Cost Models: Role In Analysis

Cost Modeling In Project Analysis

- Expensive To Develop
  - Time Consuming
  - Data Intensive
  - Significant Validation Effort
- Easy To Deploy
  - Microcomputer-Level of Computation Involved
  - Spreadsheet Level of Calculation
- Opportunities for Sophisticated Analyses

Types Of Analyses

- Sensitivity Analyses - Assessment of Business Risk
  - Factor Prices
  - Operating Conditions
  - Technological Change
- Cost Target Assessments - Comparative Analyses
  - General Comparisons; Particularly Effective With Parallel Models
  - "How Many Miracles To Achieve Cost X?"
- Performance Assessment / Benchmarking Analyses

Injection Molding Model

	A	B	C	D	E	F	G
2		INJECTION MOLDING TECHNICAL COST MODEL					
3		MIT - Materials Systems Laboratory					
4							
5							
6		PART/MATERIAL INPUTS					
7		Material	58				
8		Weight	3632	grams			
9		Maximum Wall Thickness	3.00	mm			
10		Average Wall Thickness	3.00	mm			
11		Projected Area	6968	sq cm			
12							
13							
14		EXOGENOUS DATA					
15		Annual Production Volume	100	(000/yr)			
16		Product Life	5	yrs			
17		Direct Wages (w/ benefits)	$12.50	/hr			
18		Working Days/Yr	240				
19		Working Hours/Day	16				
20		Capital Recovery Rate	10%				
21		Working Capital Period	3	months			
22		Price, Building Space	$1,500	/sq m			
23		Building Recovery Life	30	yrs			
24		Price of Electricity	$0.080	/kWh			
25		Accounting Life of Machine	20	yrs			
26		Overhead Burden (% fc)	35.0%				

Model / Data

Injection Molding Model (continued)

	A	B	C	D	E	F	G
29		PROCESS INPUTS					
30		Productive Time (% total time)	85.0%				
31		Material Scrap Rate	2.0%				
32		Reject Rate	1.0%				
33		Direct Laborers Per Machine	1				
34		Dedicated Equipment (1/0)	0	(1=y;0=n)			
35		Number of Cavities	1				
36		Auxiliary Equip. Cost (% mmch)	20.0%				
37		Installation Cost (% mmch)	20.0%				
38		Maintenance Cost (% invc)	5.0%				
39		Tool Actions (1/0)	0	(1=y;0=n)			
40		Toolmaker Shop Rate	$100.00	/hr			
41		Baseline Mold Life	1,000,000	cycles			
42		Electricity Requirement	0.75	kWh/kg			
43		INJECTION MOLDING OVERRIDES					
44		Molding Press & Tool Data:					
45		Clamping Force	0	kN			
46		Press Investment	$0				
47		Unit Tool Investment	$0				
48							
49		Cycle Time & Tool Costs:					
50		Cooling time	0	sec			
51		Total Cycle Time	0	sec			

Model / Data

Injection Molding Model (continued)

	I	J	K	L	M	N	O
1							
2		INJECTION MOLDING - COST SUMMARY					
3							
4							
5		VARIABLE COSTS	per piece	per year	percent		
6		*Material Cost*	$7.82	$782,411	63.99%		
7		*Energy Cost*	$0.34	$33,741	2.76%		
8		*Labor Cost*	$0.33	$32,763	2.68%		
9		Total Variable Cost	$8.49	$848,915	69.43%		
10							
11		FIXED COSTS	per piece	per year	percent	investment	
12		*Main Machine Cost*	$1.00	$100,113	8.19%	$852,317	
13		*Auxiliary Equipment Cost*	$0.17	$16,685	1.36%	$142,053	
14		*Tooling Cost*	$1.13	$113,227	9.26%	$429,220	
15		*Fixed Overhead Cost*	$0.92	$92,114	7.53%		
16		*Building Cost*	$0.33	$33,156	2.71%	$312,559	
17		*Maintenance Cost*	$0.13	$13,159	1.08%		
18		*Cost of Working Capital*	$0.05	$5,306	0.43%		
19		Total Fixed Cost	$3.74	$373,760	30.57%	$1,594,097	
20							
21		Total Fabrication Cost	$12.23	$1,222,675	100.00%		
22							
23							

Model / Data

Injection Molding Model (continued)

