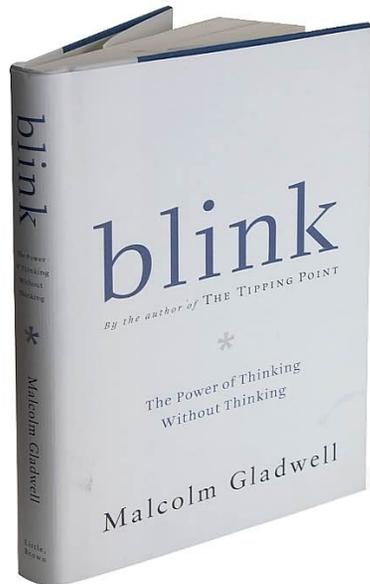




“Thin-Slicing” for Costers Estimating in the *Blink* of an Eye



Neal D. Hulkower, Ph.D.

Vice President, Operations

nhulkower@mcri.com

(703) 584 7001



Topics

- **A Story**
- **About Thin-Slicing**
- **Why Thin-Slicing is Important to Cost Analysts**
- **Examples**
- **Learning to Thin-Slice**
- **Audience Participation**
- **Caveat**
- **Summary**



A Story

Estimating the Bill to Edit a Dissertation



About Thin-Slicing

**“Thin-slicing’ refers to the ability of our unconscious to find patterns in situations and behavior based on very narrow slices of experience.”
Blink, p.23.**

“It is a profoundly erroneous truism, repeated by all copybooks and by eminent people when they are making speeches, that we should cultivate the habit of thinking about what we are doing. The precise opposite is the case. Civilization advances by extending the numbers of important operations which we can perform without thinking about them. Operations of thought are like cavalry charges in battle--they are strictly limited in number, they require fresh horses, and must only be made at decisive moments.”

- Alfred North Whitehead

“When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature.”

- Sigmund Freud

<http://www.gladwell.com/blink/biblio/index.html>



About Thin-Slicing: Is it the Same as Intuition?

“You could also say that it’s a book about intuition, except that I don't like that word. In fact it never appears in ‘Blink.’ Intuition strikes me as a concept we use to describe emotional reactions, gut feelings--thoughts and impressions that don't seem entirely rational. But I think that what goes on in that first two seconds is perfectly rational.”

