



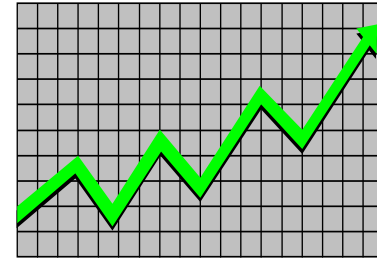
Parametric Cost Estimating **a Joint Industry / Government Initiative**

**Implementing The Parametric Cost
Estimating Initiative at
Lockheed Martin Astronautics**

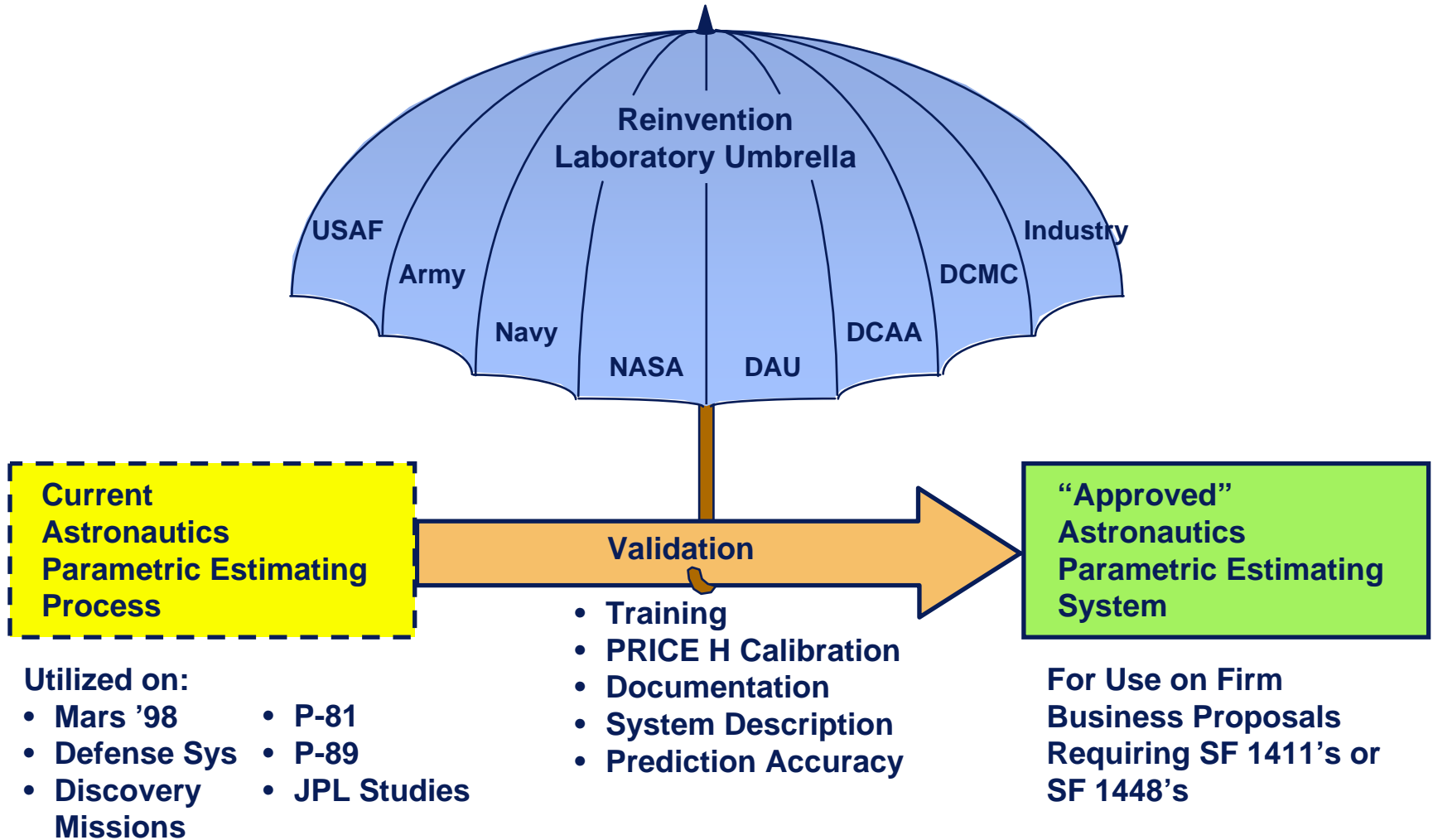
Marty Deutsch
PRICE Symposium '98
22-23 October 1998