	I	J	K	L	M	N	O
24		RELATED VARIABLES					
25							
26		Material Requirements:					
27		Raw Material Price	$2.09	/kg			
28		Trim Scrap Rate	2.0%				
29		Annual Material Input	374,359	kg			
30							
31							
32		Process Calculations					
33		Effective Production Volume	101,011				
34		Run-Time for One Machine	68%				
35		Number of Parallel Streams	0.68				
36		Number of tools required	1				
37		Required Building Space	305	sq m			
38		Energy Adjustment Factor	1.53				
39							
40							
41		Cycle Time Calculations					
42			Predicted	Used			
43		Cooling Time (sec)	11.6	11.6			
44		Total Cycle Time (sec)	79.4	79.4			
45							
46							
47		Press & Tool Characteristics & Cost					
48			Predicted	Used			
49		Clamping Force (kN)	20,996	25,000			
50		Press Cost	$1,040,571	$1,040,571			
51		Tool Cost	$429,220	$429,220			

Model / Data

Injection Molding Model (continued)

	A	B	C	D	E	F	G
2		REGRESSION ANALYSIS DATA					
3							
4		EQUIPMENT REQUIREMENTS:					
5		Mold Pressure Intercept	172	bars	2494	psi	
6		Mold Pressure Slope	224	rt.cm bar	5176	rt.in psi	
7							
8		EQUIPMENT COSTS:					
9		Machine Cost Intercept	$14,829				
10		Machine Cost Slope	$41	/kN	$365	/ton	
11							
12		TOOL COSTS:					
13		Weight Factor	0.220	hr/g	100	hr/lb	
14		Area Factor	0.423	hr/sq cm	2.73	hr/sq in	
15		Action Factor	538	hr			
16		Constant	339	hr			
17							
18		CYCLE TIME:					
19		Cooling Factor	1.35				
20		Shot Weight Factor	0.0151				
21		Constant	8.87	sec			
22							
23		BUILDING SPACE:					
24		Floor Space Coefficient	135	sq m	1453	sq ft	
25		Floor Space Scaling Exponent	0.71				

Model / Data

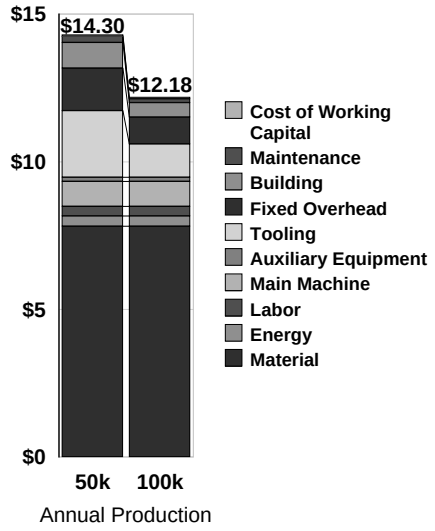
Injection Molding Model (continued)

	J	K	L	M	N	O	P
2	MATERIAL DATABASE						
3							
4					Price		
5	Type	Tradename	Grade	#	($/kg)	XML	XSC
6	POLYSTYRENE			1	$2.33	1.00	1
7	PVC (RIGID)			2	$0.84	0.80	1
8	ABS			3	$2.22	1.00	1
9	POLYPROPYLENE (HOMO)			4	$0.97	1.05	1
10	NYLON 6			5	$4.38	1.00	1
11	POLYCARBONATE			6	$3.96	0.85	1
12	ACETAL (HOMO)			7	$3.43	0.90	1
13	HDPE			8	$0.81	1.00	1
14	POLYPHENYLENE ETHER			9	$2.93	0.98	1
15	PET			10	$3.52	0.90	1