<http://www.gladwell.com/blink/index.html>

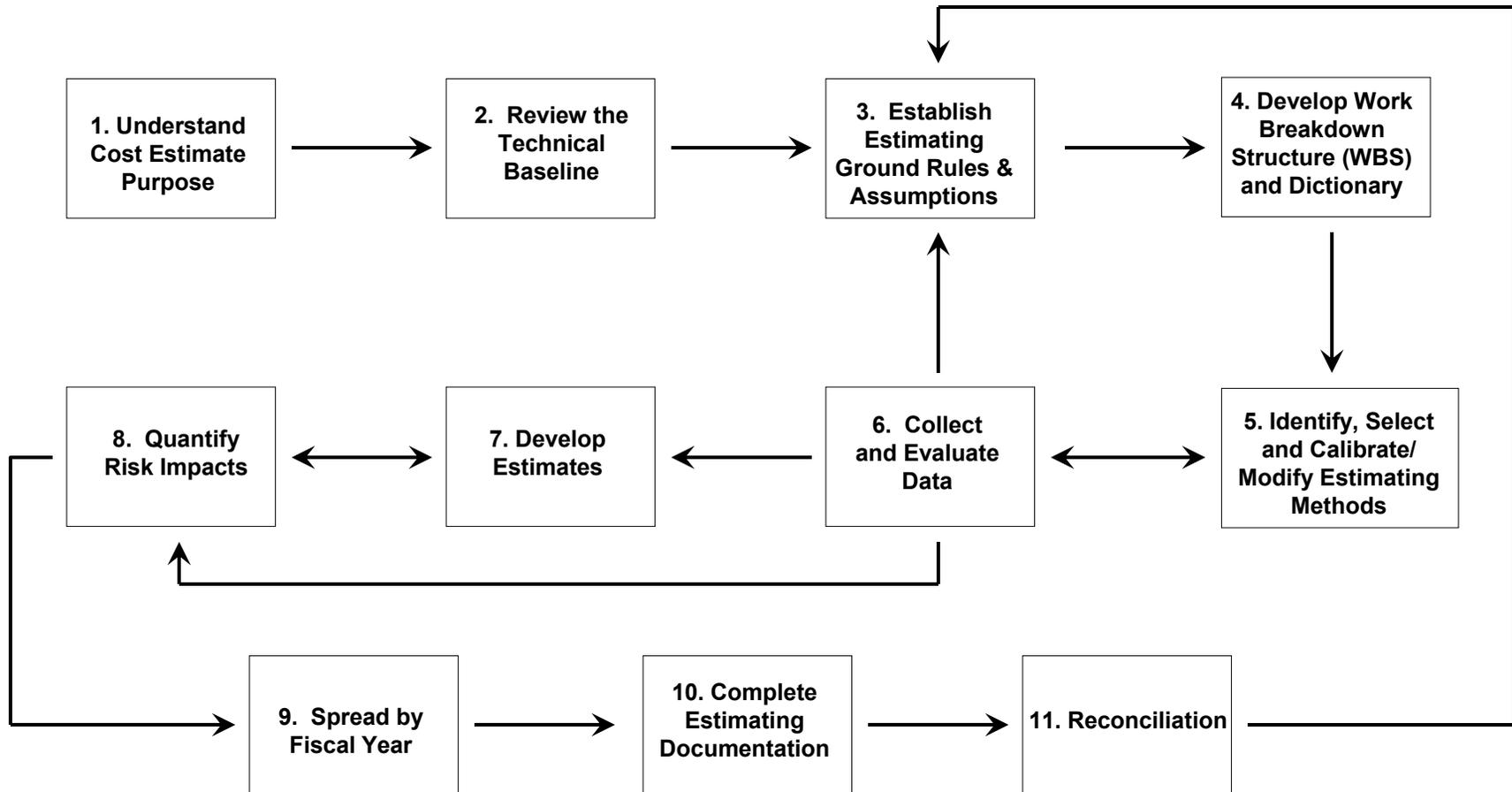


Why Thin-Slicing is Important to Cost Analysis



"Creating
Customer-Focused
Success"

Estimating Process Flow

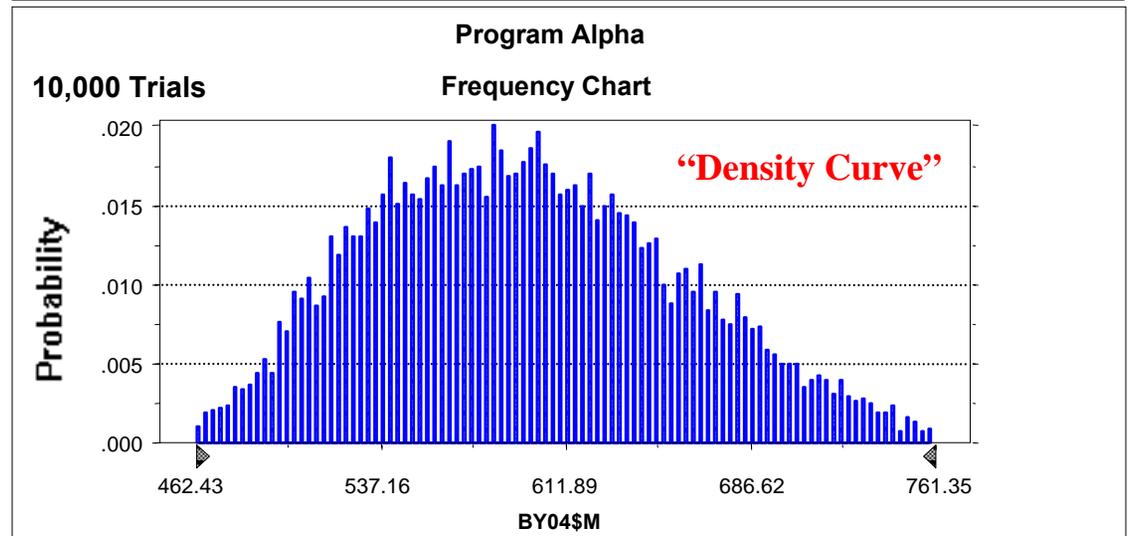
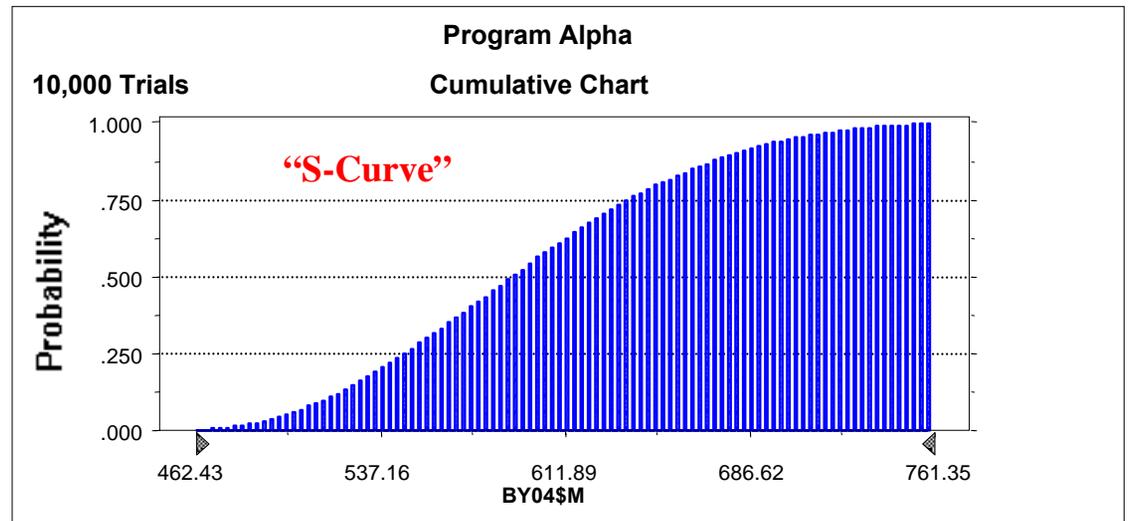




