PRESENTATION 4.4.5

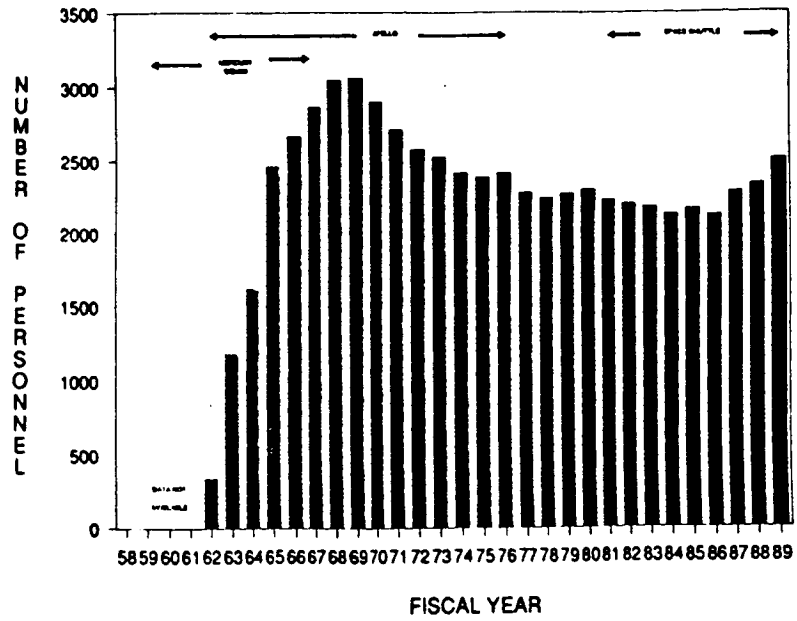
LAUNCH OPERATIONS MANPOWER YESTERDAY, TODAY AND TOMORROW

GEORGE OJALEHTO
VITRO CORPORATION
JUNE 27, 1990

SOURCES OF INFORMATION

- NASA POCKET STATISTIC - JAN 1990
- KSC GROUND OPERATIONS COST MODEL - JUN 1990
- KSC MANPOWER REPORT - NOV 1968
- SHUTTLE PROCESSING CONTRACTOR MANPOWER TREND ANALYSIS STUDIES - MAR 1990
- AVIATION WEEK "AEROSPACE FORUM" BY LT. GEN (RET.) RICHARD D. HENRY - NOV 27, 1989
- WHITE PAPER ENTITLED "IN SEARCH OF SPACE ACCESSIBILITY" BY C. ELDRED, AIR FORCE SPACE SYSTEMS DIVISION - DEC. 1989
- OPERATIONALLY EFFICIENT PROPULSION SYSTEM STUDY (OEPSS) REVIEW BY SRS TECHNOLOGIES - FEB 1990
- SHUTTLE GROUND OPERATIONS EFFICIENCIES/TECHNOLOGY STUDY (SGOE/T) BRIEFING BY BOEING - JULY 1988
- SAE TECHNICAL PAPER ENTITLED "RELIABLE LOW COST LAUNCH SERVICES" BY PETER ARMITAGE, SPACE SERVICES, INC. SEP 1989
  DISCUSSIONS WITH PETER ARMITAGE - JUN 1990
- PEGASUS BRIEFING CHARTS/TAURUS BRIEFING CHARTS FROM BILL SAAVEDRZ, ORBITAL SCIENCES CORP. - JUN 1990
  DISCUSSIONS WITH BILL SAAVEDRA - JUN 1990
- ALS COMPARATIVE ANALYSIS REPORT BY GENERAL DYNAMICS - DEC 1989

Kennedy Space Center Civil Service Level



PERSPECTIVES ON PAST AND CURRENT LAUNCH SITE MANPOWER

- **IN THE 1958 - 1962 (REDSTONE, MERCURY, GEMINI) ERA WE HANDLED UP TO 27 LAUNCHES PER YEAR WITH ABOUT 350 GOVERNMENT PEOPLE PLUS SUPPORTING CONTRACTORS**