Background & Objective

- LMA IPT formed in July 1995
- CERs are normal way of doing business
- LMA has extensively used PRICE H for studies, ROMs, etc.
- Objective is to test PRICE H as primary BOE



Astronautics Parametric Estimating Validation Process



PRICE H Training

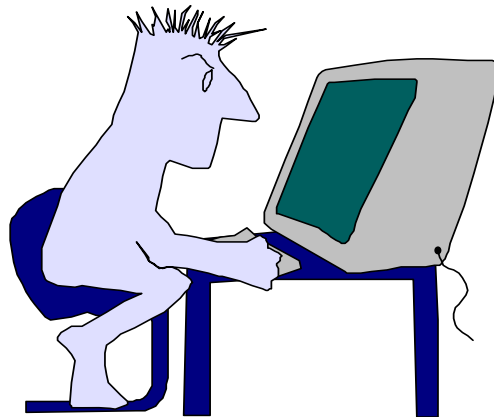
- LMA internal Parametrics Group provided training on PRICE H Version 2.0
- Formal PRICE H training on Version 3.0 in August 1996 and December 1997



LMA Calibration Plan

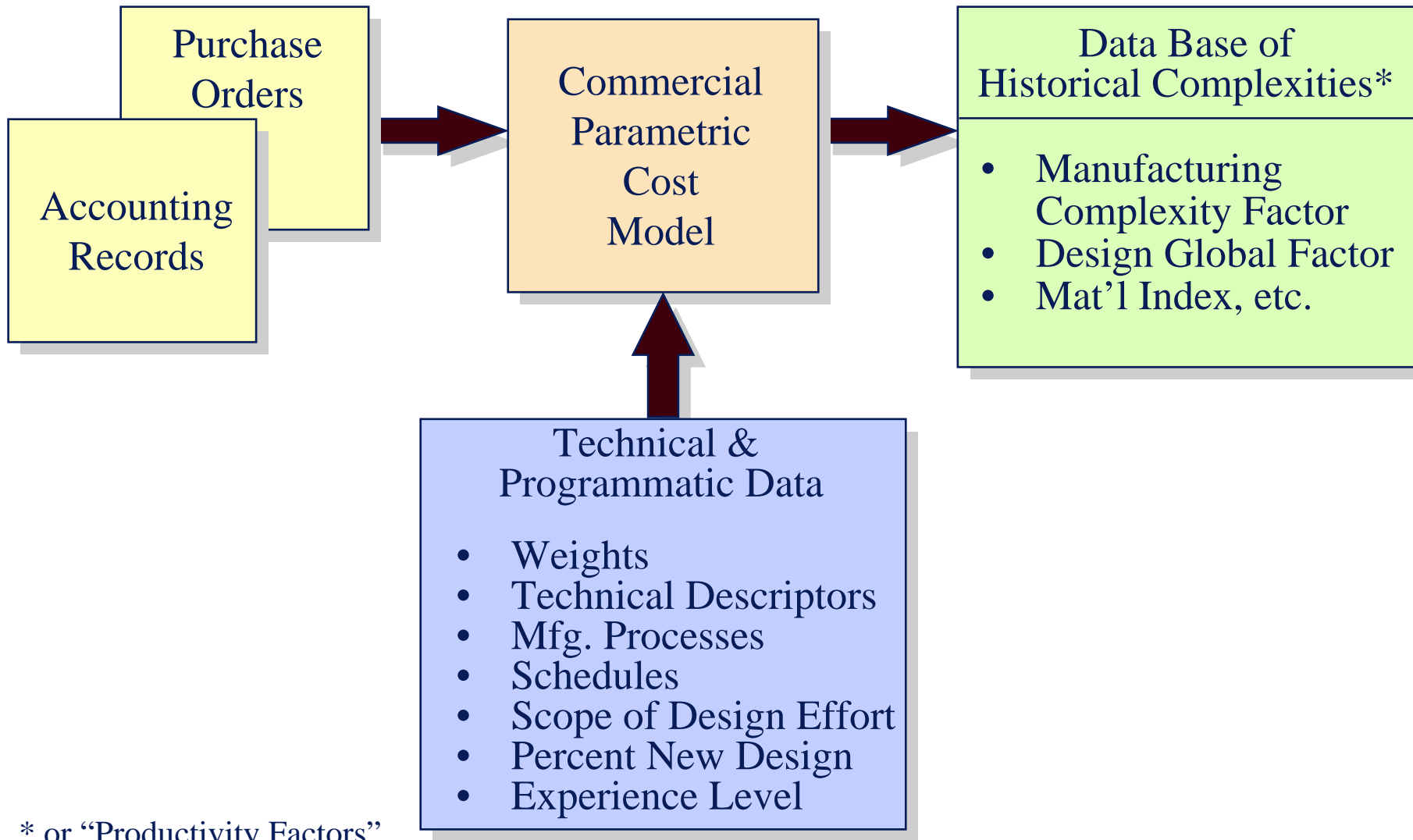
■ Calibration Definition

- The process of calculating historical complexity or productivity factors for use by a parametric model or system to reflect an organization's costs and culture.



Calibration Process

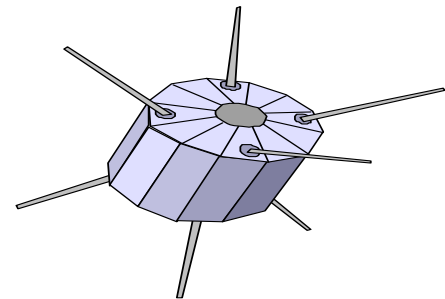
“Calibration Captures the Organization’s Cost and Culture”



* or “Productivity Factors”

LMA Calibration Plan

- Basis for Flight Systems Product Area Selection
 - Cost data available at subsystem levels
 - History of PRICE H Model usage on Planetary Exploration Programs (e.g., Mars and Discovery Missions)
 - PRICE Model data/results shared with both Internal and External Customers



LMA Calibration Plan

- Four Programs Selected for Initial Calibration
 - Mars Global Surveyor (MGS)
 - Mesur Pathfinder Aeroshell
