



2014 International Forum DFMA Boothroyd Dewhurst

Using DFM to Improve Purchase Price Variance Within the Supply Chain

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Agenda

- Supply Chain Parts List
- DFM Analysis
- Design For Manufacture
- Supplier Engagement
- Results



DFMA Application



Late 80's

- Design for Assembly
- Producibility
- Integration / Implementation
- Simultaneous / Concurrent

Early 90's

- Benchmarking
- Modular
- Rapid
- Six Sigma

Late 90's

- FEA
- Cost Management
- Lean

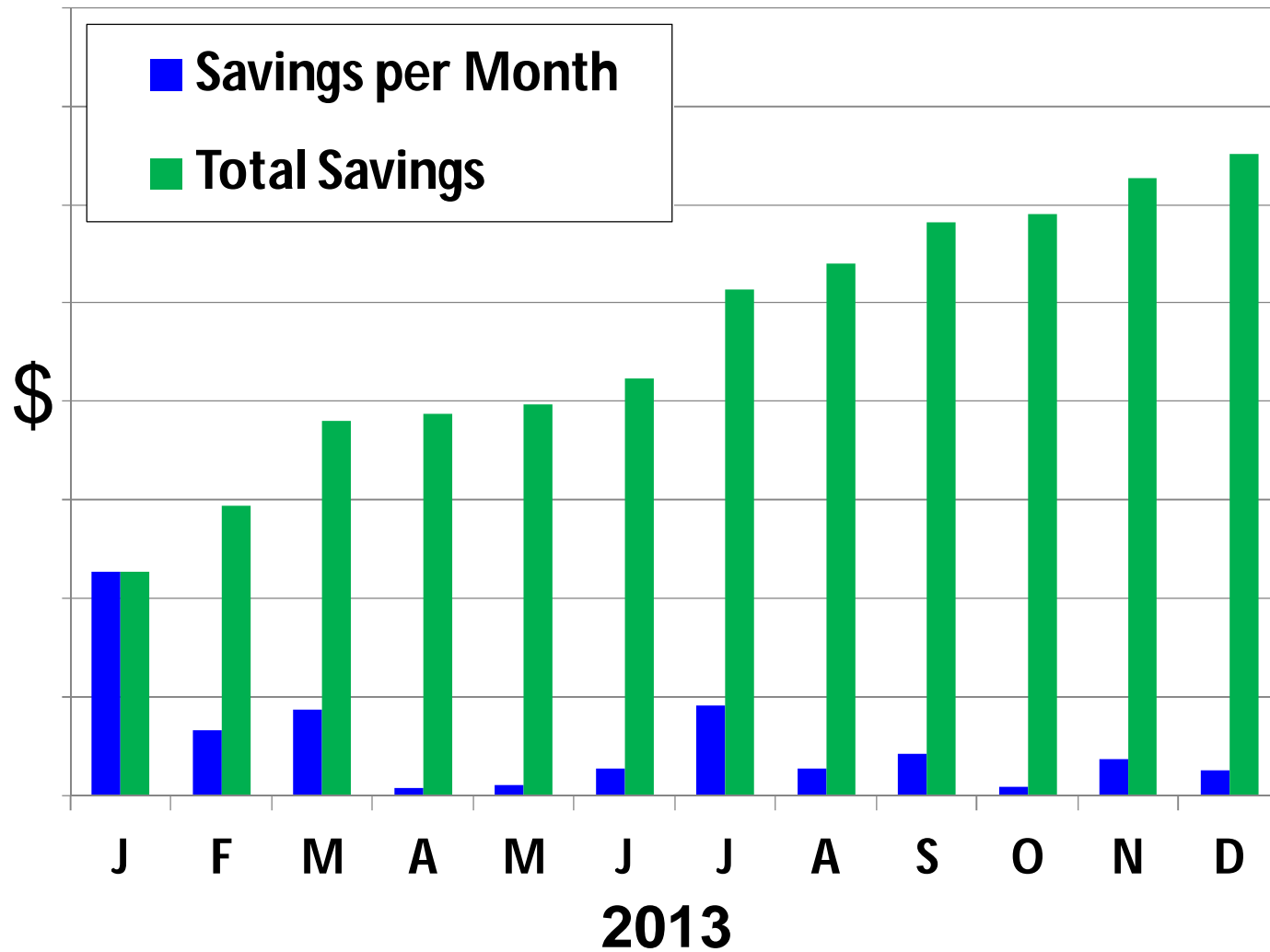
2000 - 2009

- Optimization
- Product Life Cycle
- Design for Value
- Value Stream

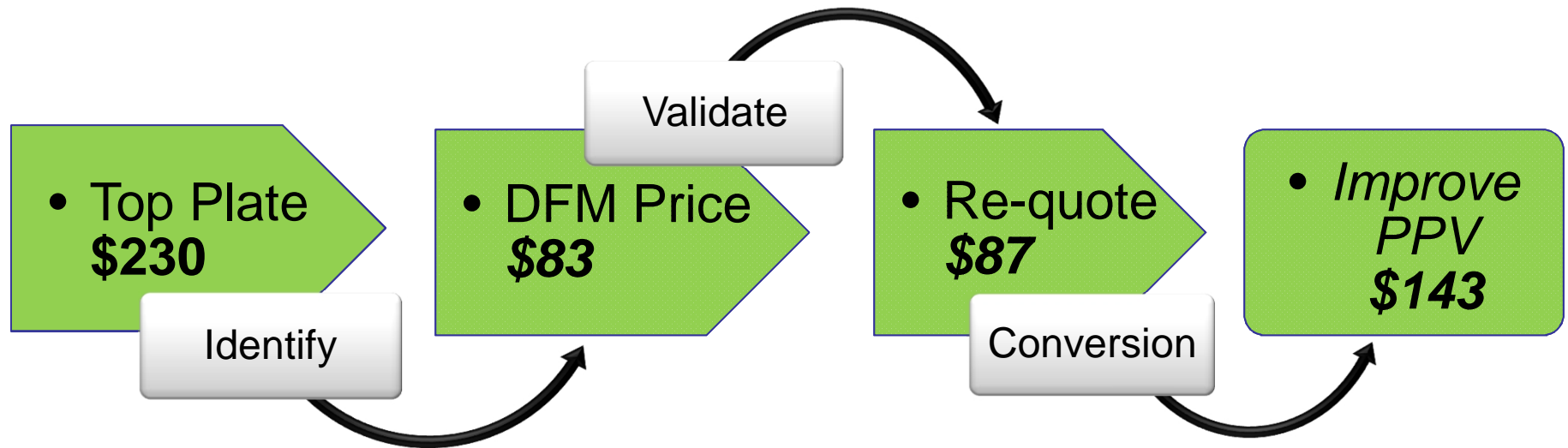
Last 4 Years

- Product / Process
- TCO
- Value Engineering
- Function

Cost Savings



DFM Process Example



- Identify – Size the opportunity, Std. Price vs. DFM Price
- Validate – Accuracy of the DFM model & design cost drivers
- Conversion – Engage suppliers

Supply Chain



- Where to start?
 - Released/Legacy Parts within Supply Chain
 - Pareto Principle – 80% of your spend comes from 20% of your parts
 - Part Numbers: $\text{Standard Price} \times \text{Volume} = \text{Total Spend}$
-