- **IN THE 1962 - 1975 (APOLLO) ERA WE HANDLED UP TO 30 LAUNCHES PER YEAR WITH ABOUT 3,000 GOVERNMENT PEOPLE PLUS 18,000 CONTRACTORS**

- **IN THE 1981 - 1989 (SPACE SHUTTLE) ERA WE HANDLE UP TO 15 LAUNCHES PER YEAR WITH ABOUT 2,500 GOVERNMENT PEOPLE PLUS 15,000 CONTRACTORS**

WHAT DID WE KNOW 30 YEARS AGO THAT WE MAY HAVE FORGOTTEN

NASA LAUNCH ATTEMPTS PER YEAR VS PERSONNEL ON HAND

Year	Manned Launches	S	U	Total Launch Attempts	KSC Personnel
1958		2	2	4	--
1959	1	9	5	14	--
1960	1	11	6	17	--
1961	4	19	5	24	--
1962	3	26	1	27	339
1963	1	15		15	1181
1964	1	29	1	30	1625
1965	5	28	2	30	2464
1966	5	30	1	31	2669
1967		27	1	28	2867
1968	2	21	2	23	3044
1969	4	21	1	22	3058
1970	1	13	1	14	2895
1971	2	17	1	18	2704
1972	2	18		18	2568
1973	3	13	1	14	2516
1974		16	1	17	2408
1975	1	19	2	21	2377
1976		16		16	2404
1977		14	2	16	2270
1978		20		20	2234
1979		9		9	2264
1980		7		7	2291
1981	2	13		13	2224
1982	3	12		12	2199
1983	4	15		15	2180
1984	5	12		12	2131
1985	9	14		14	2165
1986	2	5	2	7	2120
1987		3	1	4	2278
1988	2	8		8	2330
1989	5	7		7	2504

S-Successful
U-Unsuccessful

ESTIMATES OF CURRENT LAUNCH OPERATIONS MANPOWER

VEHICLE	LAUNCH RATE	NUMBER OF PEOPLE PER LAUNCH
TITAN	4/YR	300 WSMC 550 ESMC
ATLAS	4/YR	200 - 300 ESMC
DELTA	10/YR	150 WSMC 215 - 280 ESMC
SCOUT	2/YR	40 - 60
SPACE SHUTTLE	8/YR	900 CONTRACTOR ___ GOVERNMENT

OPERATIONAL CONCERNS

- OPERATIONS IS A MAJOR COST DRIVER ACCOUNTING FOR 25 TO 40% OF TOTAL COST PER FLIGHT FOR SOME ELVs
- SPACE SHUTTLE AVERAGE COST PER FLIGHT IS $219.2M OF WHICH $52M (23.7%) IS LAUNCH OPERATIONS COSTS
- SHUTTLE TURNAROUND TIME NOT NEAR ORIGINAL GOALS
  - ORIGINAL DESIGN GOAL — 160 HRS
  - PRE 51L GOAL — 680 HRS
  - 51L ACTUAL — 1358 HRS
  - POST 51L ACTUALS — 2000-3000 HRS

HIGH OPERATIONS COSTS ARE LARGELY THE RESULT OF COMPLEX VEHICLE/PROPULSION SYSTEM DESIGNS

PLANNED ELV TIMELINE REDUCTIONS

ATLAS FROM 55 DAYS TO 12 DAYS BY 1994

• AUTOMATION AND NEW HARDWARE	MINUS 10 DAYS
• OFF LINE PROCESSING AND NEW CENTAUR ENGINE	MINUS 15 DAYS
• NEW DESIGN HARDWARE, AVIONICS, LASER ORDNANCE	MINUS 18 DAYS

TITAN FROM 80 DAYS TO 27 DAYS BY 1994

• SRM ASSEMBLY FACILITY AND DOUBLE SHIFTS	MINUS 20 DAYS
• AGE MODERNIZATION	MINUS 4 DAYS
• OFF-LINE PAYLOAD PROCESSING	MINUS 26 DAYS
• LASER ORDNANCE	MINUS 3 DAYS

