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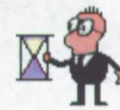
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Accurate Estimates In Less



Than A Minute



Conceptual Estimating in Excel Using
Historical Data



NASA - KSC

Glenn Butts

CCC, CGC, CMC, CFC

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Time is Money



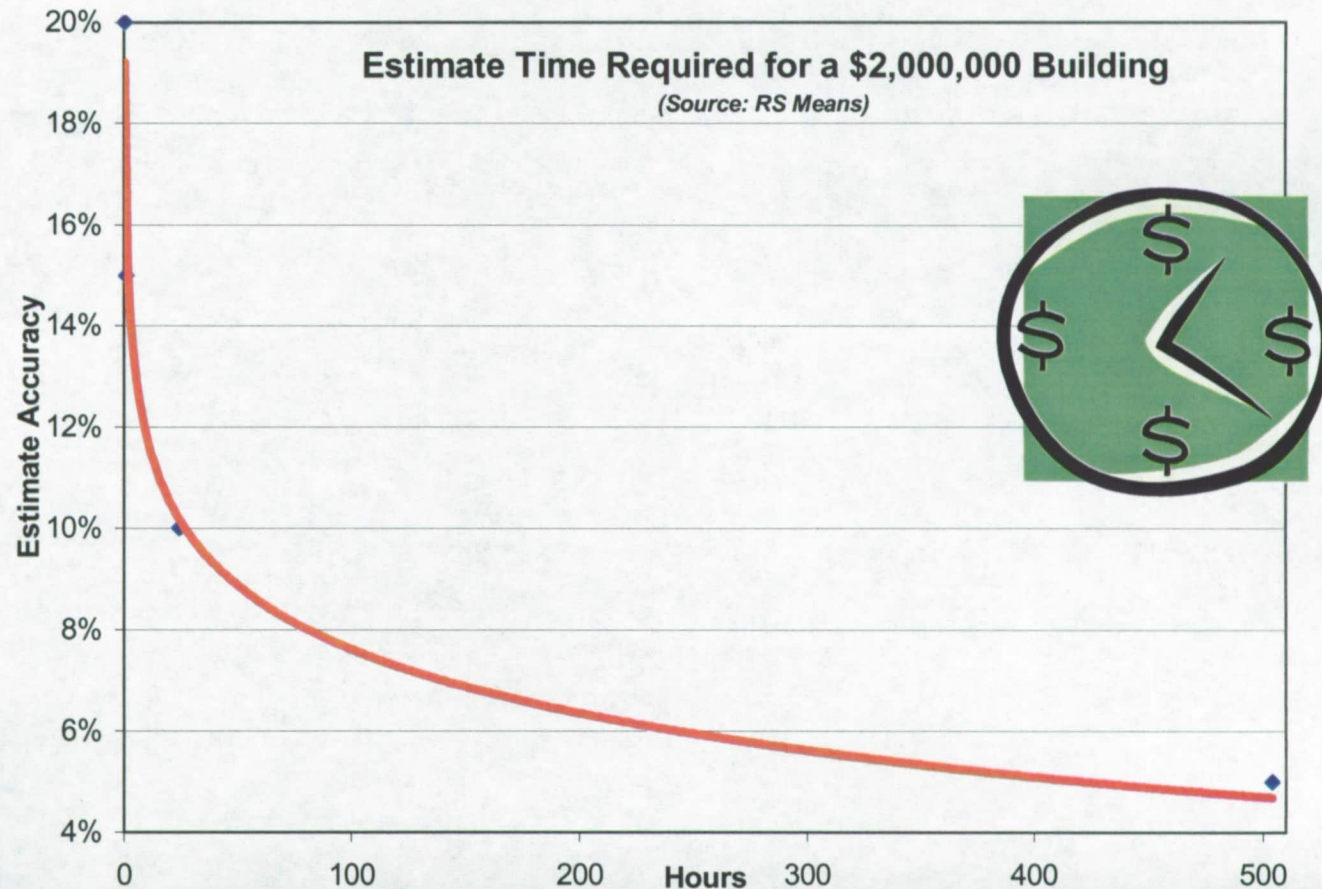
- Accurate estimates are essential
 - But only limited time to prepare
- This method is great for
 - Initial Budgets
 - “What If”
 - “How Much”
- Works on many types of projects
- Customizable to your requirements
 - Interpolation allows estimating of non-typical projects



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Time is Money



AACE Certification Guide

\$20 Millon Project Min

Est Class	% Error	Hours	Cost of Estimate	% of Job
Class 5	-50% To +100%	1	\$ 63	0.003%
Class 4	-30% To +50%	20	\$ 1,260	0.063%
Class 3	-20% To +30%	150	\$ 9,450	0.473%
Class 2	-15% To +20%	300	\$ 18,900	0.945%
Class 1	-10% To +15%	600	\$ 37,800	1.890%

\$20 Millon Project Max

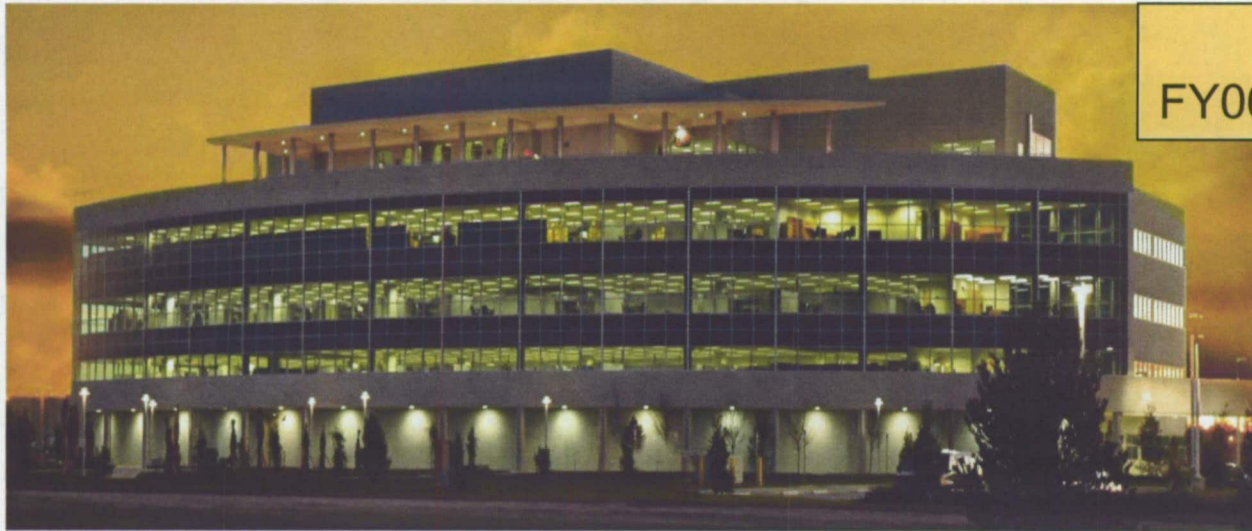
Est Class	% Error	Hours	Cost of Estimate	% of Job
Class 5	-50% To +100%	200	\$ 12,600	0.63%
Class 4	-30% To +50%	300	\$ 18,900	0.95%
Class 3	-20% To +30%	1,500	\$ 94,500	4.73%
Class 2	-15% To +20%	3,000	\$189,000	9.45%
Class 1	-10% To +15%	6,000	\$378,000	18.90%

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How much is a new office?