What a Cost Estimate Looks Like

<u>Percentile</u>	<u>Value</u>
10%	516.81
20%	538.98
30%	557.85
40%	575.48
50%	592.72
60%	609.70
70%	629.19
80%	650.97
90%	683.01

<u>Statistics</u>	<u>Value</u>
Trials	10,000
Mean	596.40
Median	592.72
Mode	---
Standard Deviation	63.18
Range Minimum	450.19
Range Maximum	796.68





Where Thin-Slicing Typically Happens in Cost Analysis

- **During quick-turnaround drills or in “casual discussions” usually involving an important decision maker**
 - Ballpark estimating
 - ROMing
- **As part of sanity checking**
 - In your customer’s head
 - In just about every project teammate’s head
 - Everyone is a cost analyst
 - Many have well-tempered guts

But You Can Thin-Slice at Any Step in the Process!



Example 1: Anatomy of My Thin-Slice

- **Inputs**
 - How much I paid to have my dissertation typed in 1977: \$85 for 77 pages
 - Number of pages of the new dissertation: 160
 - Initial estimate of \$250 by other analyst
 - Hint that this estimate was too low
- **My thin-sliced estimate: \$10/page with a bit of a discount: \$1500**
- **Invoice for services: \$1470**



Example 2: My First Estimate

JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM

312/80.3-1570

14 November 1980

TO: J. R. French
 FROM: N. D. Hulkower NDH
 SUBJECT: Cost Estimate for a Mission to Rendezvous with Anteros with a Launch in 1985
 REFERENCE: Hulkower, Neal D., "Input for Cost Estimates for Asteroidal Rendezvous Missions," JPL IOM 312/80.3-1560, 5 November 1980.

In the referenced memorandum, I mentioned that alternative estimates of the cost of the three missions to rendezvous with asteroids will be presented. Since the scientists have decided not to suggest strawman payloads for the two later missions, I have prepared an estimate for the 1985 Anteros opportunity only. This study assumes that the percents of the total cost for each item listed below is approximately the same as for ISPM (International Solar Polar Mission). The costs for the scientific instruments were gathered independently from several scientists. Donna Pivrotto assisted.

The costs in millions of FY81 dollars follow.

Modified Tiros Spacecraft (including 16 2/3% additional for contract management):	\$ 46.70
SSI, NIMS	14.10
Mission Operations	20.70
Project Management	12.90
Science Support Mission Design	6.50
	<u>\$100.90</u>
Additional Cost for X-ray Spectrometer	10.00
	<u><u>\$110.90</u></u>
Grand Total	\$110.90

NDH:blf

Distribution: J. C. Beckman, G. D. Low, D. L. Matson, A. Metzger, B. C. Murray, H. W. Partma, D. L. Pivrotto, D. G. Rea, W. E. Ruhland, D. B. Smith, D. Turner, C. W. Uphoff, Advanced Projects Group (312), LCPC List



Example 2: A Rule of Thumb

Total space mission cost is 3 times the space vehicle cost.

Donna Shirley

$3 \times 46.7 = 140.1$ compared to 110.9

Conclusion: Uh-oh



Example 3: Why Are They So Cheap?

- **An artisan organization's software development environment consistently offered bottom-up estimates that are lower than parametric estimates**
- **What is going on?**
 - **Productivity of organization "off the charts"?**
 - **Software development process of organization differs from that of the models?**
 - **Some software cost book kept elsewhere?**



Example 4: What Should Be the License Fee?

- **A True Story**
- **Some factors**
 - **Duration of license (generally unlimited for some of our stuff, sometimes annual)**
 - **Usage of the product in terms of numbers of forms, checks, or mail pieces processed per hour or day, and the number of sites in which the software will be installed**
 - **Any limitations imposed by customer such as exclusivity (this adds a zero) or prohibitions of any kind imposed on us**
 - **Whether source code has to be delivered (if so, we charge a large premium)**
 - **“What the Market will bear”**



Example 4 (Chart 2)

- **Some more factors**
 - **Quantities...we give discounts for minimum purchases over some period of time or sometimes indefinitely**
 - **Third-party license fees we have to pay to others (we'll, of course, include some markup)**
 - **“Pain-in-the-ass” factors for particularly annoying customers or ones you'd like to have go away**
 - **Whether maintenance, upgrades, or other post release services are included (we try to keep these separate)**
 - **What it cost to develop**



Example 4 (Chart 3)

- According to Bob Reiss, a columnist for *Inc.* magazine and former CEO of several small successful companies, there are only **Four Numbers** you need to know to understand a company's financial position
- The Four Numbers are ...
 - The company's cash flow
 - The cost breakdown of his products
 - The break-even analysis for his company
 - **The break-even analysis for each of his products**



Example 4 (Chart 4)

- **From The Four Numbers to the license fee**
 - **The Four Numbers were provided monthly by our Controller**
 - **One of these numbers was the breakeven analysis for the crystal database technology**
 - **Taking into account several of “The Factors” plus a reasonable margin, we settled on a proposed license fee**



Learning to Thin-Slice

- **Conscious efforts**
 - Pay attention to what things cost and why they cost what they do
 - Collect and study trend charts
 - Play with reliable cost models to discern their sensitivities to the drivers
 - Develop and adopt rules of thumb then test them periodically against reality
 - Develop a healthy skepticism
 - Get good at analogizing
 - Practice doing arithmetic in your head (rounding helps)
- **You can't help but thin-slice - but just see how good you are at it for a while before sharing**



Audience Participation



Exercise 1: Everything OK?