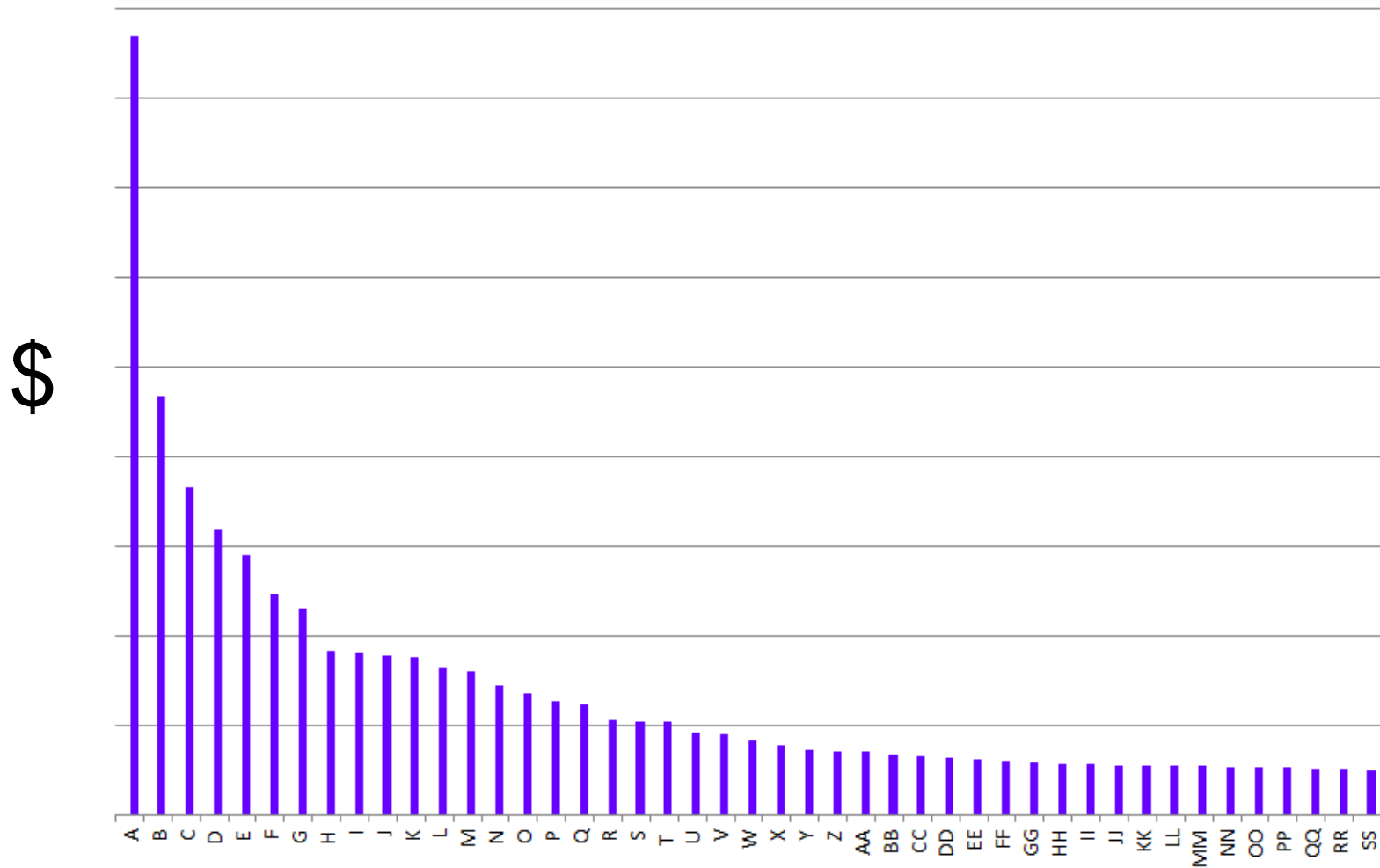
For each Part:

- Standard Price
- Yearly Volume
- Batch / Lot size
- Dwg / Model

For each DFM Analysis:

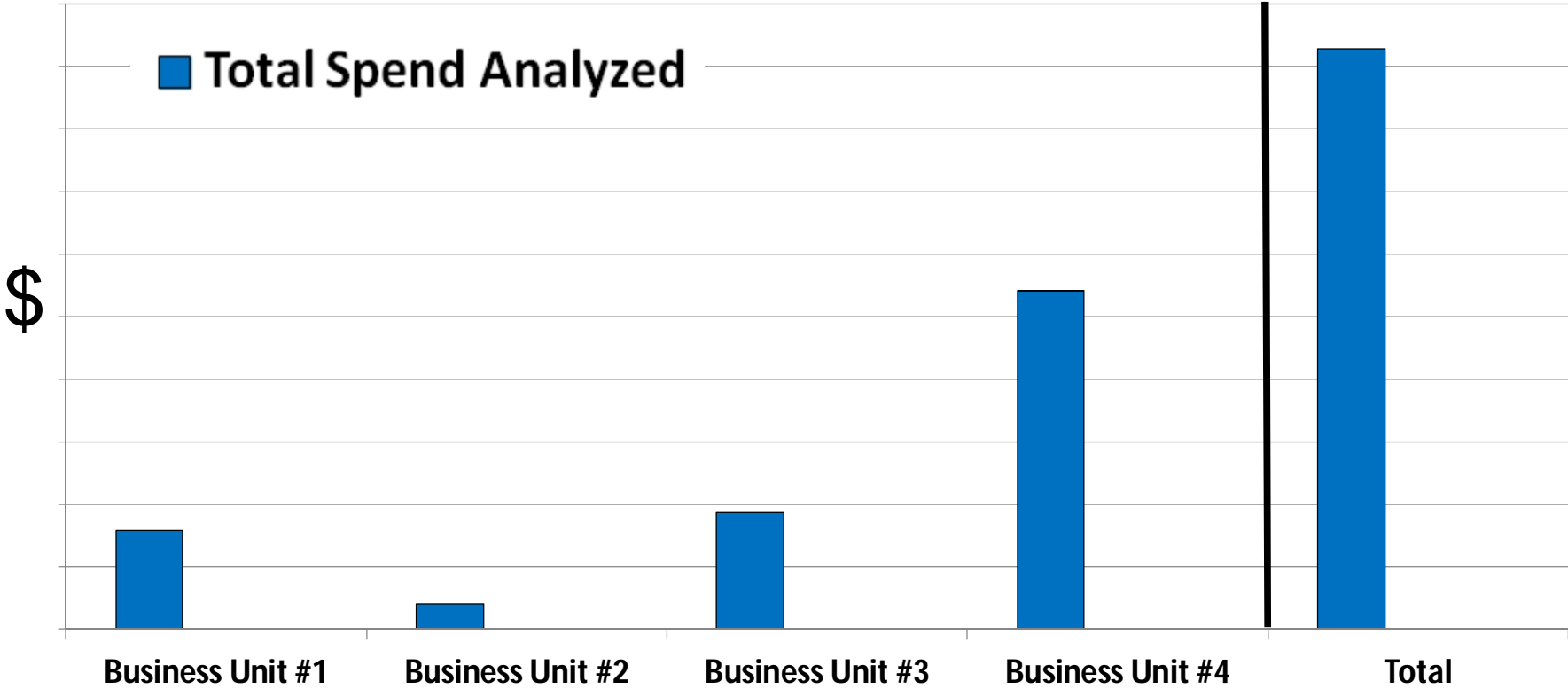
1. Identify cost drivers
2. Suggestions to reduce cost (VE Process)
 - What else would do the job?
 - What would that alternative cost?

