Advanced Product Development Team
Team X

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13 August, 2002

Thermal and Fluids Analysis Workshop
12-16 August, 2002
Houston, Texas

Advanced Product Development Team
Team X

Agenda

- Team X Charter
- Concurrent Design Process
- Cost/Schedule Metrics
- Design Team Tools
- Distributed Concurrent Engineering (DCE) Process/Tools
- Subsystem Design Tools
- Cost Validation
- Advantages of Team X Process

Team-X Charter

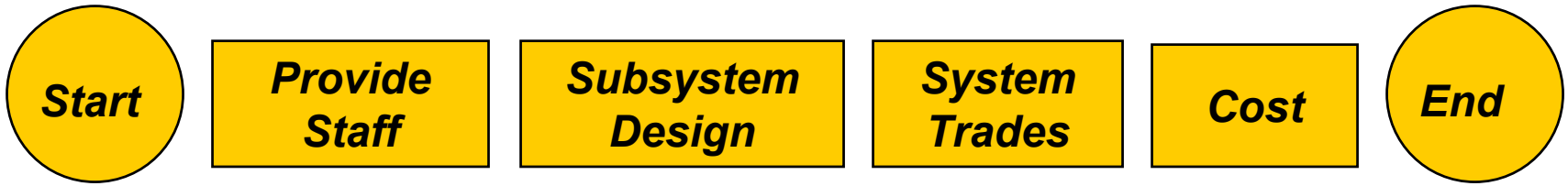
The Advanced Projects Design Team ("Team X") was started in April of 1995. The team was chartered to:

- Improve the speed and quality of JPL's new mission concepts.
- Create a reusable study process with dedicated facilities, equipment, procedures, and tools.
- Develop a database of initial mission requirements that can be easily updated and electronically transferred for use in subsequent project phases.
- Develop mission generalists from a pool of experienced engineers.