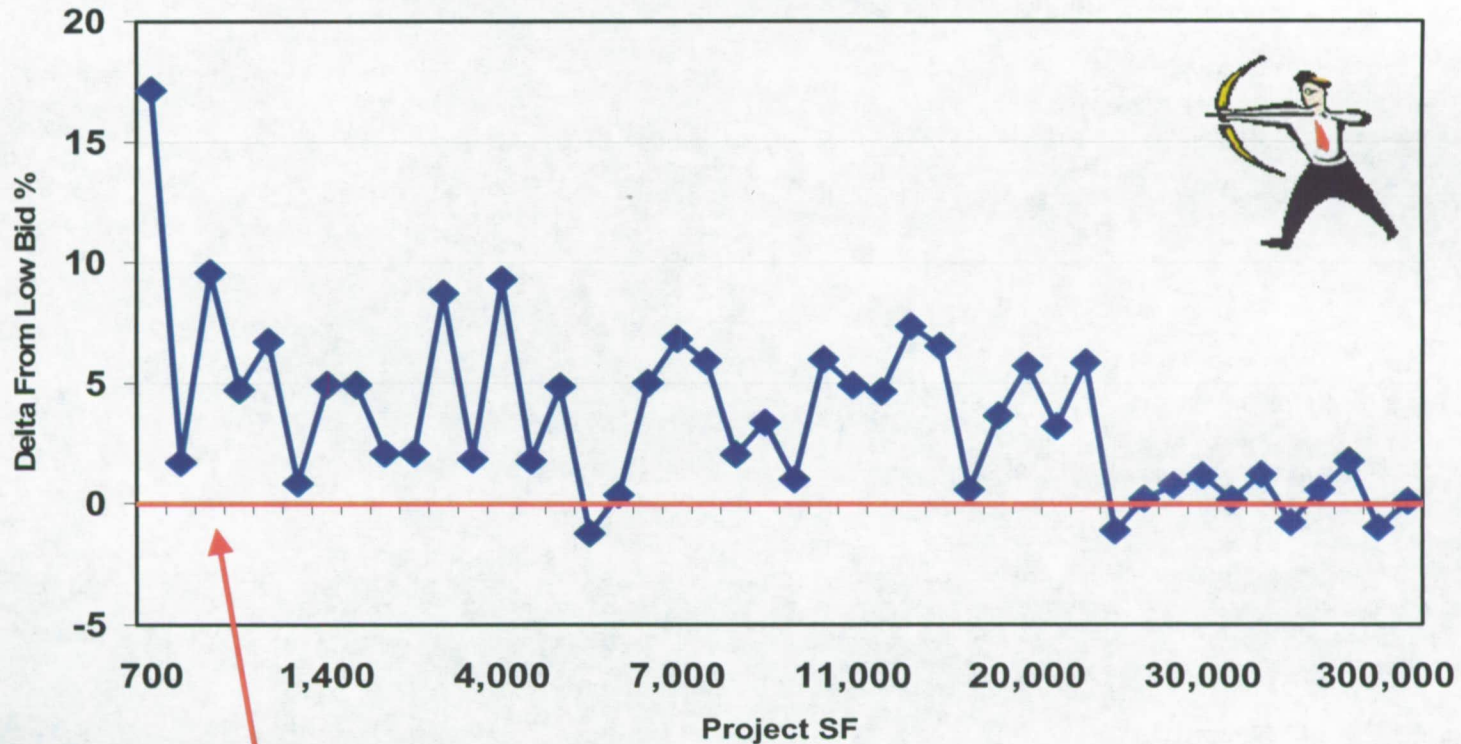
189,000 SF
FY06 Cost - \$154 per SF

1,440 SF
FY 06 Cost - \$276 per SF



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Parametric Estimates can be Very Accurate



Low bid for each project

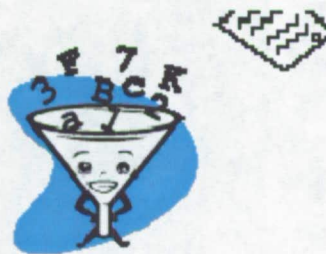


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Basic Concept

- Historical data used to estimate new projects
- Data is
 - Collected
 - Filtered
 - Normalized
 - Averaged
 - Adjusted for specific project



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Data Collection

Project Number	Use	Scope	Type	Project Class	PROJECT TITLE	Unit Cost	UM	Bid Date	Original Size	No. of Bids
8	Processing	New	Platform	GSE	PCR Mid-body Umbilical unit (10.5 Tons structural steel) class 100,000 clean room located on the RSS	600.88	SF	Apr-77	228	4
9	Specialty	New	Steel	Bldg	OAA Environmental Chamber (aluminum room) 160 SF	839.48	SF	May-77	160	6
10	GSE	New	Steel	GSE	MLP Tail Service Masts	410.90	SF	May-77	1,618	3
11	Office	New	Sprinkler	Bldg	Fire Protection Operations Support Building Bldg 1270J 38 Heads	4.44	SF	May-77	3,636	8
12	Specialty	New	Crane	GSE	Mate/Demate Stiff Leg Crane 50 Ton 86' H	2,997.30	Ton	Jul-77	50	2
13	Shop	New	Partial	Bldg	Operational Support Building -Tech. Support Bldg. 9'4" H (2/5,000 SF metal bldg.) No Mech Or Elect Phase 1	9.56	SF	Aug-77	10,000	6
14	Utility	Mod	Pipeline	HVAC	HTHW mods zones 1 and 2 (3/6" to 8" pipe 10,156 LF) (Plant?)	75.78	LF	Sep-77	10,156	5
15	Shop	New	Partial	Bldg	Operational Support Building -Tech. Support Bldg. 9'4" H Phase 2 Building Costs in Phase 1	19.99	SF	Oct-77	10,000	6
15	Shop	New	Steel	Bldg	Operational Support Building -Tech. Support Bldg. 9'4" H Total Project	86.52	SF	Oct-77	10,000	6
16	Processing	R&R	Fans	Roof	Rebuild Gravity Roof Ventilators, VAB Building K6-0848	1,180.50	EA	Mar-76	32	7
17	GSE	New	Steel	GSE	Cargo Integration Test Equipment, O&C	95.59	SF	Apr-78	1,660	9
18	Specialty	New	Steel	Bldg	High Purity Oxygen Facility, LC-39	119.25	SF	Apr-76	1,296	7
19	Processing	Mod	Clean Room	Bldg	High Bay Shuttle Payload Vertical Processing Facility (VPF) building addition (air lock?) Platforms? Package II Phase IIA & B was bid October 20, 1978 with W&J the low bidder see exhibit XIII for bids and scope.	155.95	SF	Apr-78	20,000	5
20	Specialty	Mod	Elect	Utility	MLP #2 Piping and Cabling, Blast Deck-System. Hoist & Sound Suppression NIC, Summary	96.17	SF	May-78	21,014	5
21	Specialty	Mod	Elect	Utility	MLP #2 Piping and Cabling, Blast Deck L&M Summary	96.17	SF	May-78	21,014	5
22	Specialty	Mod	Elect	Utility	MLP #2 Piping and Cabling, Blast Deck -Budgeted Cost	96.17	SF	May-78	21,014	5
		Mod	Steel	LC	LC 37 Pad "B" Shuttle Mods, Install 300,000 Gal Water Tank, Water Pit, Sound Suppression, Crane, Pipe, Slide Wire	4,984.06	Ton	Jun-78	3,450	6
		R&R	Built Up	Roof	Roof-Over, Not Replacement of VAB High Bay Building K6-0848	2.12	SF	Jan-79	215,750	7
		New	Steel	PEMB	Facility News Facility Bid 12'H	35.88	SF	Mar-79	6,000	5
		Addition	Steel	PEMB	Office Facilities for Security Patrol 19'H	40.06	SF	Mar-79	1,706	5



