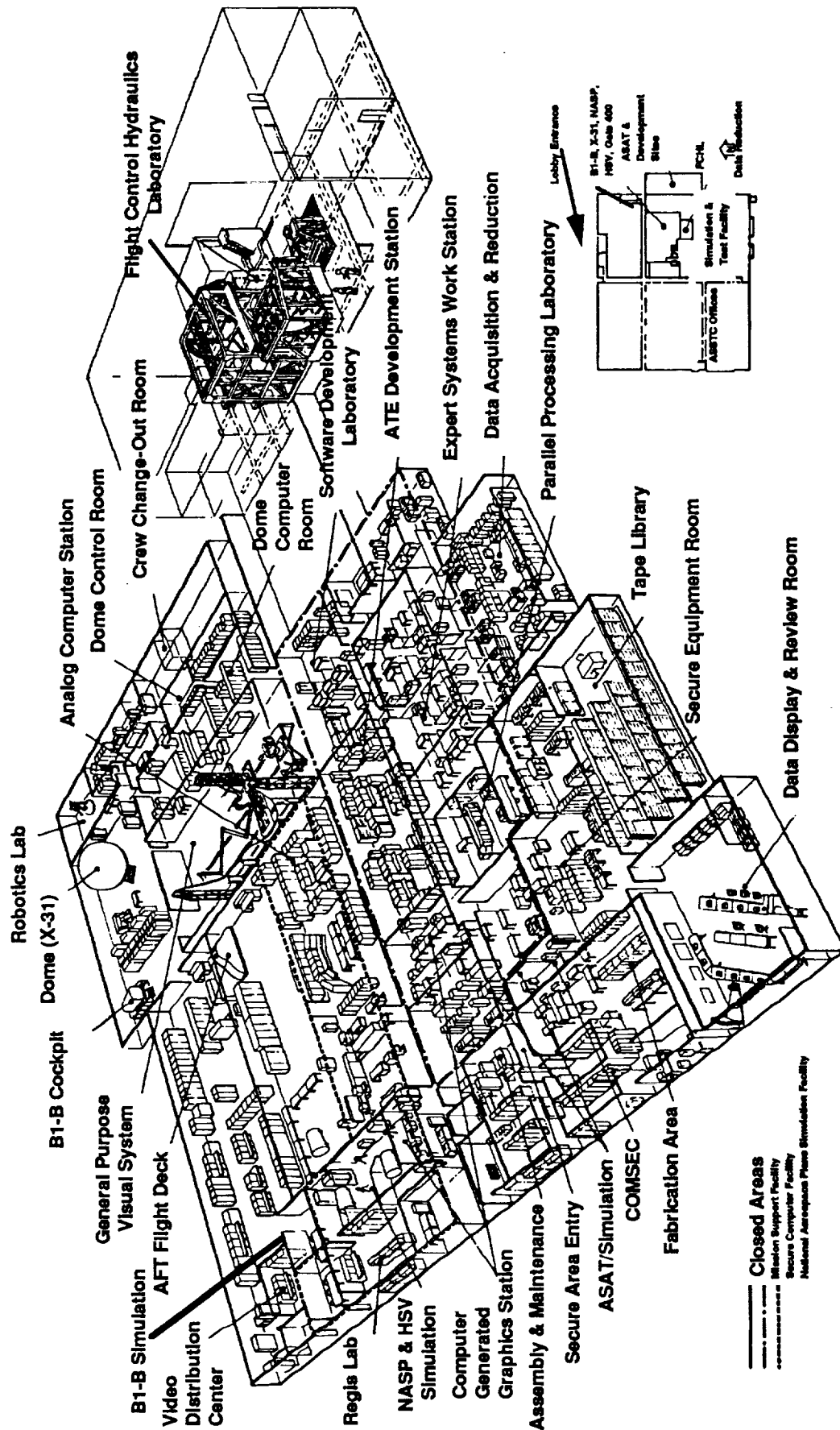Space Systems Division

P. D. Schoen

20

RI-SSD

6/14/91

300

ASSTC Facility Supports Extensive Development and Operations

Robotics Lab
B1-B Cockpit
Dome (X-31)
General Purpose Visual System
AFT Flight Deck
B1-B Simulation
Video Distribution Center
Regis Lab
NASP & HSV Simulation
Computer Generated Graphics Station
Assembly & Maintenance
Secure Area Entry
ASAT/Simulation
COMSEC
Fabrication Area

Analog Computer Station
Dome Control Room
Crew Change-Out Room
Dome Computer Room
Software Development Laboratory
ATE Development Station
Expert Systems Work Station
Data Acquisition & Reduction
Parallel Processing Laboratory
Flight Control Hydraulics Laboratory

Tape Library
Secure Equipment Room
Data Display & Review Room

Closed Areas
Mission Support Facility
Secure Computer Facility
National Aerospace Plane Simulation Facility

Lobby Entrance
B1-B, X-31, NASP, HSV, Gate 400 ASAT & Development Sites
Simulation & Test Facility
PCHL
Data Reduction
ASSTC Offices

RI-SSD
6/14/91

Rockwell International
Space Systems Division

P. D. Schoen

21