Supply Chain Parts List

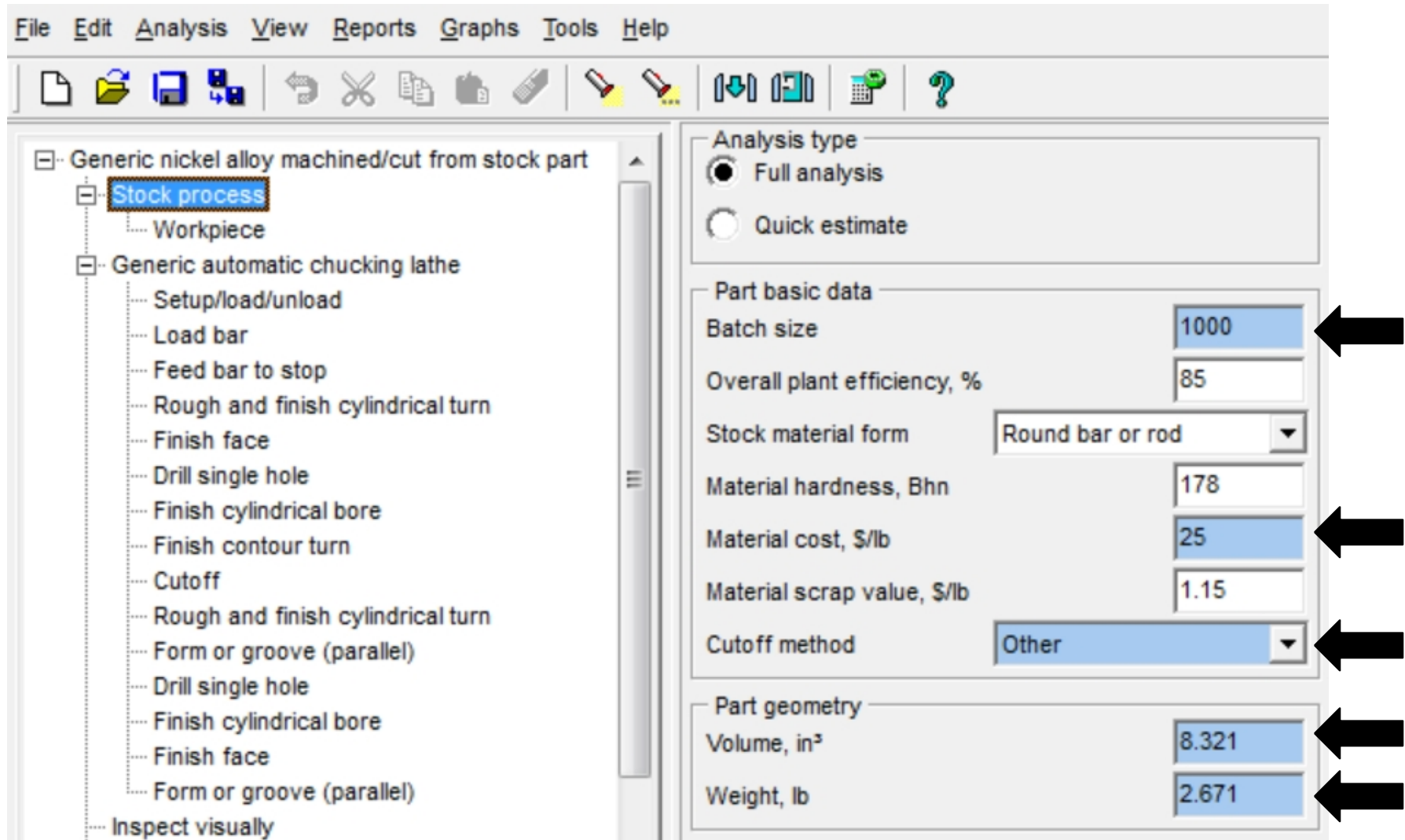


Part Number

Supply Chain - Spend



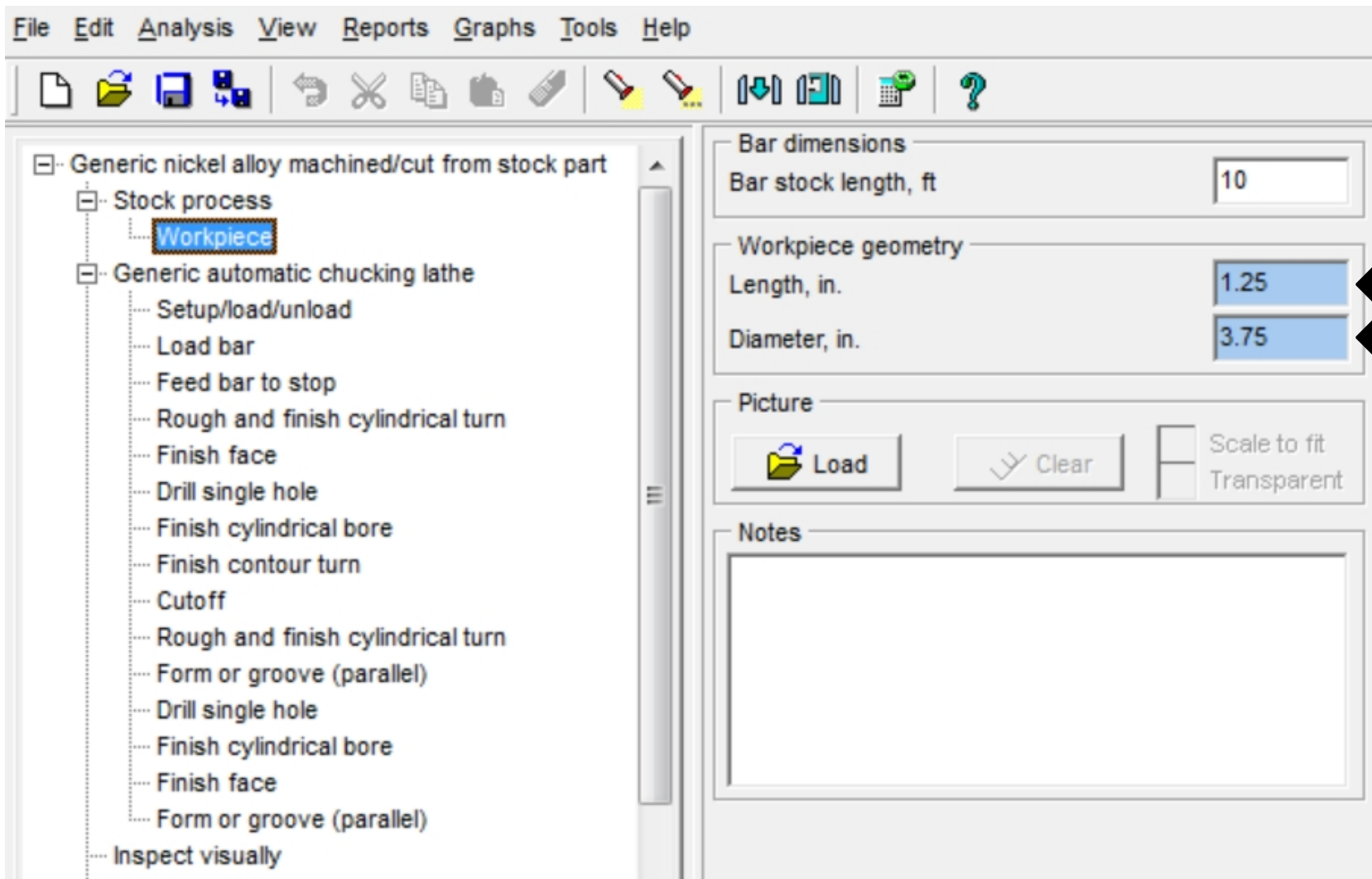
DFM Software – Material



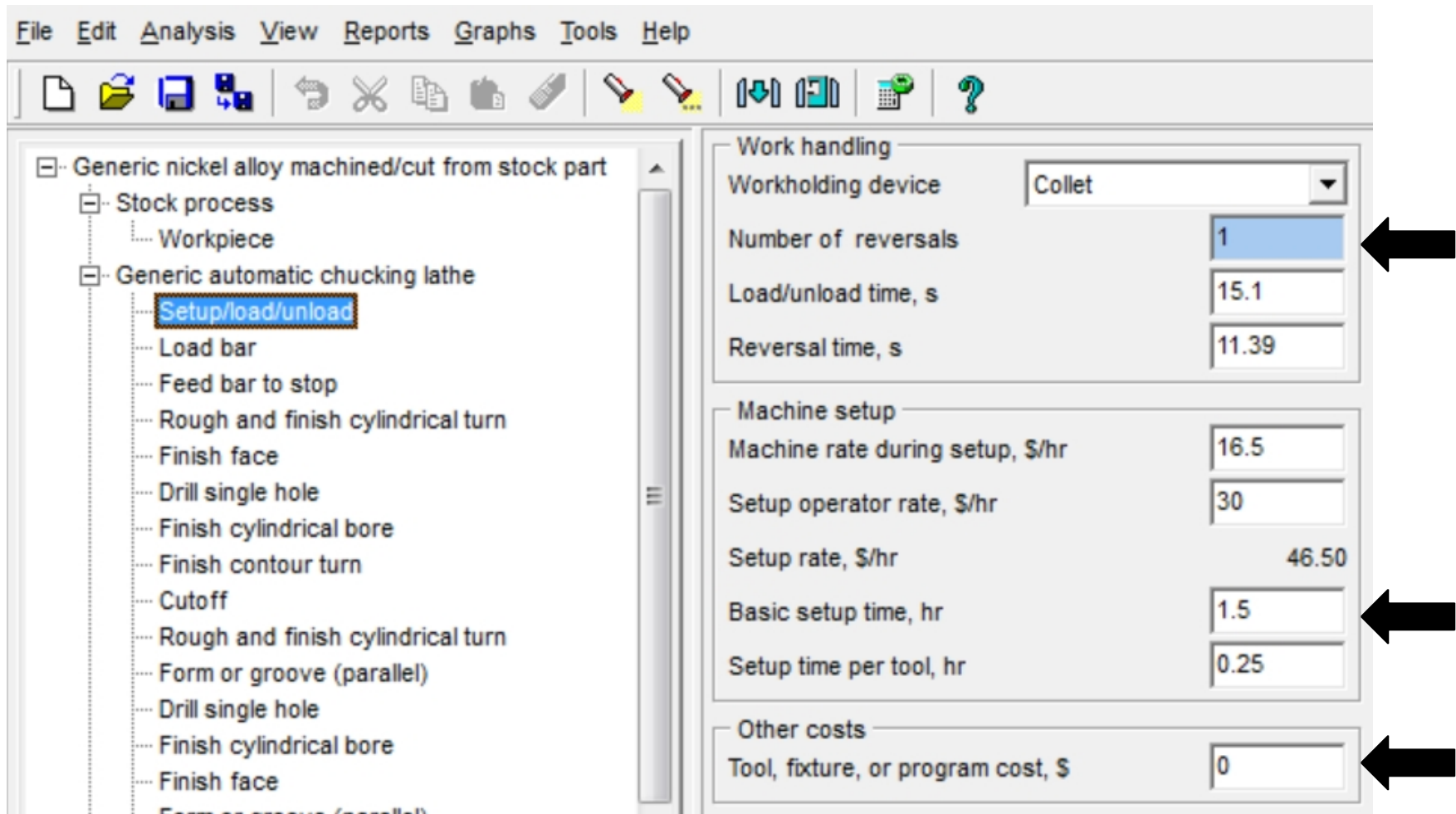
The screenshot displays the DFM software interface. On the left is a process tree for a 'Generic nickel alloy machined/cut from stock part'. The 'Stock process' is highlighted. The right pane shows analysis parameters for 'Full analysis'.

Parameter	Value
Batch size	1000
Overall plant efficiency, %	85
Stock material form	Round bar or rod
Material hardness, Bhn	178
Material cost, \$/lb	25
Material scrap value, \$/lb	1.15
Cutoff method	Other
Volume, in ³	8.321
Weight, lb	2.671

DFM Software – Material



DFM Software - Setup