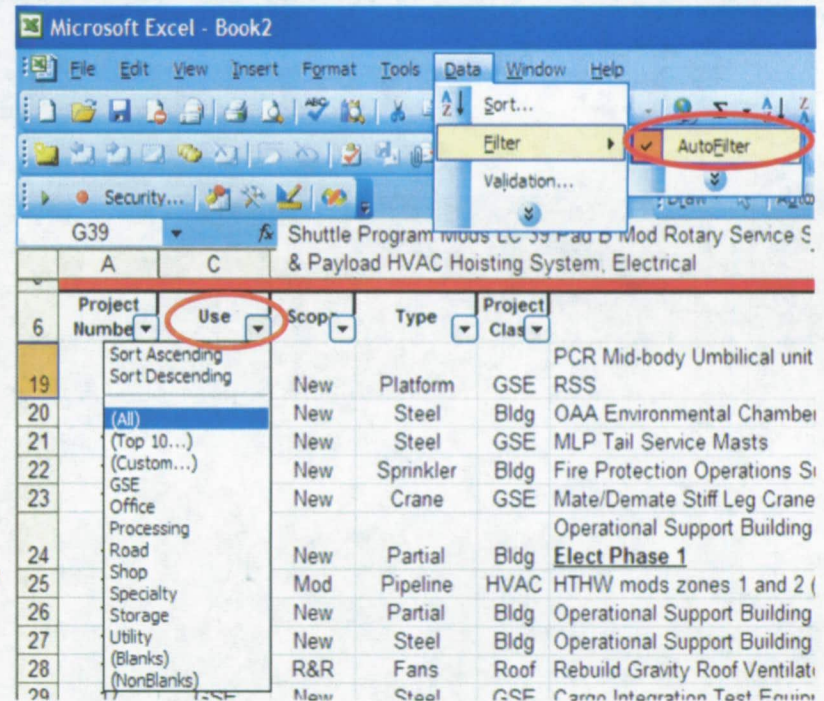
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Filter Methods

- Manual
 - Slow
- Excel Data Filter
 - Easiest
- VBA – Filter Copy
 - Sub Copy_Filter()
 - Sheets("Sys#").Range("A13:BQ5000").AdvancedFilter
Action:=xlFilterCopy, _
 - CriteriaRange:=Range("A13:AR14"),
CopyToRange:=Range("A17:AR17"), Unique:=False
 - End Sub





Formulas



- Formulas are in Excel format
 - * = multiplication
 - / = division
 - ^ = exponent

10784.36
5x
9÷1
2.71828

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Number of Bidders

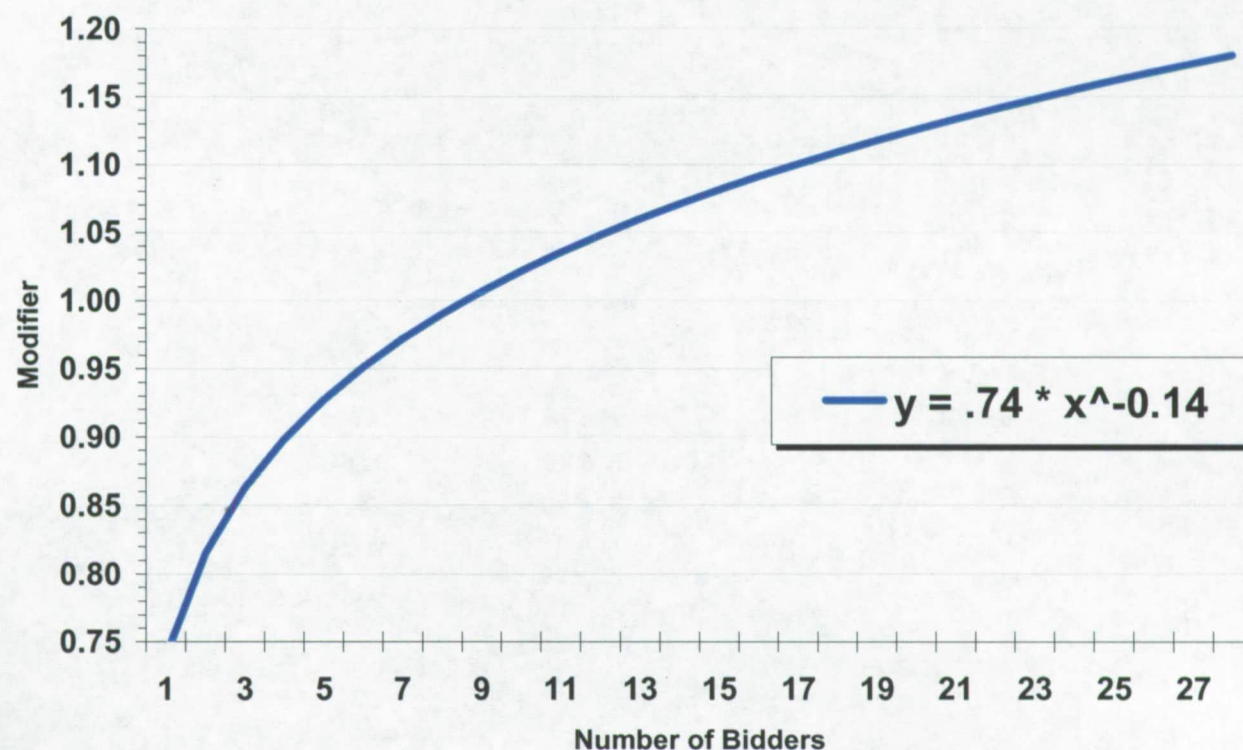
- Adjust costs for the number of bidders
 - Corrects for market conditions
- Algorithm from historical bid data
 - Note: Bids by a 8(a) Set Aside, or HUBZone can result in higher costs than corrected for by algorithm