WBS	Low	Most Likely	High
1.1	123	456	789
1.2	105	112	121
1.3	6766	6981	7785
1.4	55610	63301	62222
1.5	41562	56797	69000
1.6	785	785	1523
1.7	12123	19999	20145
1.8	5466	7895	10555
1.9	4432	4453	7896
1.10	71	69	67
1.11	39854	45698	52555
1.12	1029	1088	1029
1.13	1017	2456	3477
1.14	48892	48829	69874
1.15	8892	18829	30051
1.16	3351	3350	8781

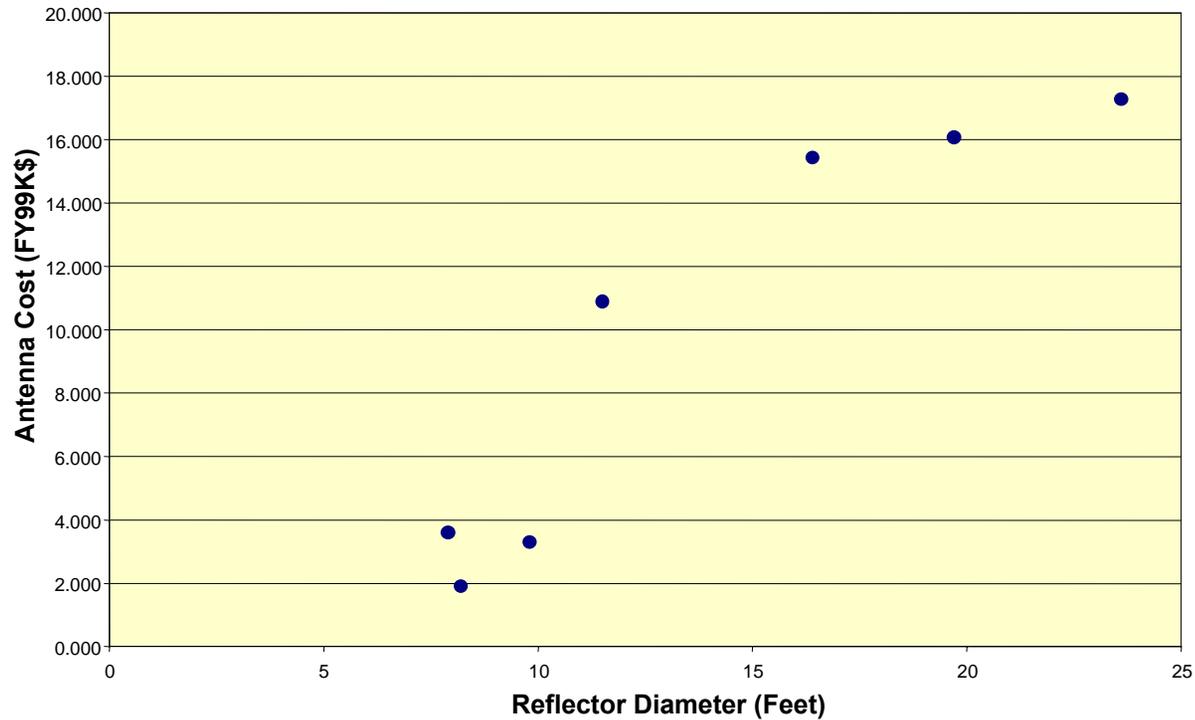


Exercise 1: Nope!

WBS	Low	Most Likely	High
1.1	123	456	789
1.2	105	112	121
1.3	6766	6981	7785
1.4	55610	63301	62222
1.5	41562	56797	69000
1.6	785	785	1523
1.7	12123	19999	20145
1.8	5466	7895	10555
1.9	4432	4453	7896
1.10	71	69	67
1.11	39854	45698	52555
1.12	1029	1088	1029
1.13	1017	2456	3477
1.14	48892	48829	69874
1.15	8892	18829	30051
1.16	3351	3350	8781



Exercise 2: Best equation?