The screenshot shows the 'Setup' window in the DFM software. The left pane displays a tree view of the manufacturing process, with 'Setup/load/unload' selected under the 'Generic automatic chucking lathe' node. The right pane contains three sections: 'Work handling', 'Machine setup', and 'Other costs'. Each section has several input fields, with three specific fields highlighted by black arrows pointing to them from the right.

Section	Parameter	Value
Work handling	Workholding device	Collet
	Number of reversals	1
	Load/unload time, s	15.1
	Reversal time, s	11.39
Machine setup	Machine rate during setup, \$/hr	16.5
	Setup operator rate, \$/hr	30
	Setup rate, \$/hr	46.50
	Basic setup time, hr	1.5
	Setup time per tool, hr	0.25
Other costs	Tool, fixture, or program cost, \$	0

DFM Software - Processing

File Edit Analysis View Reports Graphs Tools Help

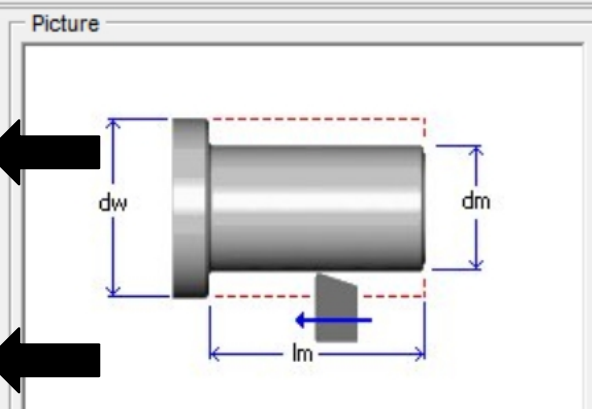
Generic nickel alloy machined/cut from stock part