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Number of Bidders



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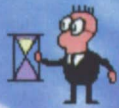


Number of Bidders

- Algorithm
 - $Y = 0.74 * \text{number of bidders}^{0.14}$
 - Y = percentage adjustment required for project
- Example
 - project with two bidders, \$126.50 per SF:
 - $0.74 * 2^{0.14} = 81.5\%$
 - $81.5\% * \$126.50 = \103.10 per SF



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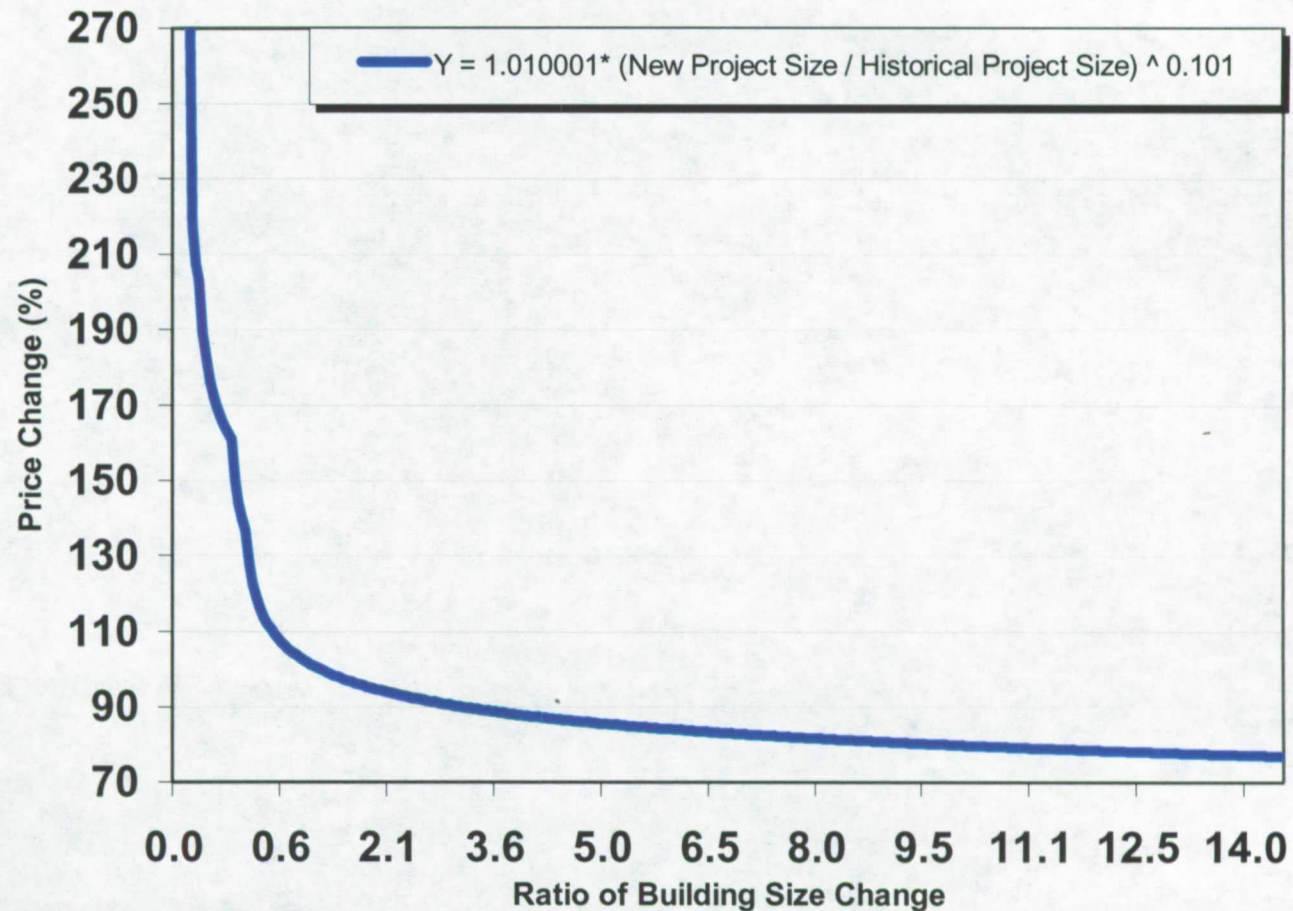


Economies of Scale

- Small projects have higher unit costs than large projects
 - $Y = 1.010001 * (\text{new project size} / \text{historical project size})^{-0.101}$
 - Projects under 3,000 SF require additional adjustment, see paper for details
- Example
 - Historical project 30,000 SF, New project 50,000 SF
 - \$103.10 per SF Cost from Step 1
 - $1.010001 * (50,000 / 30,000)^{-0.101} = .959$
 - $.959 * \$103.10 \text{ per SF} = \98.87 per SF



Economies of Scale



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Escalation

- Data must be escalated
- Excel VLookup function used
 $\text{=VLOOKUP}(\$I\$5,CE2:CF6,2,FALSE)-1$
- Cost indexes used for escalation (averaged)
 - ENR – BCI
 - ENR – CCI
 - KSC – TR-1511
- Example
 - BCI November 2005 = 4352
 - BCI April 2002 = 3583
 - $4352 / 3583 = 121\%$
 - $\$98.87 * 121\% = \119.63 per SF

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Final Adjustments

- Other adjustments as required
 - Number of stories
 - Number of bidders anticipated
 - Anticipated overtime
 - Degree of finish
 - Site development required
 - Project location
 - LEED level
 - Difficulty
 - Escalation to mid point of construction



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Final Adjustments

- Algorithms or tables
- Tables applied with Excel's Data Validation & VLookup functions
- Conditional formatting used to identify other than normal items

% of Total Project	100%	114.1%	Anticipated Number of Bidders	4	7.2%
Hrs Week	40	0.0%	Project Date	Jun-07	12.4%
# of Stories	3	4.0%	Project Location	KSC	0.0%
Site Development	Average	0.0%	Leed Level	Silver	2.3%
Finish	Average	0.0%	Difficulty	Normal	0.0%