$$y = 0.637x$$

$$y = -7.0576 + 1.2360x$$

$$y = 0.1037x^{1.6934}$$

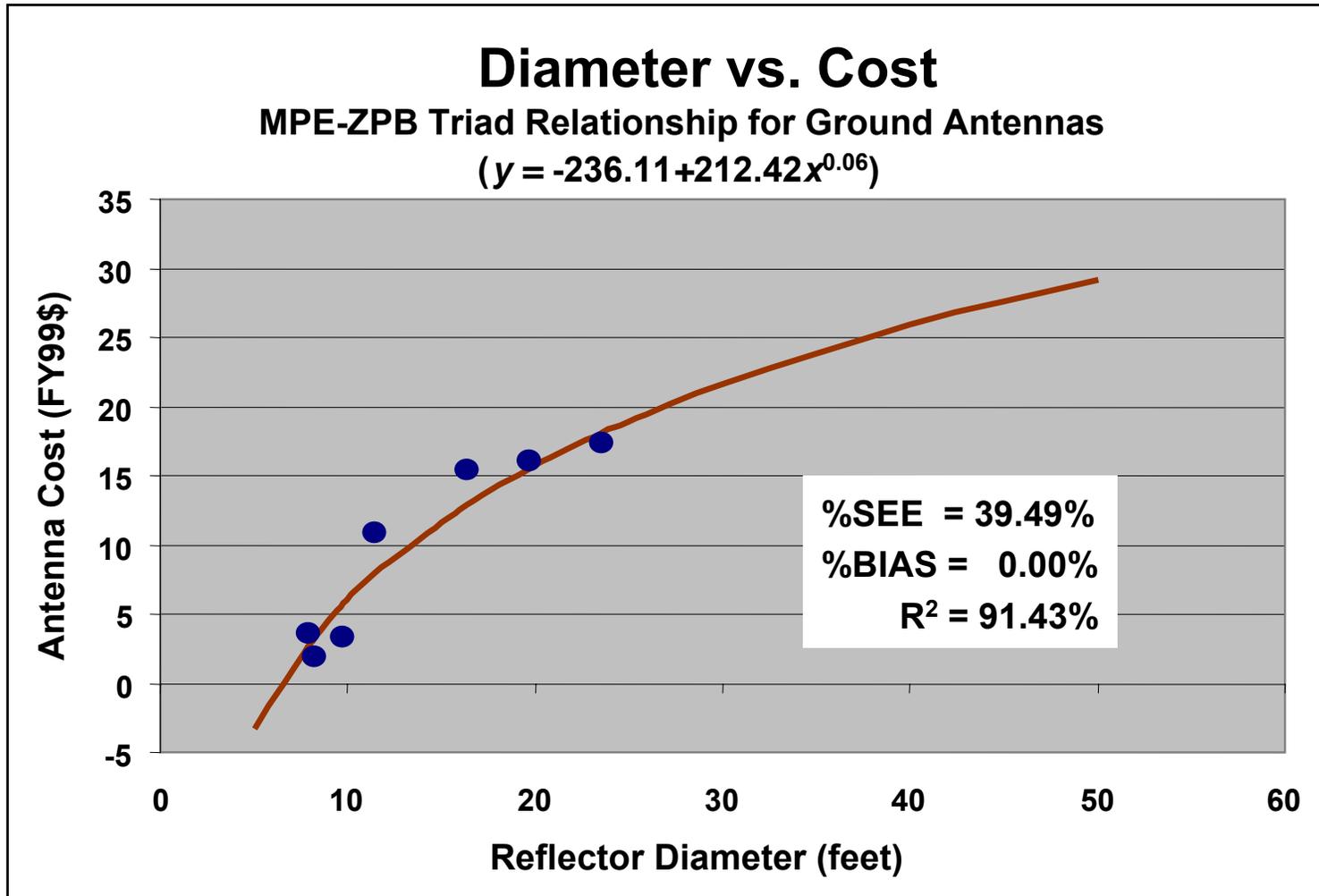
$$y = -236.11 + 212.42x^{0.06}$$

From: Steve Book, "IRLS/MUPE CERs Are Not MPE-ZPB CERs"



"Creating
Customer-Focused
Success"

Exercise 2: Here you go



From: Steve Book, "IRLS/MUPE CERs Are Not MPE-ZPB CERs"



Exercise 3: Now what?

A parametric estimate differs greatly from a bottom-up estimate.



Exercise 3: Some Ideas

- **WBS mismatch**
- **Potential bottom-up estimate issues**
 - Double counting
 - Items left out
 - Gold plating or buying in
- **Potential parametric estimate issues**
 - Cultural mismatch
 - Scale of project mismatch
 - Doesn't account for critical cost driver



Exercise 4: Assumptions on Hardware Costs

- **All technology development will be done outside of this estimate**
 - **Internal Secure Communications Network (ISCN) technology development will be done using Science and Technology (S&T) Space funds**
 - **Demonstration/Validation (Dem/Val) in the ISCN acquisition program may be minimum or eliminated due to strong ISCN-related technology and system-level demonstration programs**
- **Risk**
 - **There will be no risk from technical performance or schedule compression – this will be true when an effective oversight on S&T Space budget is implemented**
 - **No nonrecurring engineering (NRE) for transmitter/receiver (T/R) modules as they will be commercial-off-the-shelf (COTS) by the time of use**
- **15-year lifetime for all components – This assumption may be conservative**



Exercise 4: Wishful Thinking!

- **Critical risk items assumed away**
 - **Technology readiness of network**
 - **Funding for necessary technology development**
 - **No Dem/Val before insertion in system**
 - **COTS modules will be available**
 - **Unreasonable life expectancy**
- **A disaster waiting to happen!**



Exercise 5: Give Me A ROM For ...