Model | Data

One Sort of Analysis - Structure of Cost

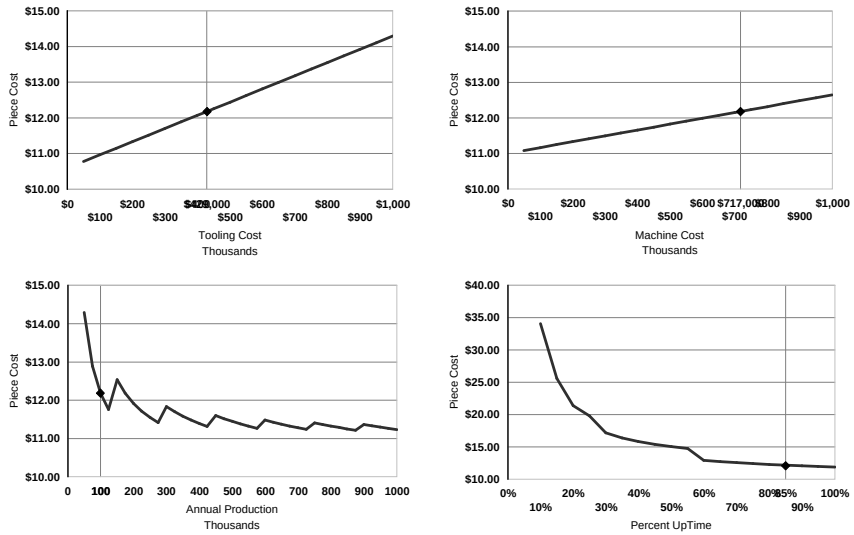
- Cost Structure
  - Variable
    - *Materials*
    - *Labor*
    - *Energy*
  - Fixed
    - *Machine(s)*
    - *Tooling*
    - *Building*
    - *Working Capital*
- Relative Magnitudes
- Differences With Other Factors



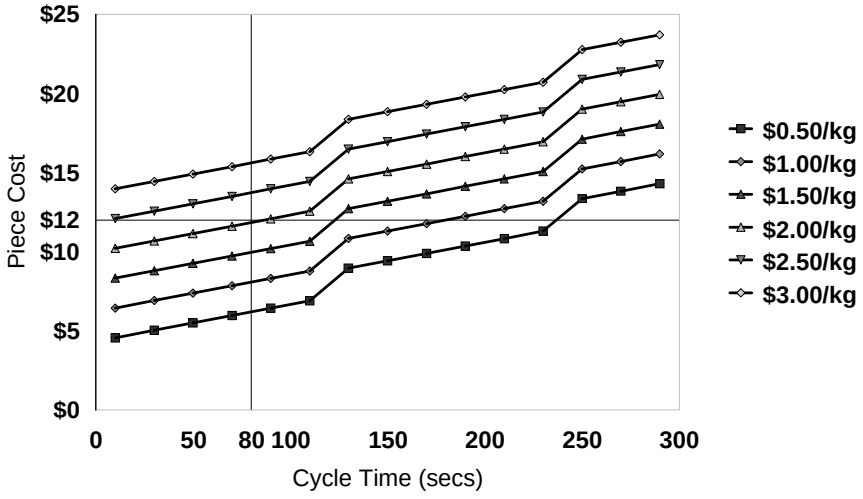
Opportunities For Sensitivity Analyses

- Factor Prices
  - Raw Material
  - Electricity
  - Labor
  - Opportunity Cost of Capital
- Capital Costs
  - Building
  - Tooling & Equipment
- Technical Factors
  - Production Cycle Time
  - Hours of Operation
- Operational Conditions
  - Dedicated Equipment / Non-Dedicated Equipment
  - Productive Time on Machine(s)
  - Production Volume
  - Product Life

Some Sensitivity Analyses



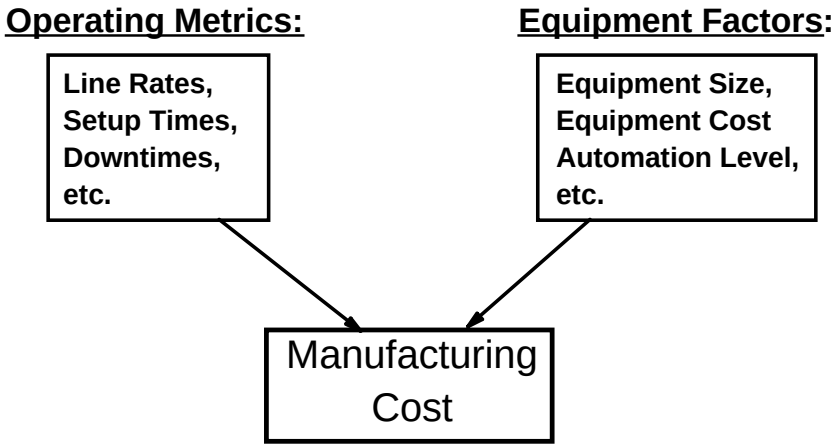
Material Cost & Processing Time Interaction