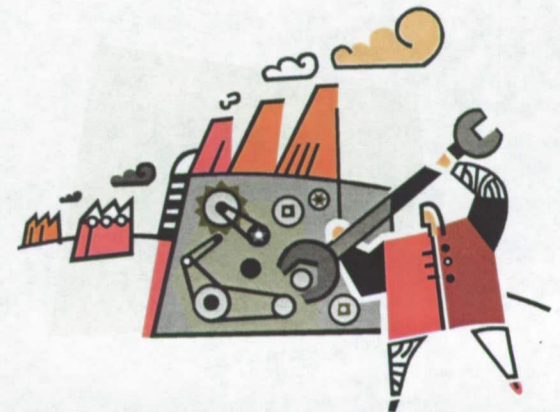


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Final Adjustments

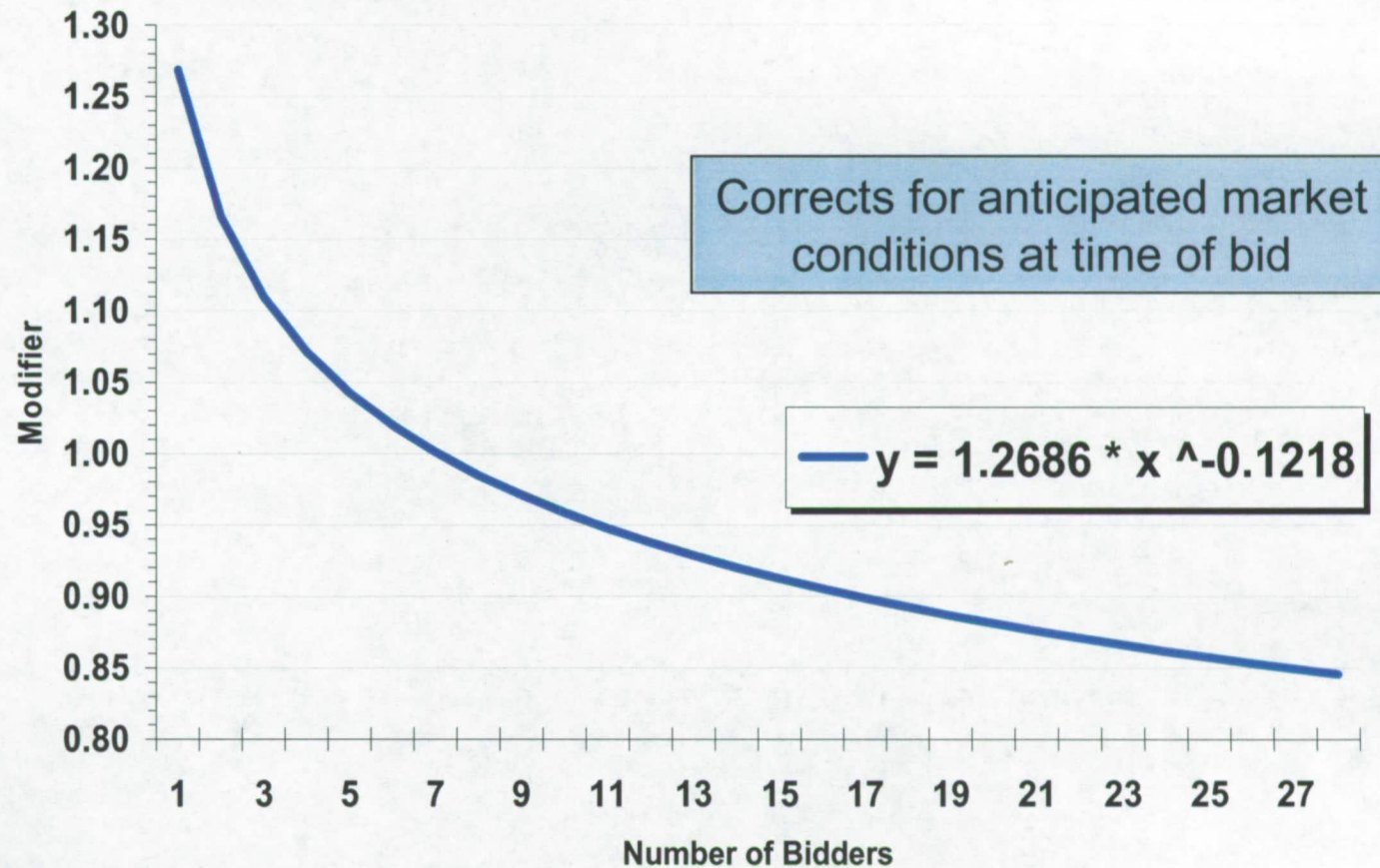
- Factors must be calculated correctly
 - $(\text{Factor 1} + 1) * (\text{Factor 2} + 1) * (\text{Factor 3} + 1) =$ markup percentage
- Method avoids compounding markups



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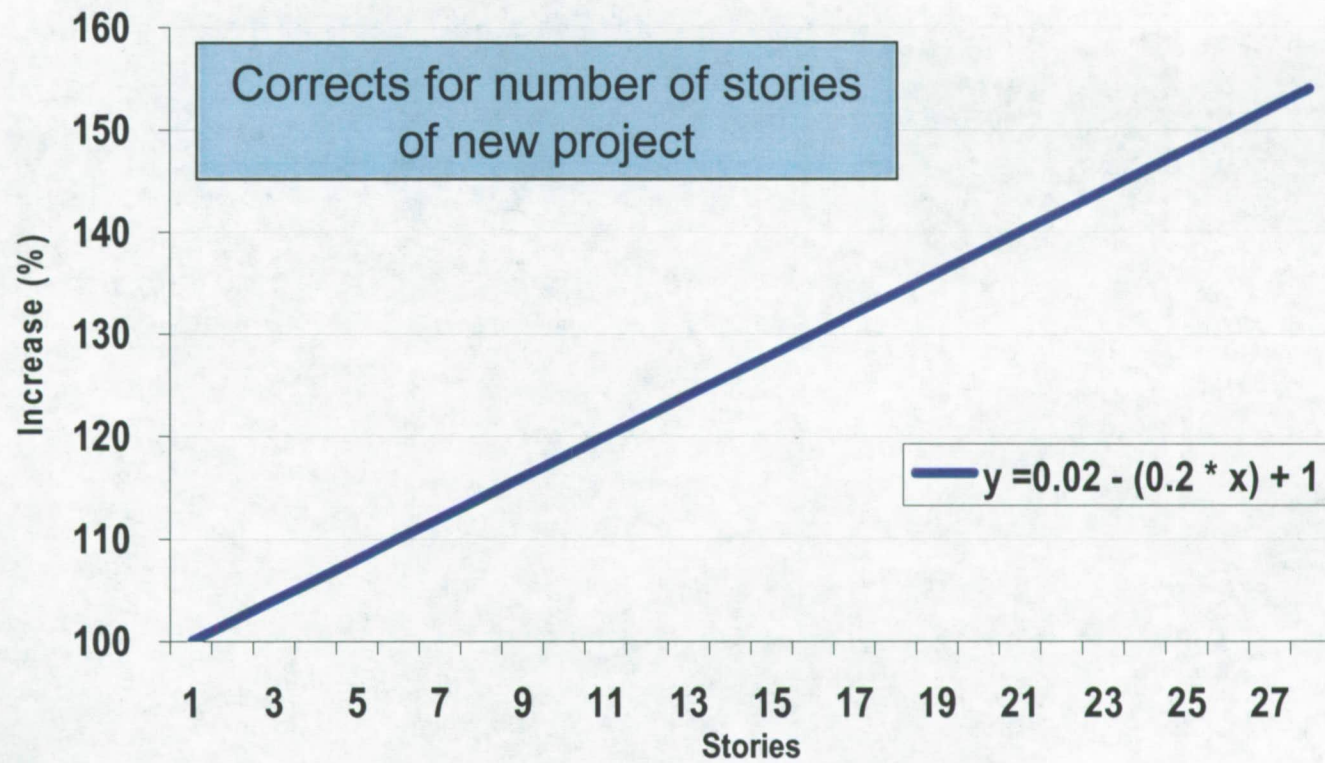
Number of Bidders