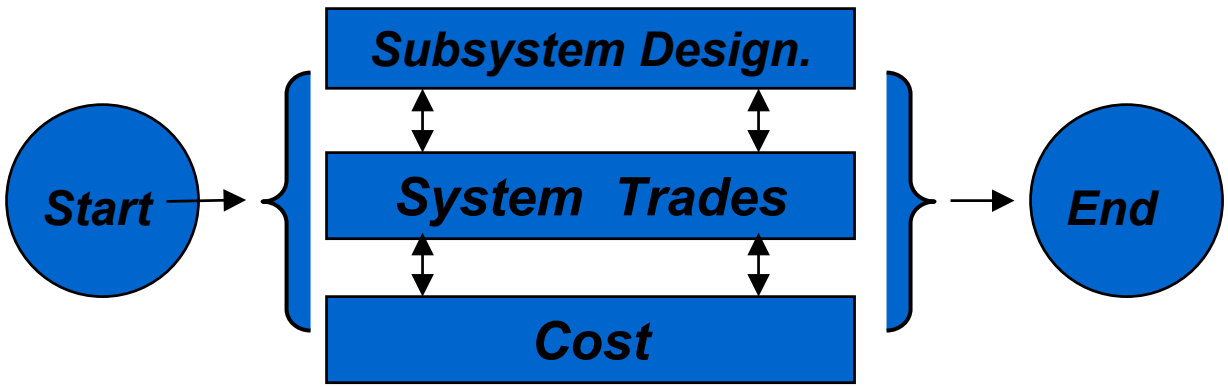
Over 450 completed studies to date

Concurrent Design Process

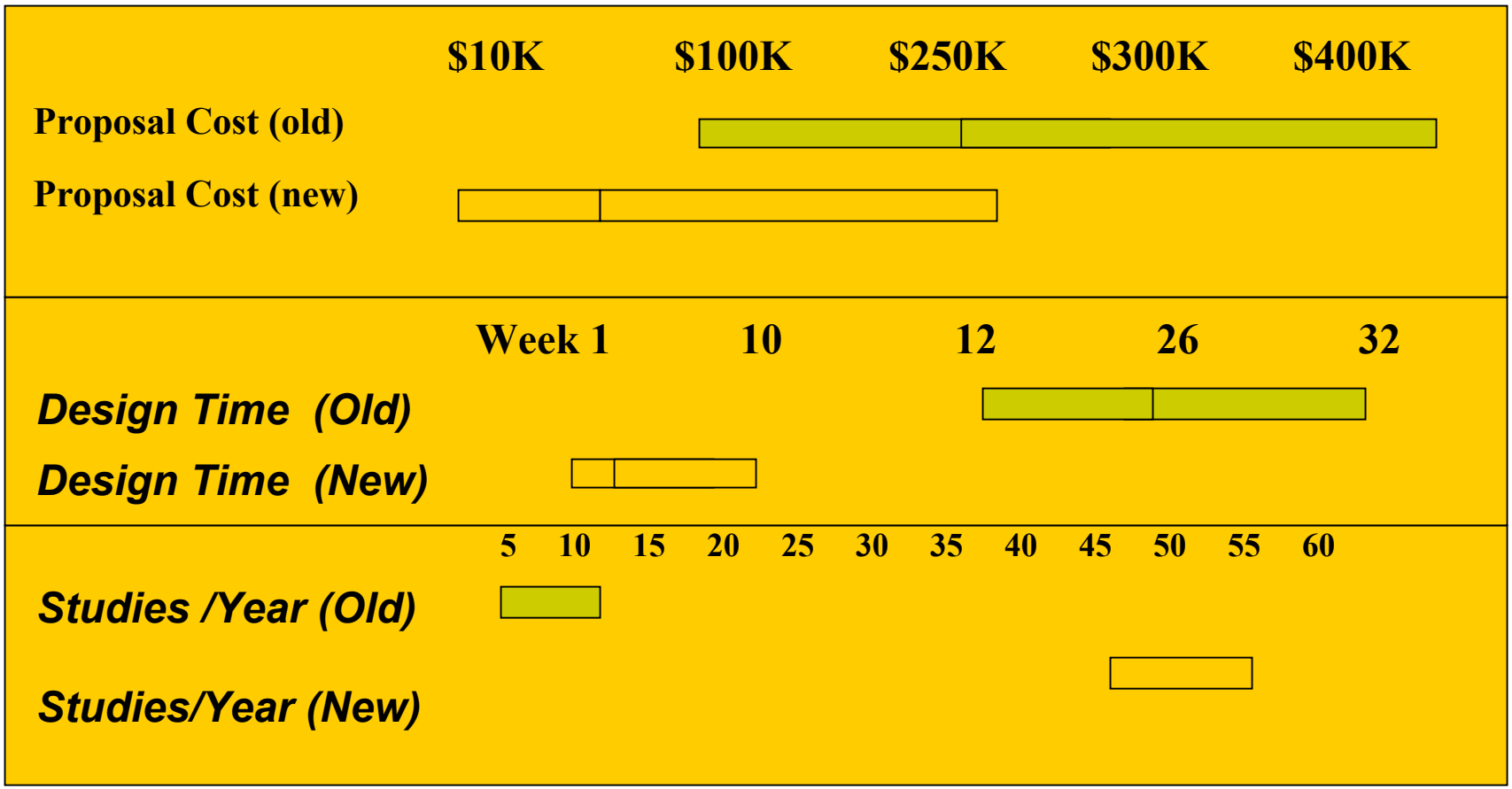
Old Process – Sequential



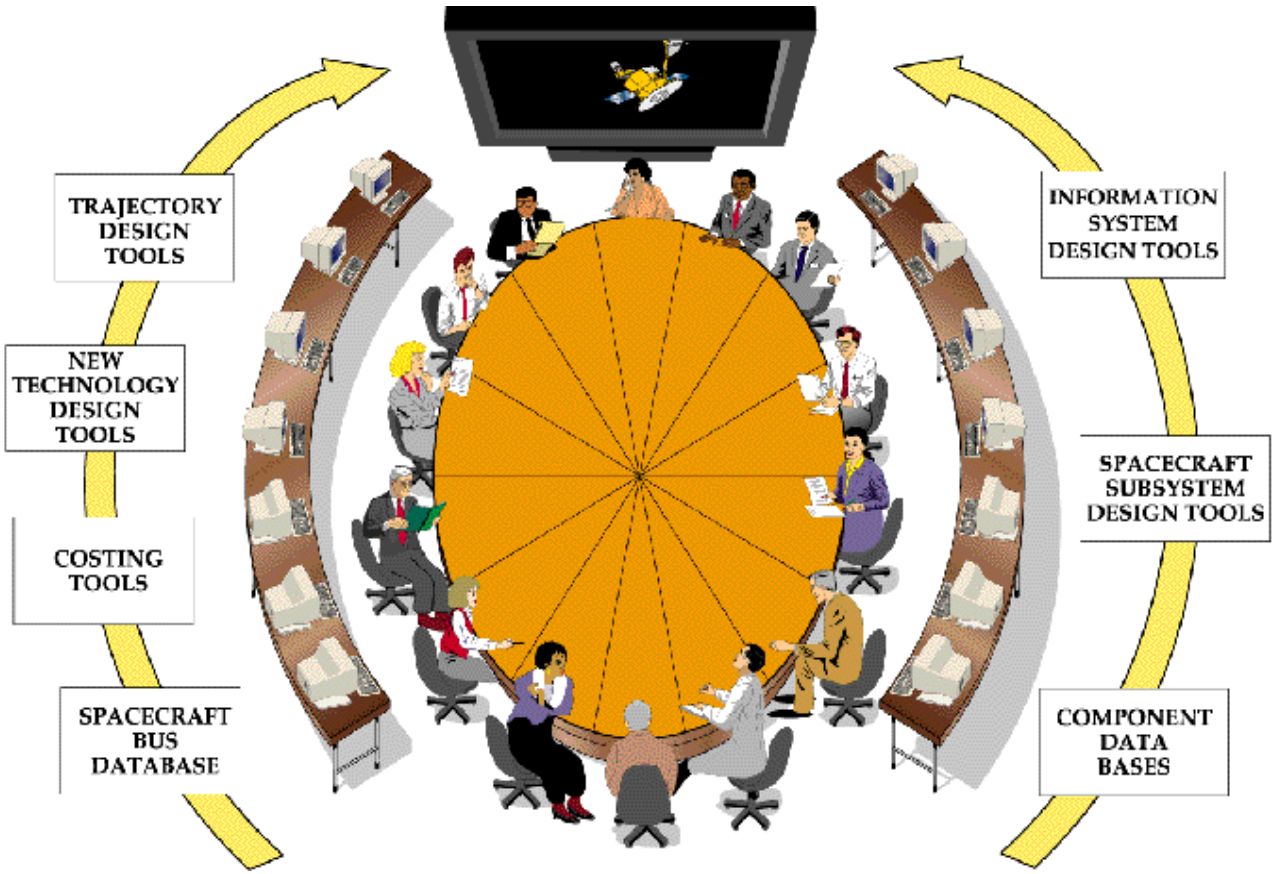
New Process – Concurrent



Cost/Schedule Metrics



Design Team Tools



The DCE Process

- Meet with the customer, define the study and mission objectives.
- Meet with team leaders to determine roles and responsibilities.
- Meet with the customer and a subset of the team to develop requirements and identify pre-session analyses.
- Provide top level requirements and results from pre-session analyses to the combined DCE team.

DCE Tools

- Each team uses existing internal tools and processes with minimum modification.

- For external communication we use existing COTS tools:
  - Video teleconferencing utilizing ISDN lines.
  - Meet-me phone lines.
  - NetMeeting and/or Timbuktu application sharing software for visual data sharing.
  - VPN and/or Timbuktu to dynamically share local files.

Subsystem Design Tools

Design tool used for the Team X studies is an Excel coupled tool.

The Excel tool for all subsystems, as well as programmatics, and systems rollup are interlinked such that an on-put from any subsystem will be routed to all subsystems to which this data is necessary to complete its function.

The reporting tool is Word, and has a notes section as well as a reporting section.