- **A 300 kg small satellite for NASA**
- **10,000 ESLOC of military mobile software in C++**
- **A late model F16**
- **An aircraft carrier**



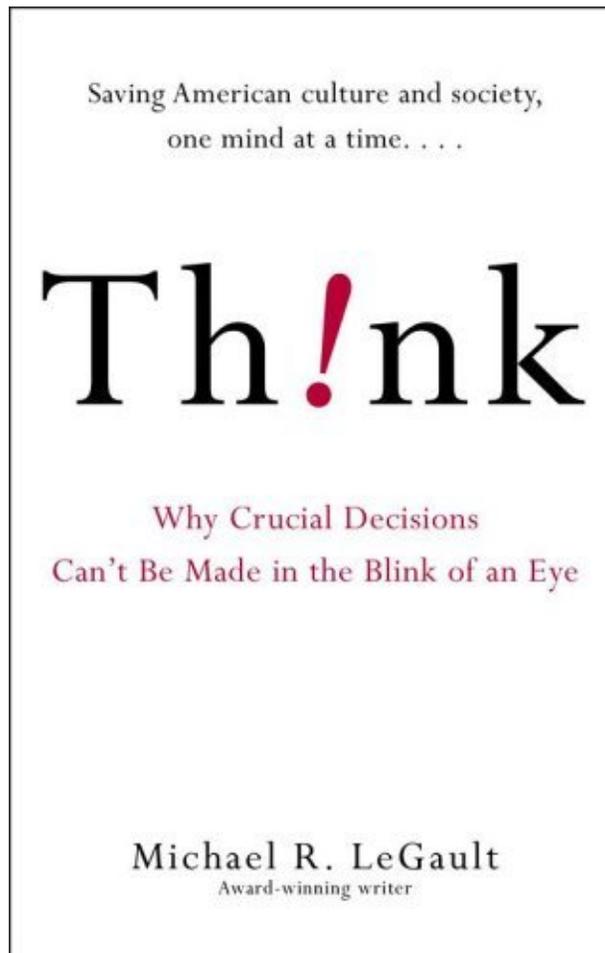
Exercise 5: My Thin-Slices

- **A 300 kg small satellite for NASA:**
 $300 \times \$156\text{K/kg (FY06)} = \46.8M (FY06)
- **10,000 ESLOC of military mobile software in C++:**
 $(10,000 \text{ ESLOC}/148 \text{ ESLOC/SM}) \times \$22.3\text{K/SM} \approx \1.5M
- **A late model F16: \$25M**
- **An aircraft carrier: \$4B**



Caveat

- **Blinking is not a substitute for Thinking**





Summary

- **Thin-slicing is useful during all steps in the cost estimating process and especially to guide analyses and to check results**
- **Almost everyone thin-slices but only those who have quietly tested how well they do it should do so in public**
- **The best *Blinking* is done after one has done a lot of *Thinking***