X = Number of bidders



Number of Stories



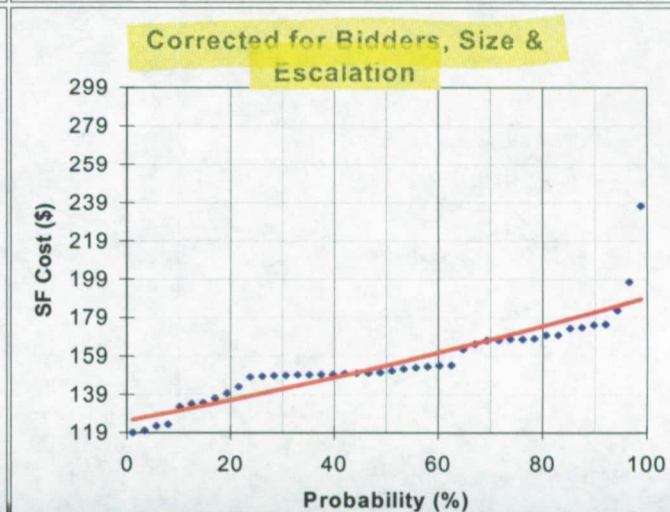
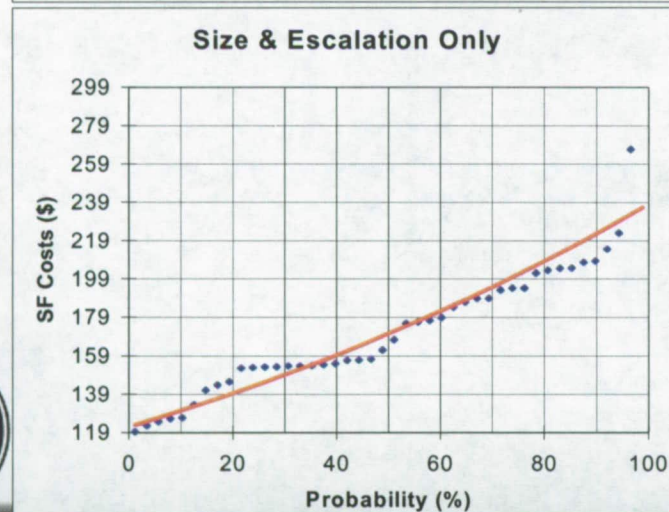
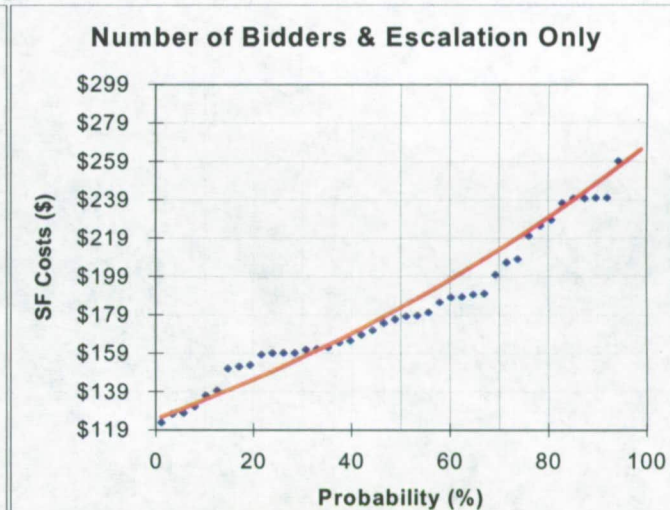
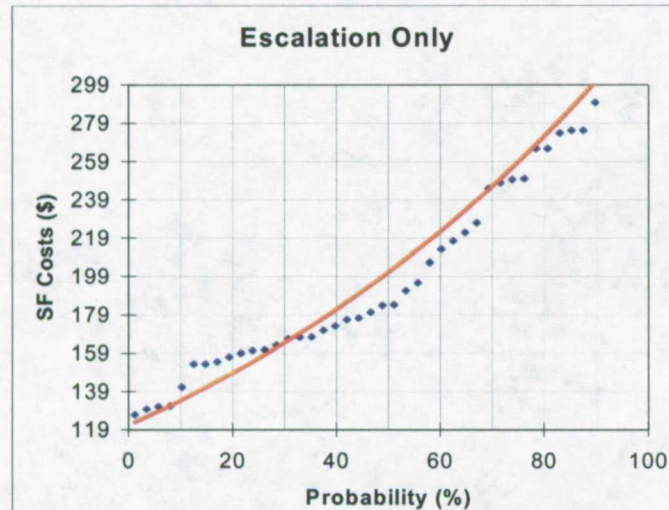
X = Number of Stories

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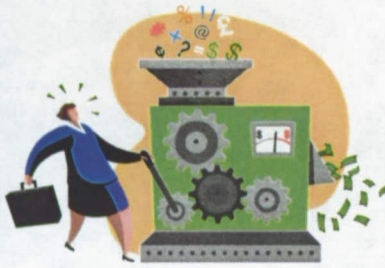