CEM Tool

	Unit	Mass [kg]	Contingency %	CBE + Contingency [kg]	Power [W] Science	Telecom	TCM	Cruise	Launch	NASA TRL	Comments
TOTAL		**7.51**	**27%**	**9.51**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**6**	
Thermal (Spacecraft only)		7.44		7.44	10.1	10.1	10.1	10.1	10.1		Assumes
Thermal Subsystem Type (Passive/Active)											
Sum of Elements to Check		7.51	27%	9.51							
Multilayer Insulation		4.52	30%	5.88							
No. of Layers (Type 1 or 2)											Type 1
Thermal Surfaces		0.16	30%	0.20							
Films											
Paints											
Tapes											
Thermal Conduction Control		0.20	30%	0.26							
Fiberglas											
Diamond											
Louvers Total Mass	**0.0**	0.00		0.00							
Vairable Emissivity Surface (/m2)											
Thermal Radiator (Unit Area)	**0.0**	0.00		0.00							
Thermostats (Number)	**10.0**	0.50	30%	0.65							
Heaters (Number)	**5.0**	0.25	30%	0.33							
Heat Pipes (per 30 cm)	**1.0**	0.18	30%	0.23							
Passive / Variable Cond.	**0.0**	0.00		0.00							
Sensors											
Temperature	**30.0**	0.30	10%	0.33							
Others											
Sun Shade											
Aero-Shield											
Special Element											
RHU's	**0.0**	0.00		0.00							Assumes
Propulsion System (Inc. Thermostats)											
Tank Heaters	**4.0**	0.40	20%	0.48							
Line Heaters	**10.0**	1.00	15%	1.15							
Instrument Thermal Mass/Power											

Estimated Subsystem Cost ($M FY97)	**2.64**				Phase A	Phase B	Phase C	Phase D			
	Earth			Workforce	0.07	0.50	0.524	0.971			
Non Rec	0.91			Dev/Test		0.1	0.3				
Red	1.731			Flt HW				0.301			
				Test HW				0.25			

Thermal Hardware List + Power

Mission: Study Name
Element: Orbiter

Thermal System

Standard Report Equipment List

ROWS, COLUMNS, AND CELLS MAY BE DELETED FOR PRINT OUT FORMATING PURPOSES WITH USERS CAN ADJUST ROW AND COLUMN WIDTHS TO THEIR OWN PREFERENCES.

Subsystem Totals	1		7.510	20.2	10.1

Component	Flt Units	Mass/ Unit (kg)	Total Mass (kg)	Peak Power per Unit (W)	Average Power per Unit (W)
Multilayer Insulation			4.520		
Thermal Surfaces			0.160		
Thermal Conduction Control			0.200		
Louvers Total Mass	0	0.975	0.000		
Thermal Radiator (Unit Area)	0	27.000	0.000		
Heaters/Thermostats			2.150	20.2	10.1
Heat Pipes (per 30 cm)	1	0.180	0.180		
Passive Variable Cond.			0.000		
Temp Sensors			0.300		
RHU's			0.000		

System Summary

						Study Name						**Legend**			
SYSTEMS WORKSHEET						***Orbiter***								Inputs from Subsystems	
nalyst:	Matt Johnson													Inputs from Systems	
tart Date:	**2/14/1997**	Directory	C:\Documents and Settings\rmiyake\My Documents\											Inputs from SOS	
														Calculated	
Stabilization - cruise	**3-Axis**				Pointing Direction - cruise	**TBD**			Mission Duration	**TBD**	years				
Stabilization - science	**3-Axis**				Pointing Direction - science	**TBD**			Max probe sun distance	**TBD**	AU				
Pointing Control	**3600**	arcsec			Radiation Total Dose, krad	**TBD**			Instrument Data Rate	**TBD**	kb/s				
inting Knowledge	**1800**	arcsec			Science BER	**1.00E-06**			Data Storage	**TBD**	Mb				
Pointing Stability	**60**	arcsec/sec			Redundancy	**TBD**									
Determined by:	**TBD**								Maximum Link Distance	**TBD**	AU				
					Technology Cutoff	**TBD**			Return Data Rate	**TBD**	kb/s				