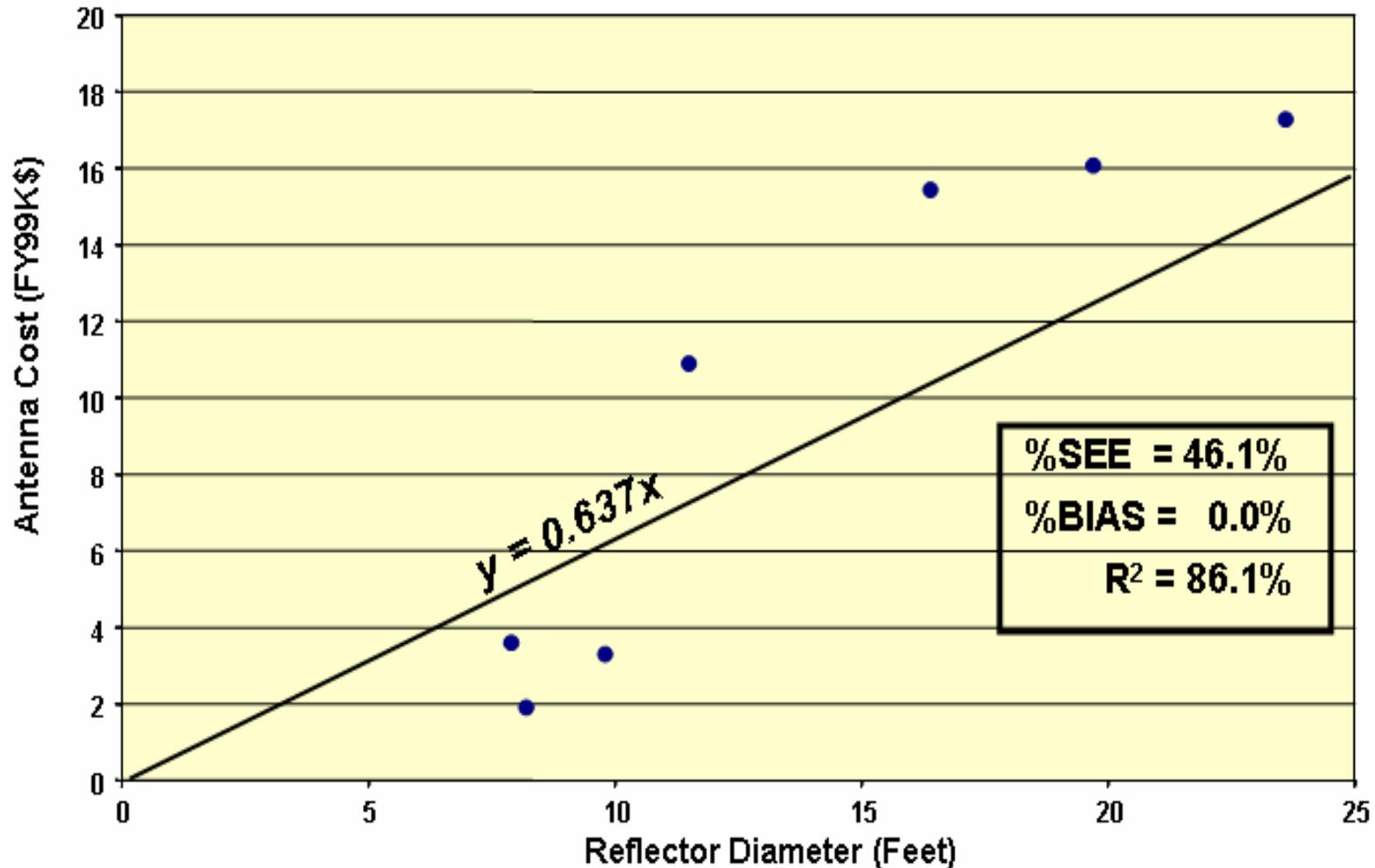


Backup Charts



IRLS/MPE-ZPB Factor CER

Dollars-per-Diameter-Foot Relationship for Ground Antennas

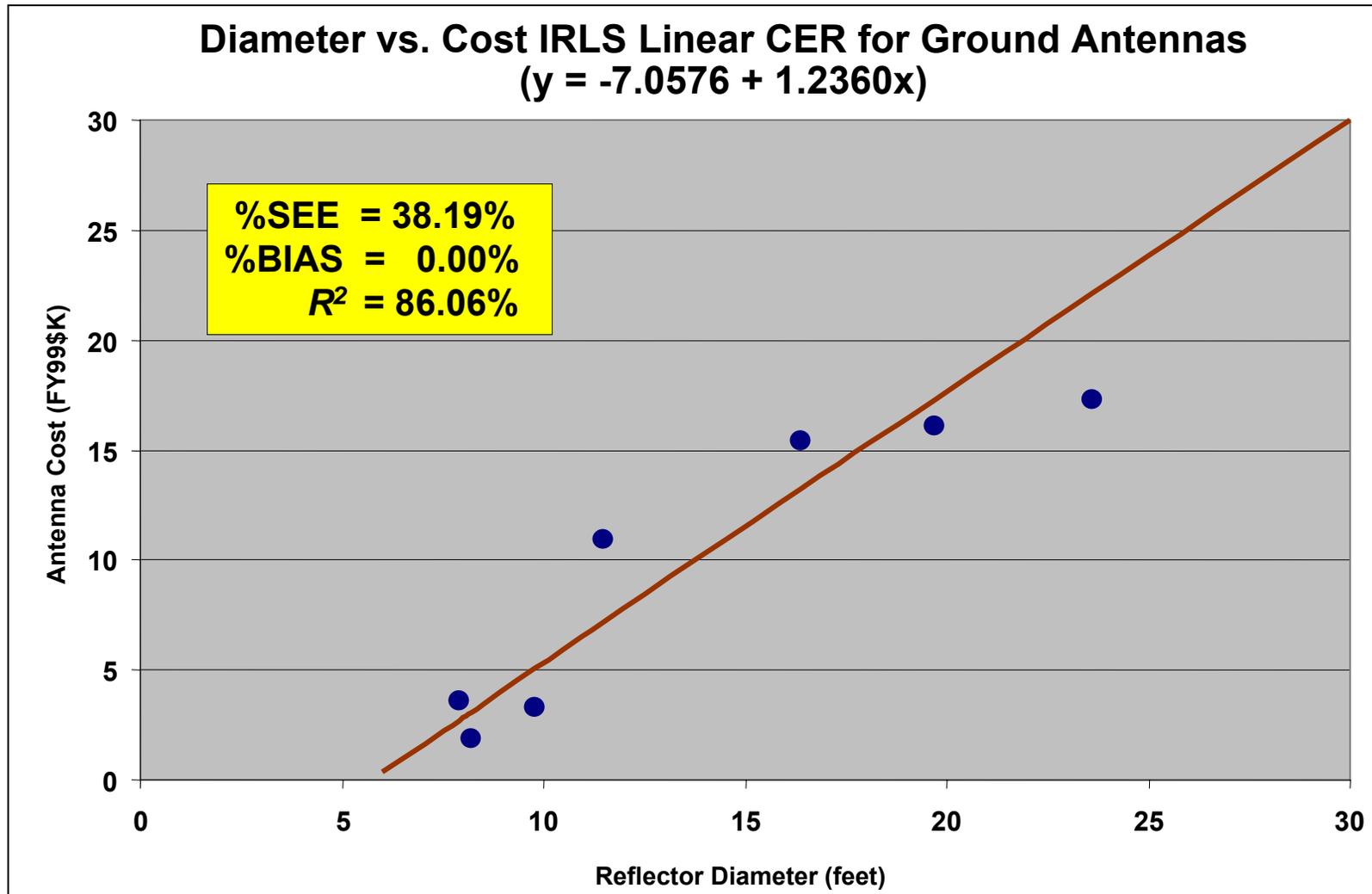


From: Steve Book, "IRLS/MUPE CERs Are Not MPE-ZPB CERs"