Result of Adjustments



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Testing



- Models must be tested after completion to verify means and methods



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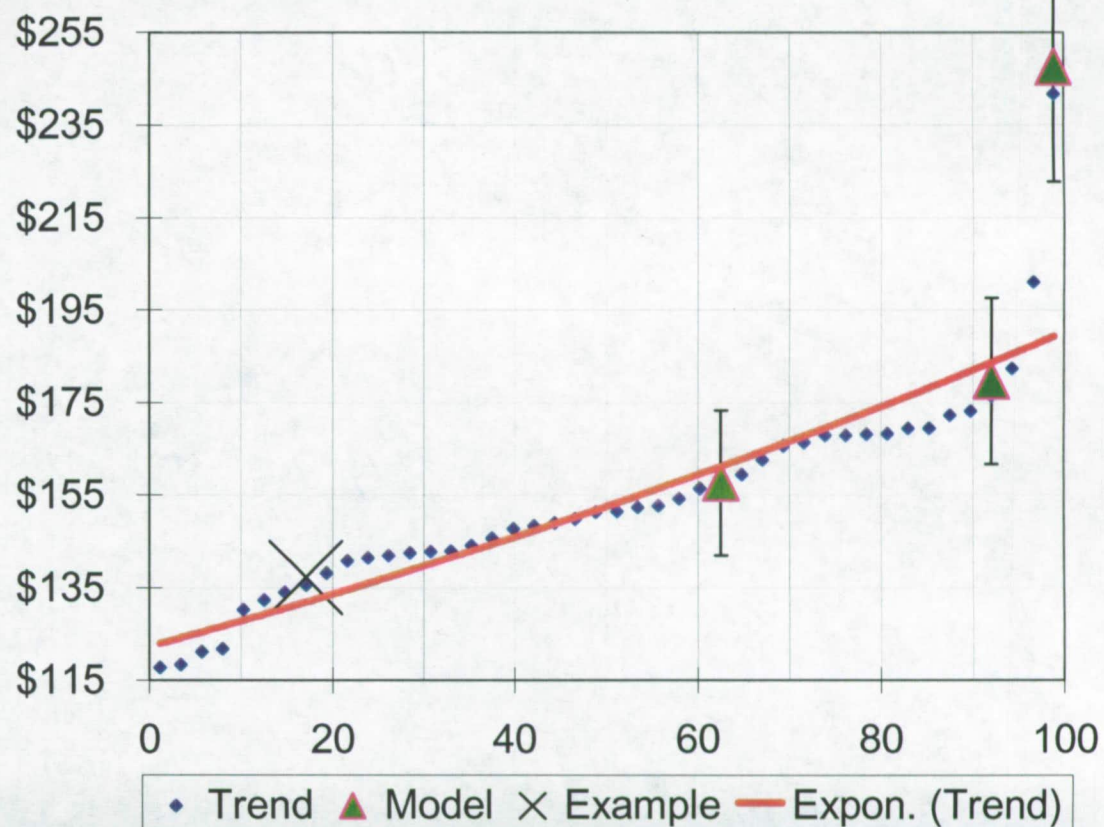
Model Output



Average Cost	Average + Standard Deviation	High Cost
\$7,916,900	\$8,972,100	\$11,984,300
\$ 158.34	\$ 179.44	\$ 239.69
Mode	Median	
\$8,539,200	\$7,689,900	
\$ 170.78	\$ 153.80	



Today's Bid Price Probability Plot



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Enhancements



- Once basic model is complete, many features can be added
- Try new ideas

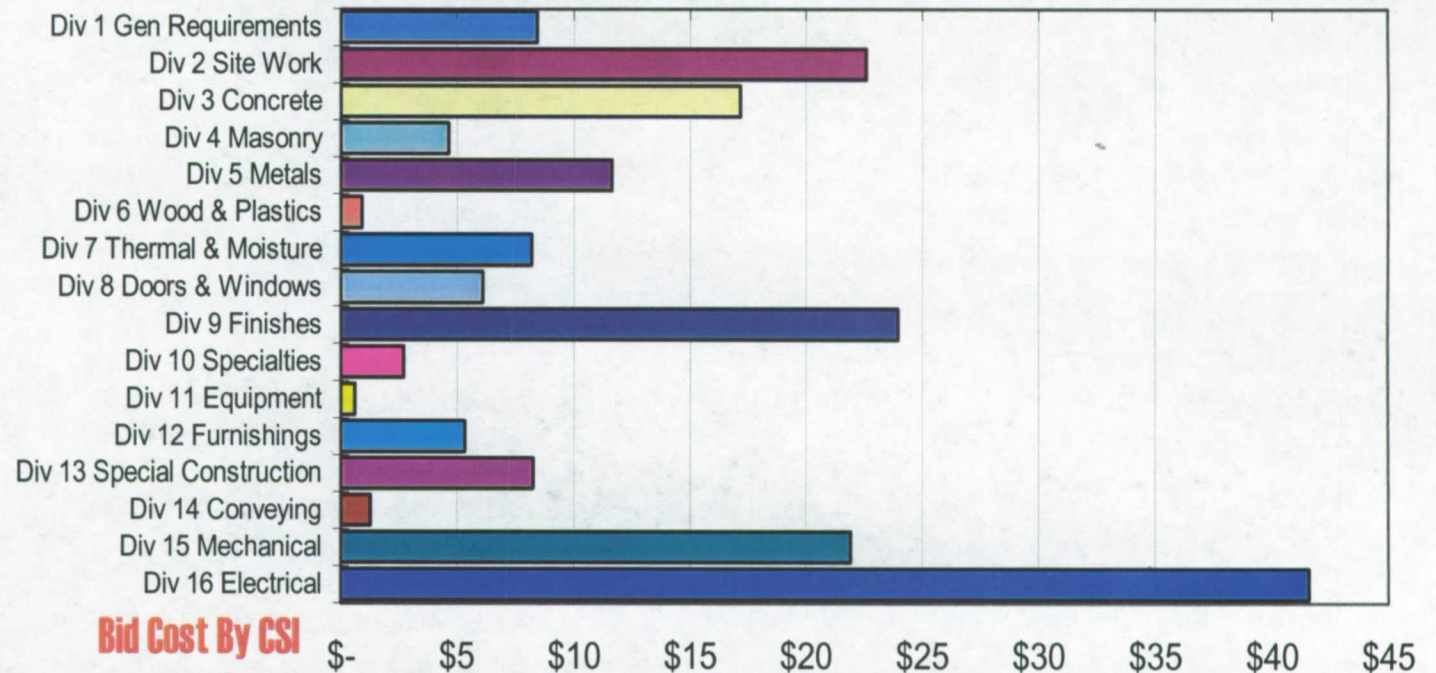


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CSI Cost By Division

- CSI costs can be estimated from data



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Custom Functions

- Excel VBA allows custom functions

Function GBSize(Historical_Size, New_Size) As Double

GBSize = 1.010001 * (New_Size / Historical_Size) ^ -0.101

End Function

Very Easy

Economies of Scale		
\$	175	Cost Per SF
	30,000	Historical SF
	4,000	New Project SF
	123.8%	Economies of Scale
\$	216.64	Adjusted SF Cost

Function Arguments

gbsize

Historical_Size 30000 = 30000

New_Size 4000 = 4000

= 1.237949679

No help available.