- Stock process
 - Workpiece
- Generic automatic chucking lathe
 - Setup/load/unload
 - Load bar
 - Feed bar to stop
 - Rough and finish cylindrical turn**
 - Finish face
 - Drill single hole
 - Finish cylindrical bore
 - Finish contour turn
 - Cutoff
 - Rough and finish cylindrical turn
 - Form or groove (parallel)
 - Drill single hole
 - Finish cylindrical bore
 - Finish face
 - Form or groove (parallel)
- Inspect visually
- Edge break
- Check with snap gage

Baseline

Tool material	Indexable carbide
Include tool replacement cost?	<input checked="" type="checkbox"/>
Diameter of work surface (dw), in.	3.75
Diameter of machined surface (dm), in.	3.688
Length of machined surface (lm), in.	1.03
Finish cut allowance on radius, in.	0.01
Surface roughness	32 μ in. 0.8 μ m
Cutting speed during rough cuts, ft/min	405
Feed per revolution during rough cuts, in.	0.004
Number of rough cuts	1
Depth of rough cut per pass, in.	0.021
Cutting speed during finish cut, ft/min	450
Feed per revolution during finish cut, in.	0.003
Power available, hp	5.50
Maximum power required, hp	0.860
Spindle speed available, rpm	5,000.000

Picture

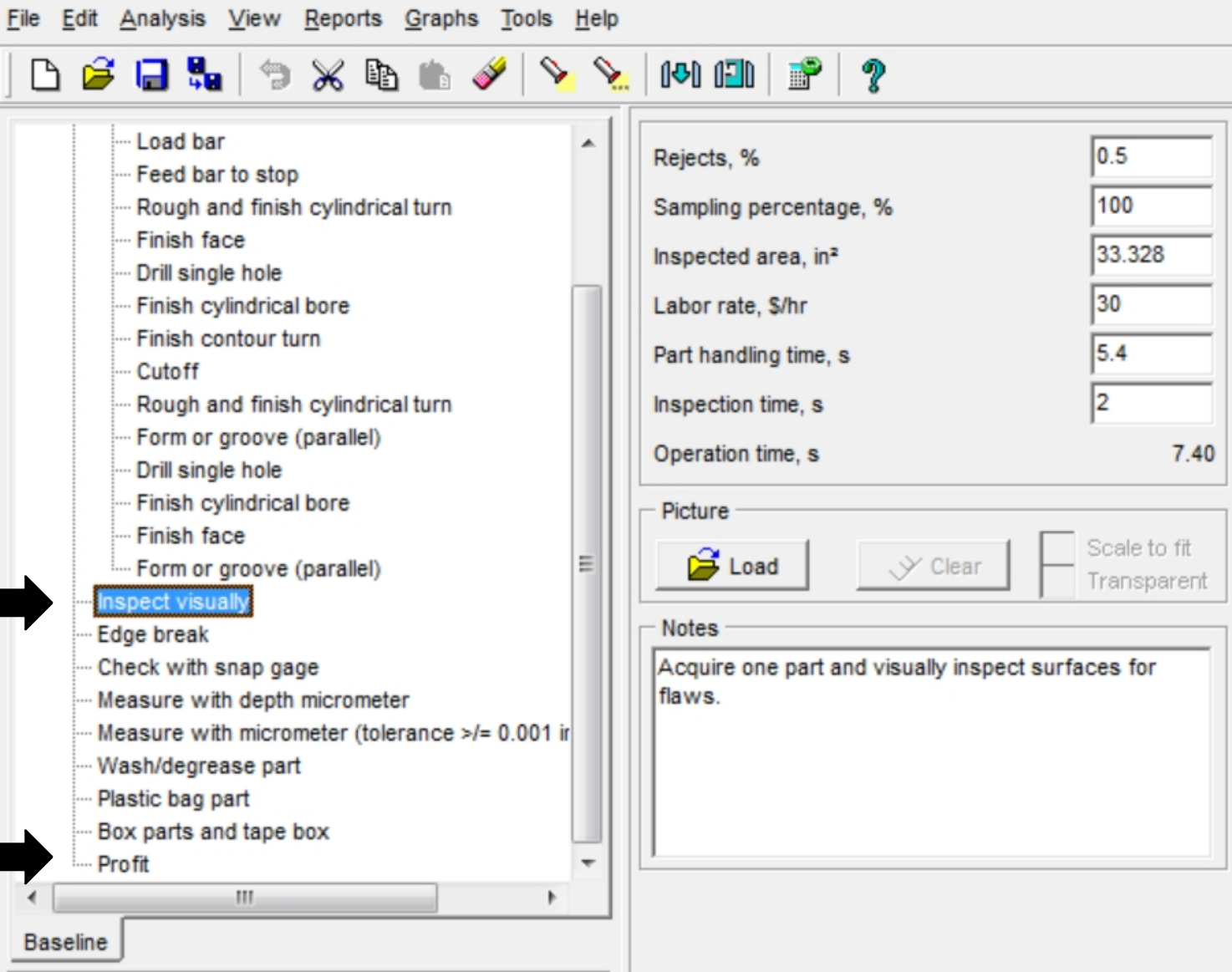


Load Clear Scale to fit Transparent

Notes

Calculates the machining time and cost for a rough cylindrical turning operation followed by a light finish cylindrical turning operation. You specify the machining allowance to be left after the rough turning operations and the number of rough turning cuts or passes required to remove the bulk of material is automatically determined.

DFM Software - Extras



The screenshot displays the DFM Software interface. The top menu bar includes File, Edit, Analysis, View, Reports, Graphs, Tools, and Help. Below the menu is a toolbar with various icons for file operations, editing, and analysis. The main window is divided into two panes. The left pane contains a list of operations, with 'Inspect visually' highlighted in blue and a black arrow pointing to it. The right pane displays inspection parameters and controls.

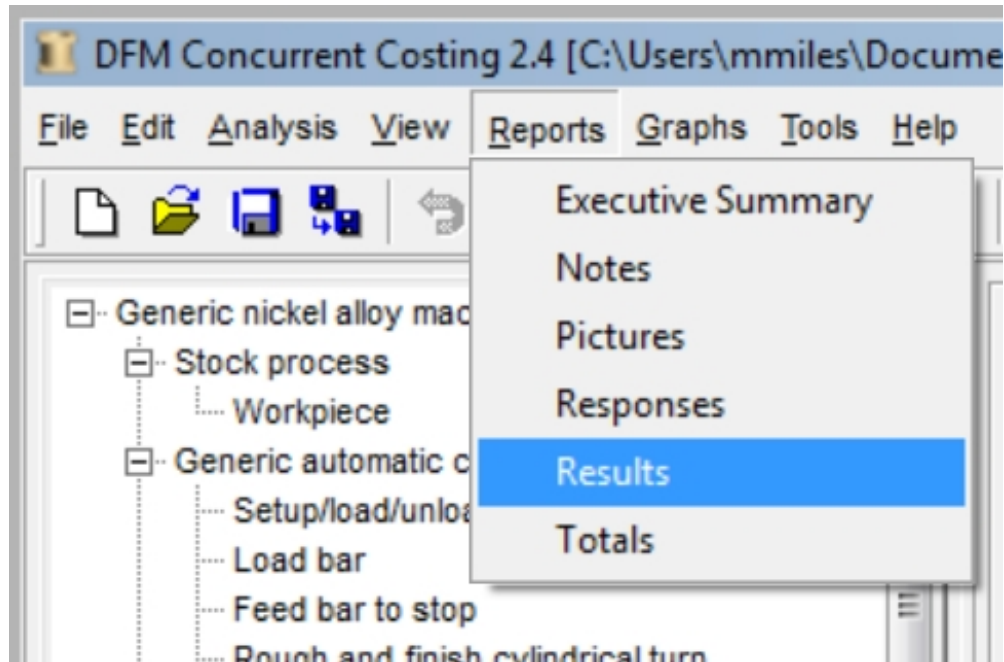
Parameter	Value
Rejects, %	0.5
Sampling percentage, %	100
Inspected area, in ²	33.328
Labor rate, \$/hr	30
Part handling time, s	5.4
Inspection time, s	2
Operation time, s	7.40

Picture controls: Load, Clear, Scale to fit, Transparent

Notes: Acquire one part and visually inspect surfaces for flaws.