"Creating
Customer-Focused
Success"

IRLS Linear CER

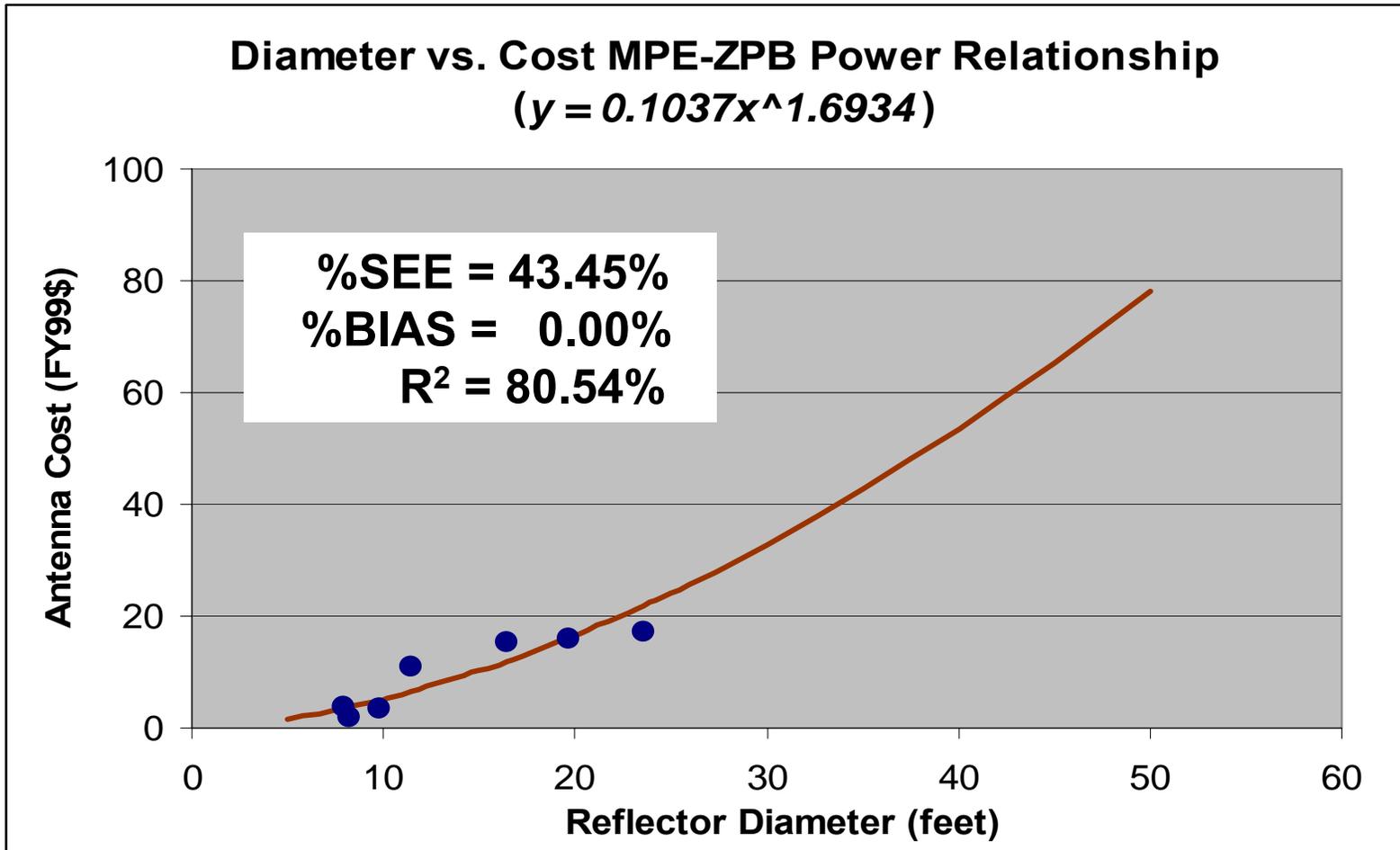


From: Steve Book, "IRLS/MUPE CERs Are Not MPE-ZPB CERs"



"Creating
Customer-Focused
Success"

MPE-ZPB Power CER



From: Steve Book, "IRLS/MUPE CERs Are Not MPE-ZPB CERs"



Acronyms

B	billion
CEO	Chief Executive Officer
CER	Cost Estimating Relationship
COTS	Commercial Off the Shelf
Dem/Val	Demonstration/Validation
ESLOC	Executable Source Lines of Code
FY	Fiscal Year
IRLS	Iteratively Reweighted Least Squares
ISCN	Internal Security Communications Network
JPL	Jet Propulsion Laboratory
K	thousand
M	million
MPE	Minimum Percentage Error
MUPE	Minimum Unbiased Percentage Error
NASA	National Aeronautics and Space Administration
NIMS	Near-Infrared Mapping Spectrometer
NRE	Nonrecurring Engineering
ROM	Rough Order of Magnitude
S&T	Science and Technology
SEE	Standard Error of Estimate
SM	Staff months
SSI	Solid State Imaging
T/R	transmitter/receiver
WBS	Work Breakdown Structure
ZPB	Zero Percentage Bias