 - Cassini Propulsion Module Subsystem
 - Small Spacecraft Technology Initiative (SSTI)

LMA Calibration Plan

- Basis for MGS, Aeroshell, Cassini, & SSTI Selection
 - Future Flight Systems Work aligned with these efforts
 - More current technologies were employed on these programs
 - Availability of cost data at subsystem and some component levels

LMA Calibration Plan

■ Data Collection

- Estimating Data Bank (EDB) for Costs
- Purchase Order (PO) History Files
- Technical and Programmatic Data
 - Critical Design Review (CDR) Reports
 - Mass Properties
 - Schedules
 - Interviews with Product Integrity Engineers (PIEs)

LMA Calibration Plan

- Developed Joint Team Calibration Methodology
 - Utilize PRICE H 3.0/4.0 (Labor & Material)
 - Many sensitivity runs shared with team
 - Some false starts
 - Team agreement on final approach
 - Shared Cassini final calibration results with team prior to calibrating remaining 3 programs

Astronautics Calibration Results

- Make Items and Buy Items
- Prototype Mfg. Hours Mode; PRICE H 3.0/4.0
- Performed 55 End Item Calibrations from 4 Programs
 - 28 Make (20 Structural/Mechanical; 8 Electronic)
 - 27 Buy (22 Structural/Mechanical; 5 Electronic)
- Full Calibration Documentation
 - PRICE H Inputs and Outputs
 - Mass Properties
 - Interviews