Baseline

DFM Summary - Results




- Reports \ Results
- Link Results to drawing, similar to a First Article Inspection report

Example: 303 SS Burst Plug Housing (lathe part)

- DFM processing time ~ 1100 seconds
- Supplier routing ~ 1200 seconds

DFM Summary - Results

Number matches “process-to-dimension” on the dwg



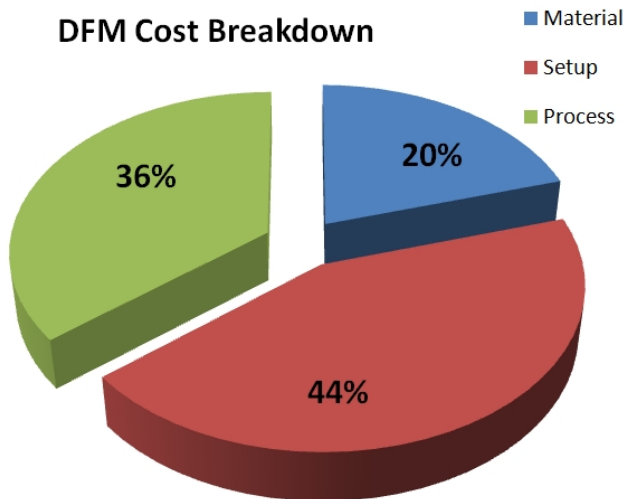
Process Chart	Batch Size	Cost per part, \$						Operation time per part, s	
		Material	Setup	Process	Rejects	Piece part	Tooling		Total
19 Finish face				0.06		0.06		0.06	6.00
20 Finish face				0.03		0.03		0.03	3.00
Generic CNC machining center	40		1.16	4.78	0.32	6.26		6.26	439.30
Setup/load/unload			1.16	0.46		1.62		1.62	46.30
21 Rough and finish single peripheral end mill				2.18		2.18		2.18	197.00
22 Rough and finish face mill				0.48		0.48		0.48	41.00
23 Rough and finish face mill				0.45		0.45		0.45	39.00
24 Drill multiple holes				0.29		0.29		0.29	28.00
25 Rough and finish single slot end mill				0.25		0.25		0.25	24.00
26 Rough and finish single slot end mill				0.34		0.34		0.34	32.00
27 Rough and finish single slot end mill				0.34		0.34		0.34	32.00

DFM Summary Example

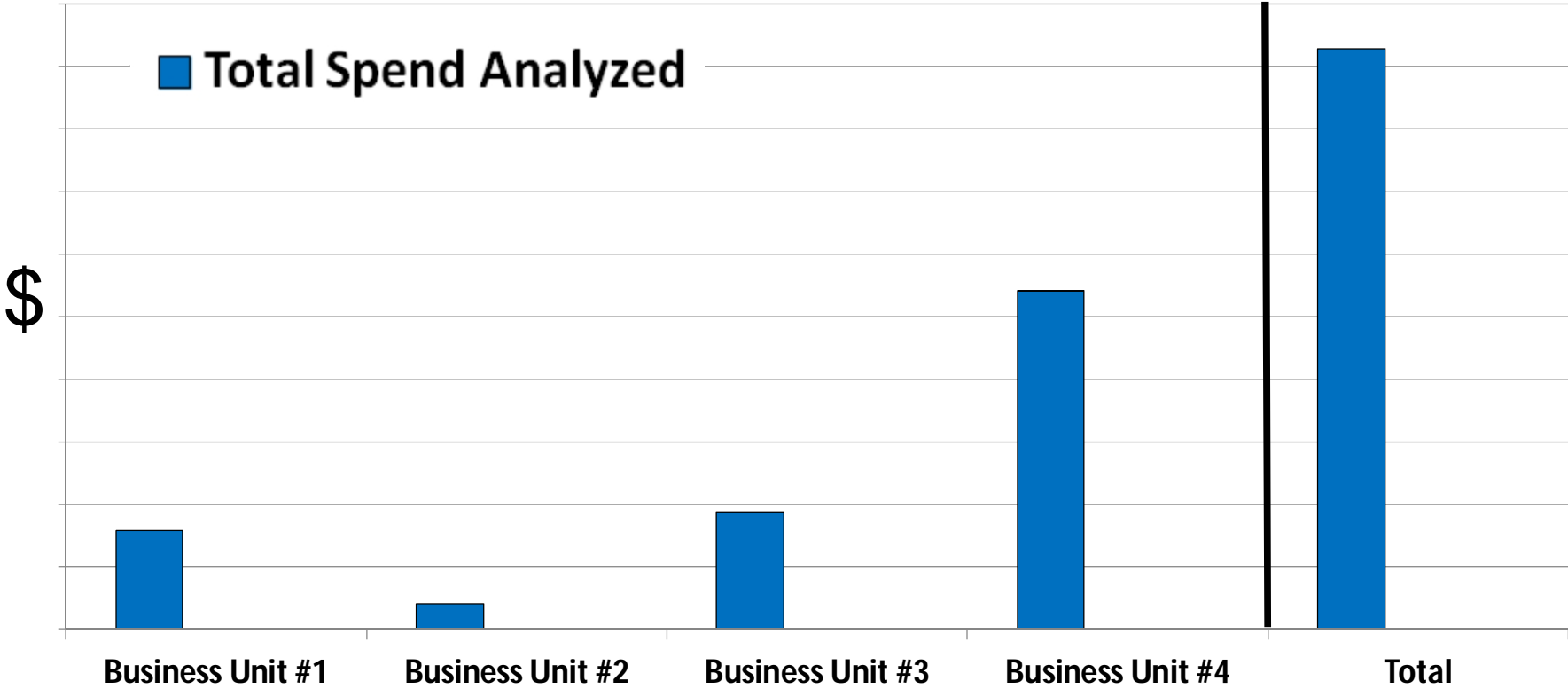


— Std Price	\$21.55
— DFM 10pc US	\$12.76
— DFM 25pc US	\$11.62
— DFM 10pc Asia	\$6.21