TODAY'S SMALL LAUNCH VEHICLE LAUNCH MANNING EXPECTATIONS

- ORBITAL SCIENCES CORPORATION
  - PEGASUS
    - ONE ENGINEER ON BOARD B-52 WITH AIRCRAFT CREW OF 3 (4 TOTAL)
    - SIX ENGINEERS FOR INTEGRATION SUPPORT
    - SIX ENGINEERS FOR FLIGHT CONTROL

    TOTAL OF 13 PEOPLE SUPPORTING LAUNCH
    (AIRFORCE RANGE PERSONNEL NOT COUNTED)
  - TAURUS
    - EXPECT 15 TO 18 PEOPLE TO SUPPORT LAUNCH (PAD, ASSEMBLY, INTEGRATION)
    - EXPECT 6 FOR BLOCKHOUSE (LAUNCH CONTROL)
    - LAUNCH SEQUENCE HAS 5 DAYS TO SETUP AND ACTIVATE AND THEN LAUNCH WITHIN 72 HOURS
- SPACE SERVICES, INC
  - CONSORT (SUBORBITAL)
    - 4 SSI ENGINEERS PLUS 4-6 INTEGRATION SUBCONTRACTOR ENGINEERS (8 TO 10 TOTAL PER LAUNCH)
  - CONESTOGA (ORBITAL)
    - ABOUT 18 PEOPLE FOR LAUNCH SUPPORT EXPECTED

TODAY'S SMALL LAUNCH VEHICLE DESIGN/OPERATIONS PHILOSOPHY

- MAXIMUM SYSTEM RELIABILITY
  - SIMPLE DESIGN
  - CONSERVATIVE DESIGN PRACTICES
  - QUALITY COMPONENT SELECTION
  - PROVEN MODERN ELECTRONIC COMPONENTS
- SIMPLE LAUNCH INTEGRATION AND PRE-FLIGHT CHECKOUT
  - MAXIMUM USE OF PREASSEMBLY AND PRETEST CHECKOUT AT MANUFACTURING PLANTS
  - MINIMUM FIELD GROUND SUPPORT EQUIPMENT AND FACILITIES
  - HORIZONTAL ASSEMBLY/INTEGRATION PRIOR TO ERECTION
  - PRE-CHECKED CORE/PAYLOAD FLIGHT-CONFIGURED PRIOR TO TRANSPORTING TO PAD
  - TRANSPORTING TO PAD BY SPECIAL VANS/HANDLING DOLLIES
  - LIMITED OR NO FIXED STRUCTURES AT LAUNCH SITE EXCEPT FOR SIMPLE LAUNCH STAND/STOOL
- MINIMUM RANGE SUPPORT REQUIREMENTS

FIXED PRICE LAUNCHES FORCES ONE TO CUT COSTS

PERSPECTIVES ON FUTURE LAUNCH OPERATIONS

- AS COMPLEXITY OF FLIGHT AND GROUND SYSTEMS INCREASES, SO DOES COST
  - FLIGHT/GROUND SYSTEMS MUST BE SIMPLIFIED
- MAINTAINABILITY/EASE OF ACCESS MUST BE DESIGNED IN
- OPERATIONAL REQUIREMENTS MUST BE A PART OF THE CONCEPTUAL DESIGN PHASE
- OVERALL VEHICLE INTEGRATION MUST BE EMPHASIZED EARLY
- LARGE COMPLEX LAUNCH CONTROL CENTERS MUST BE ELIMINATED
- MASSIVE GROUND/LAUNCH VEHICLE DATA AND CONTROL LINKS MUST GO AWAY
- PAYLOADS MUST BE PREPACKAGED, HAVE MINIMAL INTERFACES, AND BE PROCESSED OFF-LINE

PERSPECTIVES ON FUTURE LAUNCH OPERATIONS (CONTINUED)