Cost Models as a Benchmark Tool

- Cost is the main reason to strive for high manufacturing productivity levels
- Numerous manufacturing performance metrics are often analyzed as a proxy for cost
- Need for a method to evaluate the trade-offs among productivity metrics
- Cost modeling provides a means for making the needed trade-offs by combining the various productivity measures in a single cost metric

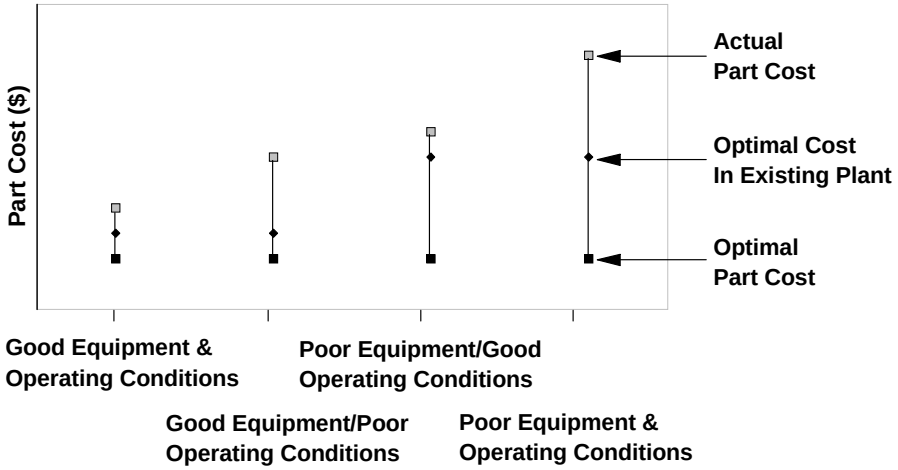
Cost Based Approach to Benchmarking



Cost - Benchmarking Case Study: Automotive Press Shops

- Productivity data collected for 51 automotive press shops worldwide
- Data collected on the production of 5 different automotive stampings
  - rear floor pan, mid floor pan, quarter panel inner, quarter panel outer, and door frame opening
- Analysis of a "generic" rear floor pan, but according to the equipment and operating conditions used in the actual plants for their own rear floor pans.

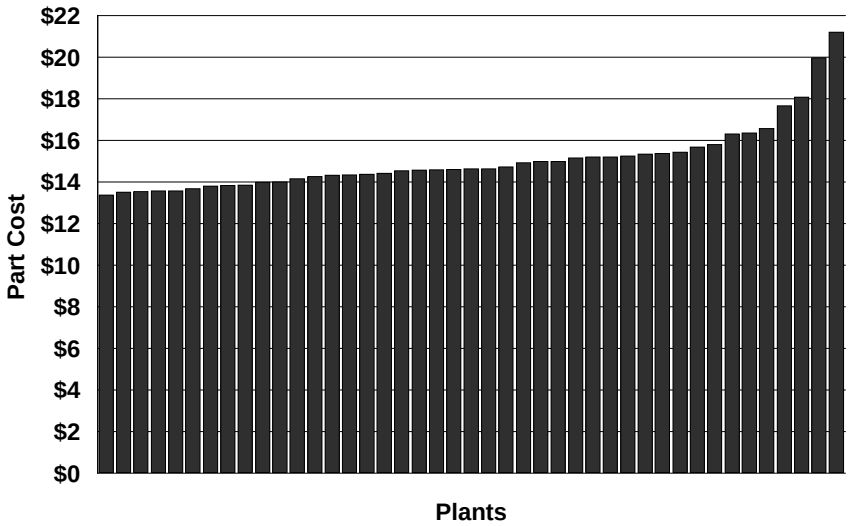
Example of Cost Approach to Benchmarking