Update Now

Update Database

Save Updates All

	Mass Fraction	Mass (kg)	Subsys Cont. %	CBE+ Cont. (kg)	Mode 1 Power (W) Science	Mode 2 Power (W) Telecom	Mode 3 Power (W) TCM	Mode 4 Power (W) Cruise	Mode 5 Power (W) Launch	NASA TRL To-day	Subsystem Cost M$	Last Updated
Payload												
Instruments	0.0%	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0	$0.0	11/4/1997 8:48
Payload Total	0.0%	0.0	0%	0.0	0.0	0.0	0.0	0.0	0.0			
Bus												
Attitude Control	0.0%	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0	$0.0	11/18/1997 16:32
Command & Data	0.0%	0.0		0.0	0.0	0.0	0.0	0.0	0.0	6	$3.5	1/11/2002 13:20
Power	60.1%	328.7	15%	378.9	4.2	4.2	6.3	11.2	6.3	6	$5.1	3/6/1998 9:53
Propulsion1	5.2%	28.7	0%	28.7	1.3	1.3	17.3	54.7	17.3	4	$12.4	11/5/1997 8:20
Propulsion2	0.0%	0.0	0%	0.0	0.0	0.0	0.0	0.0	0.0	0		11/5/1997 8:20
Structure	28.9%	157.9	30%	205.2	0.0	0.0	0.0	0.0	0.0	6	$15.9	6/14/1994 15:50
S/C Adapter	1.6%	8.7	30%	11.3								
Cabling	2.5%	13.7	30%	17.8								6/14/1994 15:50
Telecomm	0.0%	0.0	0%	0.0	0.0	0.0	0.0	0.0	0.0	0	$2.1	3/6/1998 12:27
Thermal	1.7%	9.5	27%	12.1	31.1	31.1	31.1	31.1	31.1	6	$1.3	3/4/1998 15:56
Bus Total		547.1	20%	654.0	36.7	36.7	54.8	97.0	54.8		$40.1	
											$1.3	Sys Mgmt&Eng.
Spacecraft Total (Dry)		547.1	20%	654.0	36.7	36.7	54.8	97.0	54.8		$1.9	MechBuildUp
Subsystem Heritage Contingency		106.9	20%		11.0	11.0	16.4	29.1	16.4		$43.4	Bus Cost
System Contingency		57.2	10%								$43.4	Bus+Inst Cost
Spacecraft with Contingency		**711.3**			**47.7**	**47.7**	**71.2**	**126.1**	**71.2**		$4.7	ATLO Cost
Propellant & Pressurant	30.3%	308.7			For S/C mass =	500		Delta-V1	2000	m/s		11/5/1997 8:20
Propellant & Pressurant	0.0%	0.0			For S/C mass =	0		Delta-V2	0	m/s	$48.1	Element Cost
Spacecraft Total (Wet)		**1020.0**										
												1/1/1900 21:15
L/V Adapter		26.2										
Launch Mass		**1046.2**										

Contingencies	Mass	Power
Instruments	30%	30%
Other	N/A	N/A
S/C, dry	30%	30%

Cost Validation

Validation the cost of the studies conducted by Team X as compared by actual costs.

There have been about 10 studies used in a validation evaluation.

The Team X cost variation used is +/- 30%.

Of the 10 studies used in the validation evaluation

5 were within +/- 10%

2 were within +/- 20%

2 were within +/- 30 %

Only 1 was out side the +/- 30 % , and was +34 %

Advantages of Team-X Process

- Enables real-time design and resolution of trade issues by all team members.
  - **Allows team members to utilize tools while interacting with others**
- Allows visibility across subsystem interfaces.
- Enables early agreement and ownership of decisions by all disciplines.
- Improve quality of JPL proposals and pre-projects
  - **Facilitates assessment of cost, risk and performance**
  - **Facilitates assessment of tradeoff and descope options**
- Improves phase-A design and saves money and schedule in the design process.