Astronautics Calibration Process

■ Lessons Learned

- Early IPT Consensus
- Data collection task most challenging
- Interview process critical
- Lots of data analysis and reconciliation
- Won't have all the data desired
- 95 % collection & analysis; 5 % actual calibration

DCAA/DCMC Calibration Analysis

■ Analysis

- Review Historical Information
- Review Technical Inputs
- DCMC Technical Analysis

■ Lessons Learned

- Data Collection Accuracy Critical
- PRICE H Model Familiarity a Must

■ Conclusions

- Future Calibrations Should be Faster, Better & Cheaper



LMA Validation Process

■ Validation Process

- Process or act of demonstrating the calibrated model's ability to function as a credible forward estimating tool or system
- Includes demonstration by the contractor that:
 - Key personnel have been adequately trained
 - Estimating procedures are available to ensure consistency of calibration/validation processes and proposal application
 - Cost Model calibration performed and documented
 - Parametric techniques are good predictors of future costs

LMA Validation Process

- Accuracy Assessment Methodology
 - Used MSP'98 Program EAC for Benchmark
 - Program is 85 % Complete
 - For Selected Subsystem Hardware End Items
 - Made estimate with PRICE H
 - Utilized most relevant calibration data
 - Compared Hours and Procurement Dollars (EAC vs Model)
 - Design & Analysis Hours
 - Fab, Assembly & Test Hours
 - Procurement Dollars
 - Documented Assumptions and Results

Validation Results

- PRICE H vs. Program EAC; Model was:
 - Structures & Mechanisms
 - Labor Hours 4.0% Lower
 - Procurement Dollars 23% Lower
 - Propulsion System
 - Labor Hours 5.0% Higher
 - Procurement Dollars 22% Lower

DCAA Audit of Validation

■ Audit Approach

- Review Recalibrations for Similar Programs
- Review Model Results for MSP'98

■ Results of Audit

- PRICE H Results are Overall within $\pm 5\%$ of Program Actuals

■ Conclusions

- MSP'98 Validation Results Provide Optimism that PRICE H Model will Provide Reasonable Future Estimates



Mars Surveyor Program (MSP)

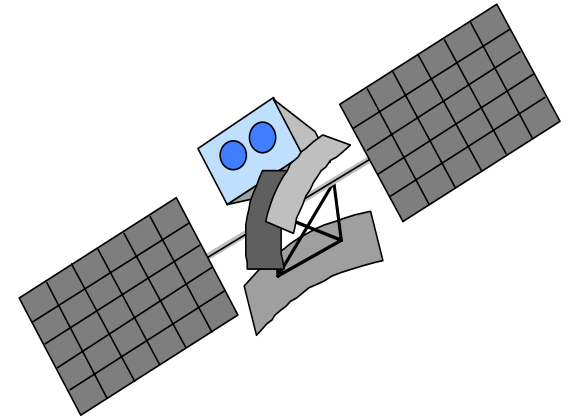
- Near Term 2001 Mission Opportunity to test Model
 - Firm Phase C/D Proposal to JPL in April 1998
 - Conduct Robotic Missions and Data Analysis to Characterize Martian Climate and Resources
 - Attempt to Determine if Life ever Existed on Mars
 - Provide Information for Planning Future Missions
 - NASA Human Exploration and Development of Space Enterprise Strategic Plan

Use of PRICE H on MSP'01 Proposal

- Develop Structures and Mechanisms Subsystem

Estimate --- as Initial Test

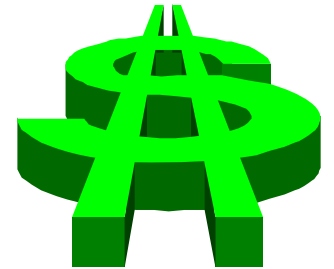
- Orbiter: 580 lbs of metals & composites
- Lander: 660 lbs of metals & composites