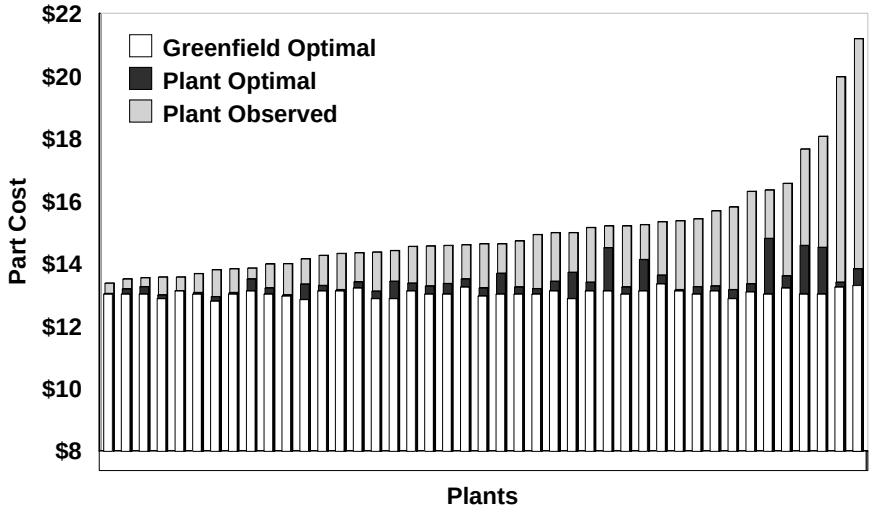
Use of Stamping Cost Model Predictive Capabilities

- Stamping cost model is able to predict numerous operating factors and equipment requirements depending on part material and geometric considerations
- Predictions based on observed practices, and thus are effectively industry benchmarks
- Operating condition predictions
  - line rates
  - die change times
  - required number of direct workers
  - etc.
- Equipment predictions
  - Press bed size
  - Press tonnage
  - Total press line cost including automation

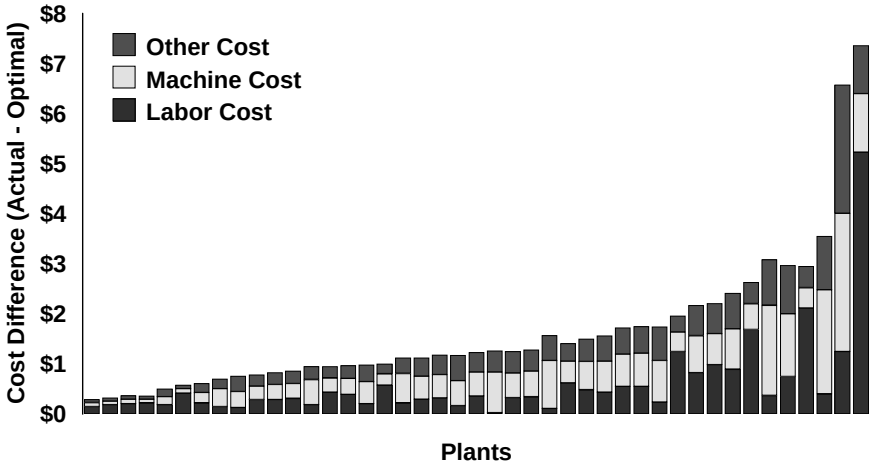
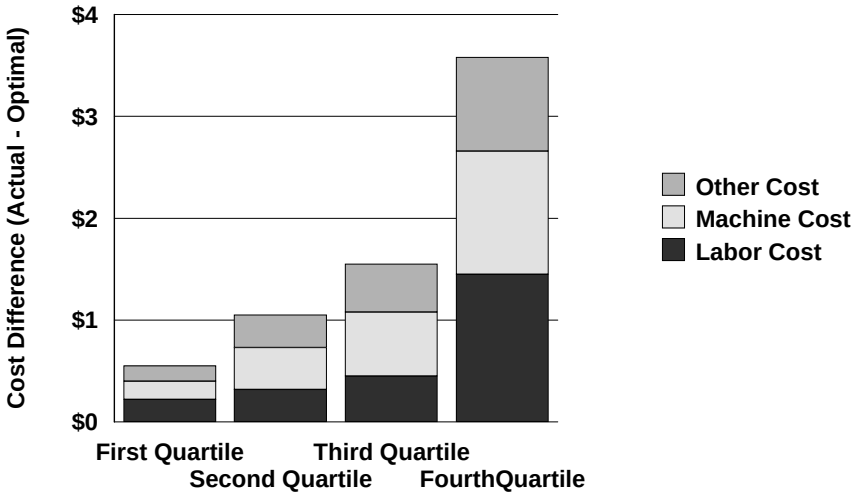
Observed Plant Cost Distribution



Optimal vs. Observed Cost



Cost Variations from Optimality



Cost Variation by Quartile