- MUST MOVE BEYOND RESEARCH AND DEVELOPMENT ENVIRONMENT TO AN OPERATIONAL ENVIRONMENT
  - PAST VEHICLES DESIGNED FOR PERFORMANCE FIRST; RELIABILITY SECOND, AND COST EFFECTIVENESS LAST
  - IT IS TIME TO CHANGE
- MUST EMPHASIZE RELIABILITY THROUGH SIMPLICITY, DESIGN MARGINS AND SELECTIVE REDUNDANCY
  - SIMPLICITY ALLOWS CONCENTRATION OF EFFORT
  - DESIGN MARGINS CAN REDUCE REDUNDANCY REQUIREMENTS
  - SELECTIVE REDUNDANCY GIVES ADDED ASSURANCE

NASA LAUNCHES PRIOR TO 1962

YEAR	LAUNCH VEHICLE	PAYLOAD	*STATUS	DATE
1958				
	Thor Able	Pioneer I	S	Oct 11
	Jupiter-C	Beacon 1	U	Oct 23
	Thor Able	Pioneer II	U	Nov 8
	Juno II	Pioneer III	S	Dec 7
1959				
	Vanguard	Vanguard II	S	Feb 17
	Juno II	Pioneer IV	S	Mar 3
	Vanguard	Vanguard	U	Apr 13
	Vanguard	Vanguard	U	Jun 22
	Juno II	Explorer	U	Jul 16
	Thor Able	Explorer 6	S	Aug 7
	Juno II	Beacon ii	U	Aug 14
	Atlas	Big Joe-Mercury	S	Sep 9
	Vanguard	Vanguard III	S	Sep 18
	Little Joe	Little Joe I	S	Oct 4
	Juno II	Explorer 7	S	Oct 13
	Little Joe	Little Joe 2	S	Nov 4
	Atlas Able	Pioneer P-3	U	Nov 26
	Little Joe	Little Joe 3	S	Dec 4
1960				
	Little Joe	Little Joe 4	S	Jan 21
	Thor Able IV	Pioneer V	S	Mar 11
	Juno II	Explorer	U	Mar 23
	Thor Able	Tiros I	S	Apr 1
	Scout	Scout X	S	Apr 18
	Thor Delta	Echo A-10	U	May 13
	Scout	Scout I	S	Jul 1
	Atlas	Mercury MA-1	U	Jul 29
	Thor Delta	Echo I	S	Aug 12
	Atlas Able	Pioneer P-30	U	Sep 25
	Scout	Scout II	S	Oct 4
	Juno II	Explorer 8	S	Nov 3
	Little Joe	Little Joe 5	S	Nov 8
	Thor Delta	Tiros ii	S	Nov 23
	Scout	Explorer S-56	U	Dec 4
	Atlas Able	Pioneer P-31	U	Dec 15
	Redstone	Mercury MR-1A	S	Dec 19

*S-Successful
U-Unsuccessful

YEAR	LAUNCH VEHICLE	PAYLOAD	*STATUS	DATE
1961				
	Redstone	Mercury MR-2	S	Jan 31
	Scout	Explorer 9	S	Feb 16
	Atlas	Mercury MA-2	S	Feb 21
	Juno II	Explorer S-45	U	Feb 24
	Little Joe	Little Joe 5A	S	Mar 18
	Redstone	Mercury MR-BD	S	Mar 24
	Thor Delta	Explorer 10	S	Mar 25
	Atlas	Mercury MA-3	U	Apr 25
	Juno II	Explorer 11	S	Apr 27
	Little Joe	Little Joe 5B	S	Apr 28
	Redstone	Mercury (Freedom 7)	S	May 5
	Juno II	Explorer S-45a	U	May 24
	Scout	Explorer S-55	U	Jun 30
	Thor Delta	Tiros III	S	Jul 12
	Redstone 4	Mercury (Liberty Bell 7)	S	Jul 21
	Thor Delta	Explorer 12	S	Aug 16
	Atlas Agena	Ranger I	S	Aug 23
	Scout	Explorer 13	S	Aug 25
	Atlas	Mercury MA-4	S	Sep 13
	Scout	Probe A	S	Oct 19
	Saturn I	Saturn Test	S	Oct 27
	Blue Scout	Mercury MS-1	U	Nov 1
	Atlas Agena	Ranger II	S	Nov 18
	Atlas	Mercury MA-5	S	Nov 29

*S-Successful
U-Unsuccessful