- Utilized Relevant Calibrations
- Reconciliation to Independent Project Discrete Estimate --- as Sanity Check
- Complete Documentation for Primary BOE

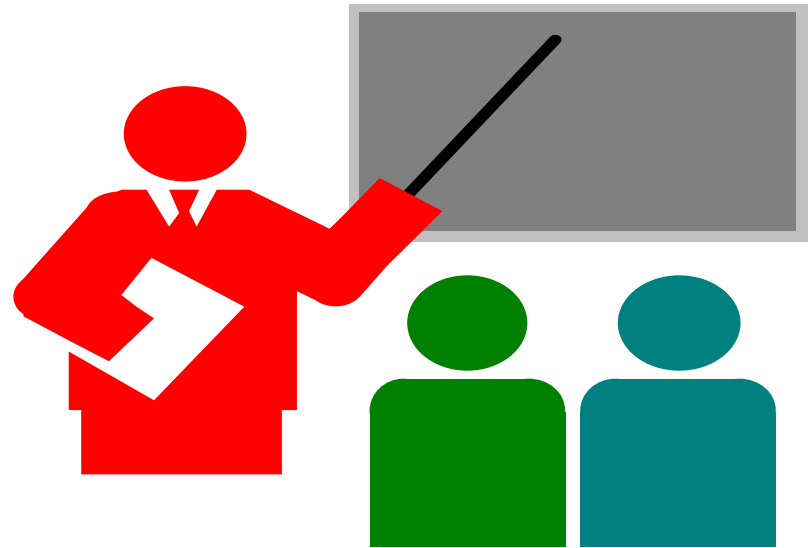
Proposal Results

- Discrete Project Estimate, for Labor, was 2.3% greater than Model Estimate
- Model Estimate for Procurement Costs was 6.0% greater than Project Estimate
- PRICE H was Primary BOE for Labor
- 65% Savings in Estimating and Writing BOE
- BOM was Primary BOE for Material



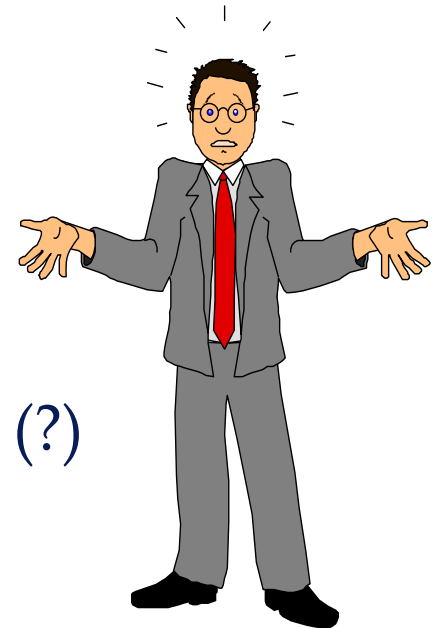
Astronautics Lessons Learned

- **Need Management Support**
- **Need Company Champions**
- **Constant Selling**
- **Sizable Start Up Cost**
- **Team Training A Must**
- **Culture Change Required**
- **A Challenging Learning Process**



Where Do We Go From Here?

- Need to Increase Top Management Commitment
- Expand Use on Flight System Proposals
 - Genesis Proposal, submitted to JPL in July 1998
 - Updated MSP'01 Proposal, submitted Aug. 1998
 - Propulsion System Center of Excellence
- Use of Models for Launch Vehicle Estimates (?)
- Additional PRICE Training
 - Trained 13 additional LMA estimators in May 1998
- Continue Active Support to PEI



PRICE H as Primary BOE

■ Proposal/Subsystem

- MSP'01
Structures/Mechanisms
- Genesis
Structures/Mechanisms
- Genesis Avionics

■ Reconciliation Results

- Project 2.3% > PRICE H
- Project 2.9% > PRICE H
- Project 5.1% > PRICE H