New_Size

Formula result = 124%

[Help on this function](#)

OK Cancel

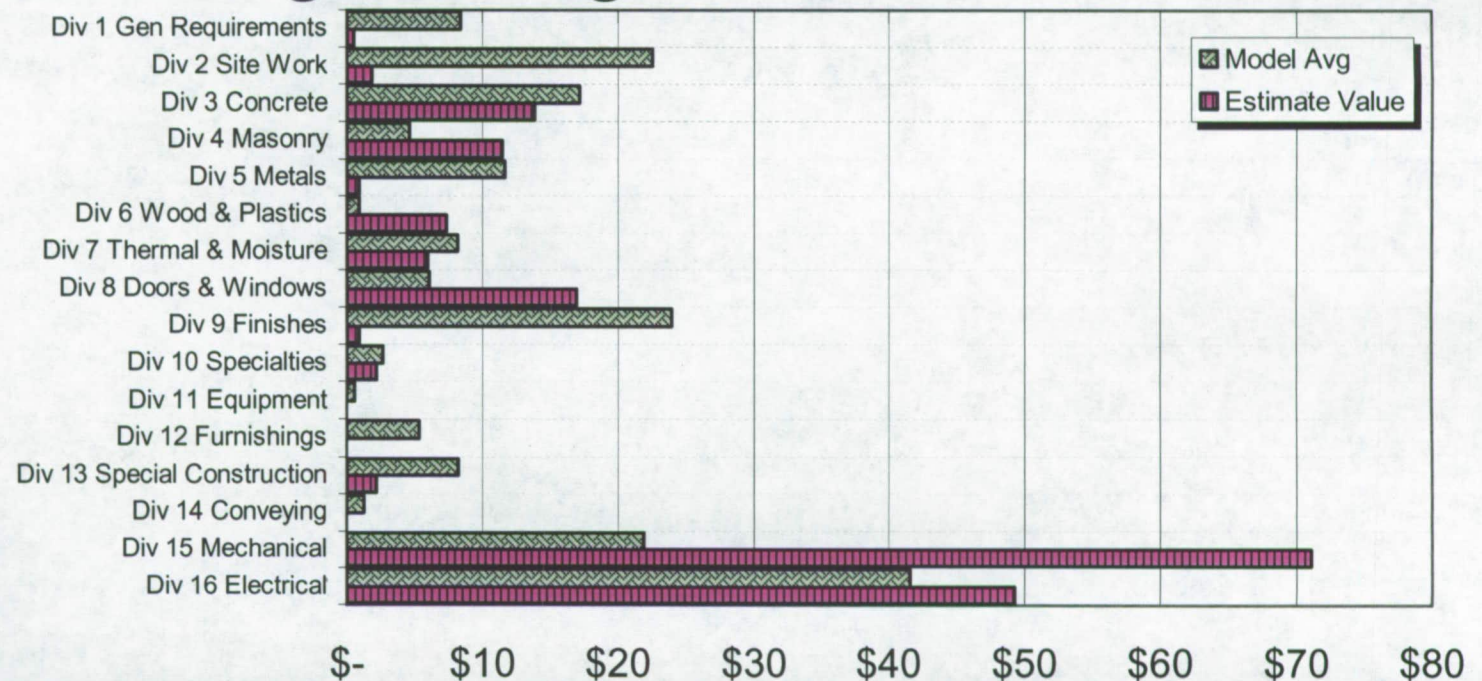


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CSI Cost By Division

- Model can be used as sanity check of detailed engineering estimates





VBA - Wizard Interface

KSC PFCM Wizard Step 1 of 6

Welcome to the KSC Parametric Facility Cost Model Wizard. This Wizard will help you create a Parametric Estimate utilizing historical data.

Project Size: 189000

Enter Project Name: OSB II

Enter your name: Butts, Glenn

Adjust Wizard Display Size: 100%

Cancel << Back Next >> Finish

KSC PFCM Wizard Step 2 of 6

Project Classification

- ☒ Building
- ☐ PEMB
- ☐ GSE
- ☐ Utility
- ☐ Roads & Parking
- ☐ Roof
- ☐ Other
- ☐ HVAC
- ☐ Select All

Scope

- ☐ Remove & Replace
- ☒ New
- ☐ Remodel / Modify
- ☐ Addition
- ☐ Select All Scopes

Cancel << Back Next >> Finish

KSC PFCM Wizard Step 3 of 6

Project Type: Concrete

Select Primary Use: Office

Select Unit of Measure: SF

Location: KSC

Bid Type: Full and Open

Cancel << Back Next >> Finish

KSC PFCM Wizard Step 4 of 6

Number of Stories: 6

LEED Certification: None

Distance from Required Utilities:

- ☐ Less Than 50 Feet
- ☒ 50 Feet To 250 Feet*
- ☐ 250 Feet To 1,000 Feet
- ☐ 1,000 Feet to 1 Mile
- ☐ 1 Mile to 5 Miles

Building Layout:

- ☒ Square / Rectangle*
- ☐ Complex Shape
- ☐ In Secure Area

Cancel << Back Next >> Finish

KSC PFCM Wizard Step 5 of 6

June 2002

Sun	Mon	Tue	Wed	Thu	Fri	Sat
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	1	2	3	4	5	6

Today: 1

Month Add: 1

Year Add: -3

Cancel << Back Next >> Finish

KSC PFCM Wizard Step 6 of 6

Enter Any Special Adjustments, or Search Terms

Additional Construction Costs: % of Total Project: Activation Comm & Testing Costs:

Custom Search Term:

Cancel << Back Next >> Finish

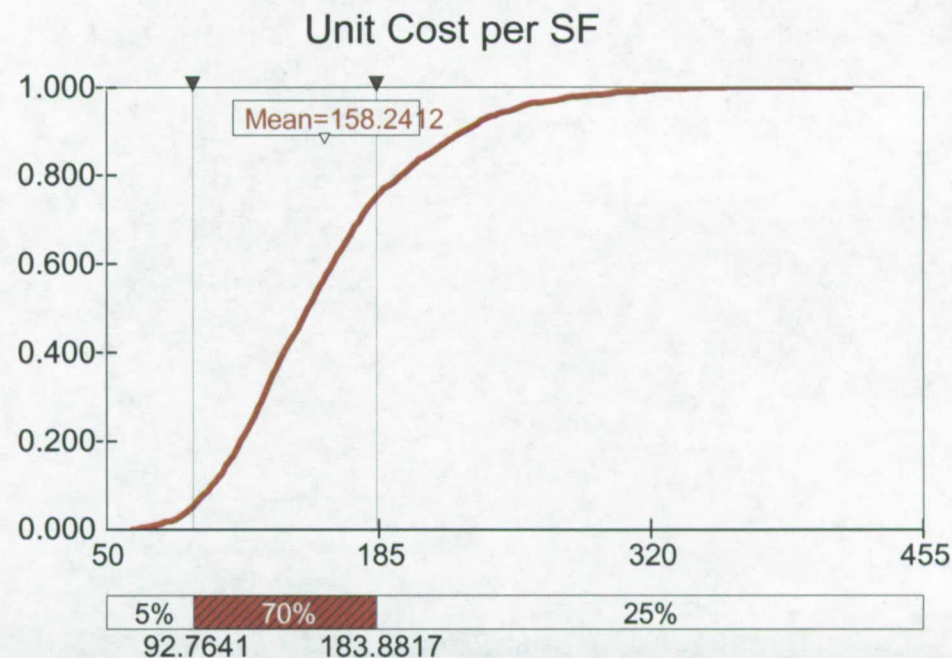
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Monte Carlo Simulation

- Monte Carlo Simulation can be added
 - Crystal Ball, @Risk & others





THANK YOU



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