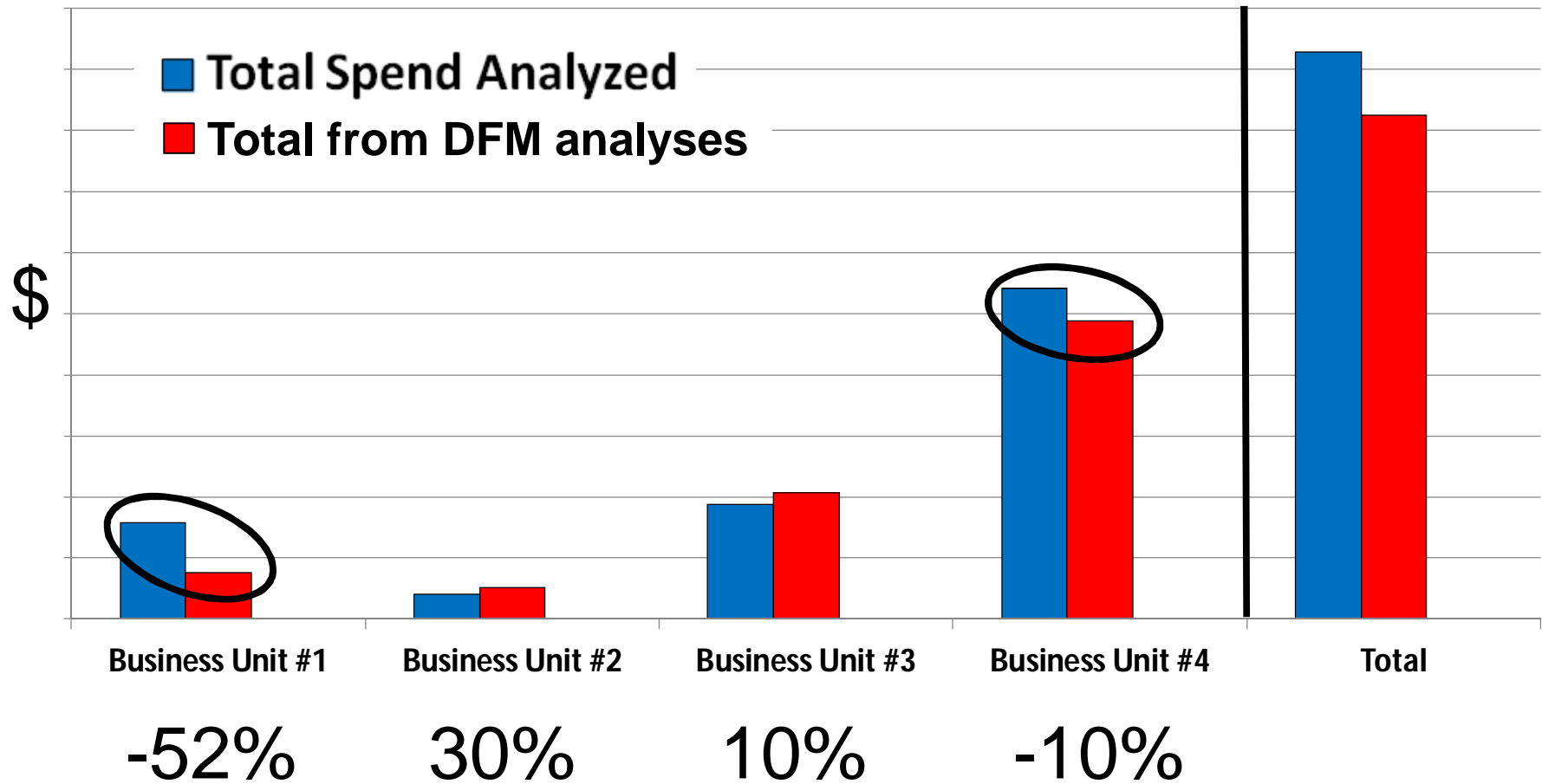
- 11GA 5032-H32
- Clear anodize finish



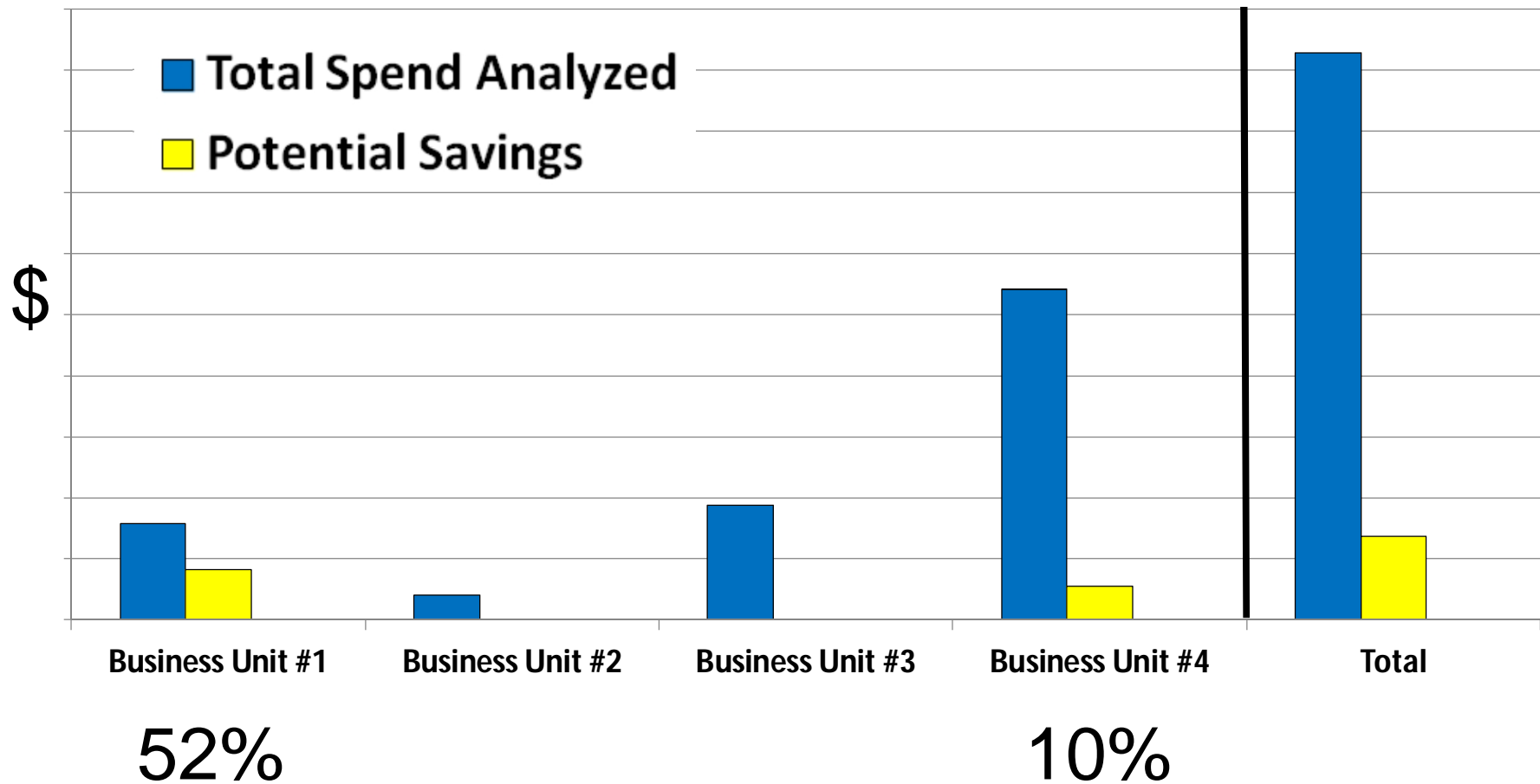
Supply Chain - Spend



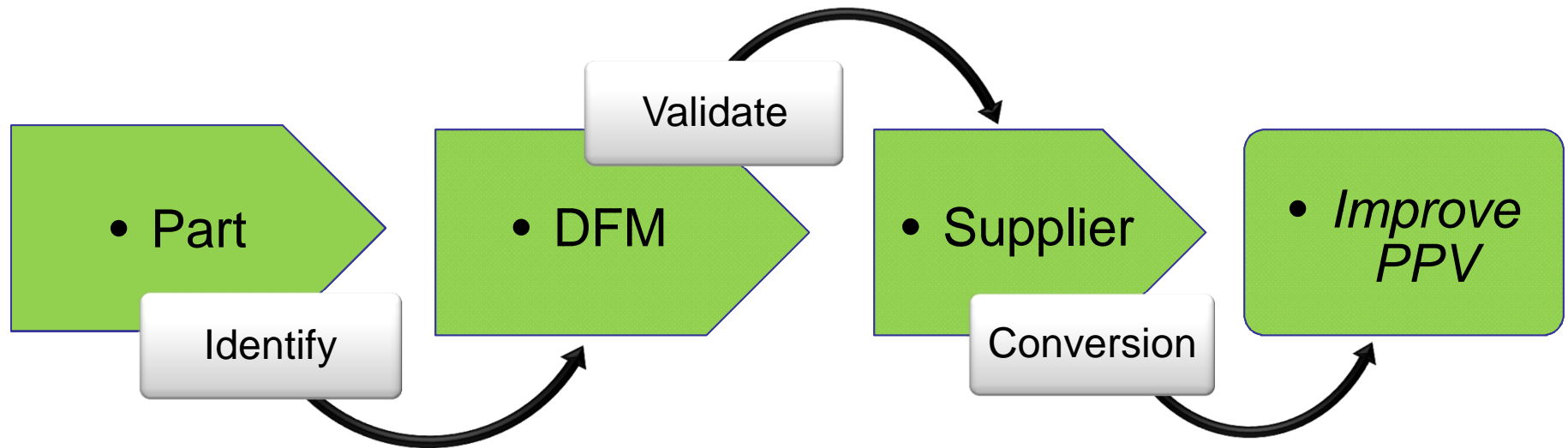
Supply Chain – Spend vs. DFM



Supply Chain – Potential Savings



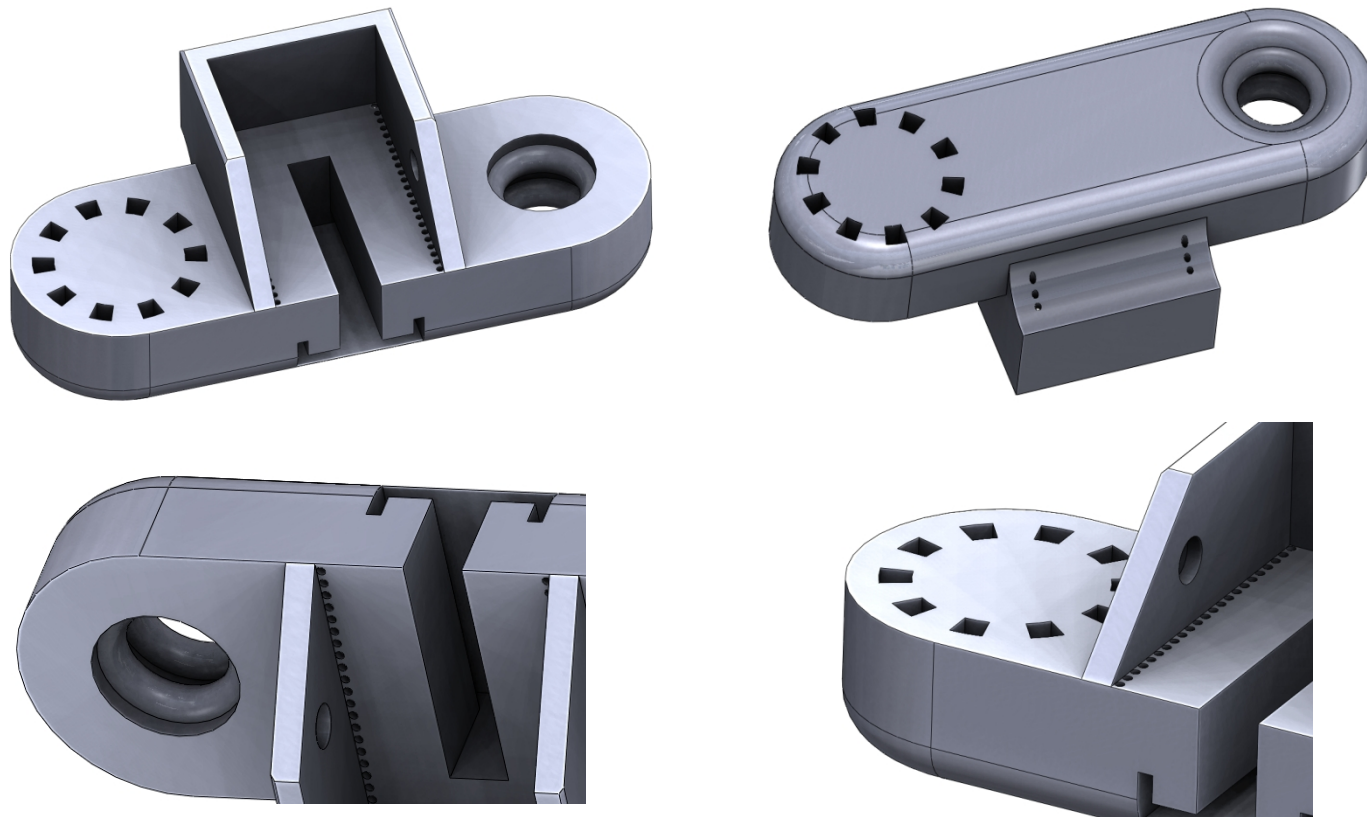
DFM Process



- Identify – Size the opportunity, Std. Price vs. DFM Price

Design for Manufacture

- Modeling makes things easy....too easy?



- *Just because you can model it, doesn't mean you can machine it.... And be cost effective*

Design for Manufacture



TOLERANCES UNLESS OTHERWISE SPECIFIED;

1. 2 PLACE DECIMAL $\pm .01$
3 PLACE DECIMAL $\pm .005$
2. FRACTIONS $\pm 1/32$
3. DRILLS < 0.5 DIA > 0.5 DIA $\begin{matrix} + .008 \\ - .003 \end{matrix}$
4. ANGLES $\pm 0.5^\circ$
5. FILLETS R .005 MAX
6. EDGES R .005 OR CHAMFER MAX
7. PART TO BE FREE OF BURRS
8. ALL DIMENSIONS ARE IN INCHES.

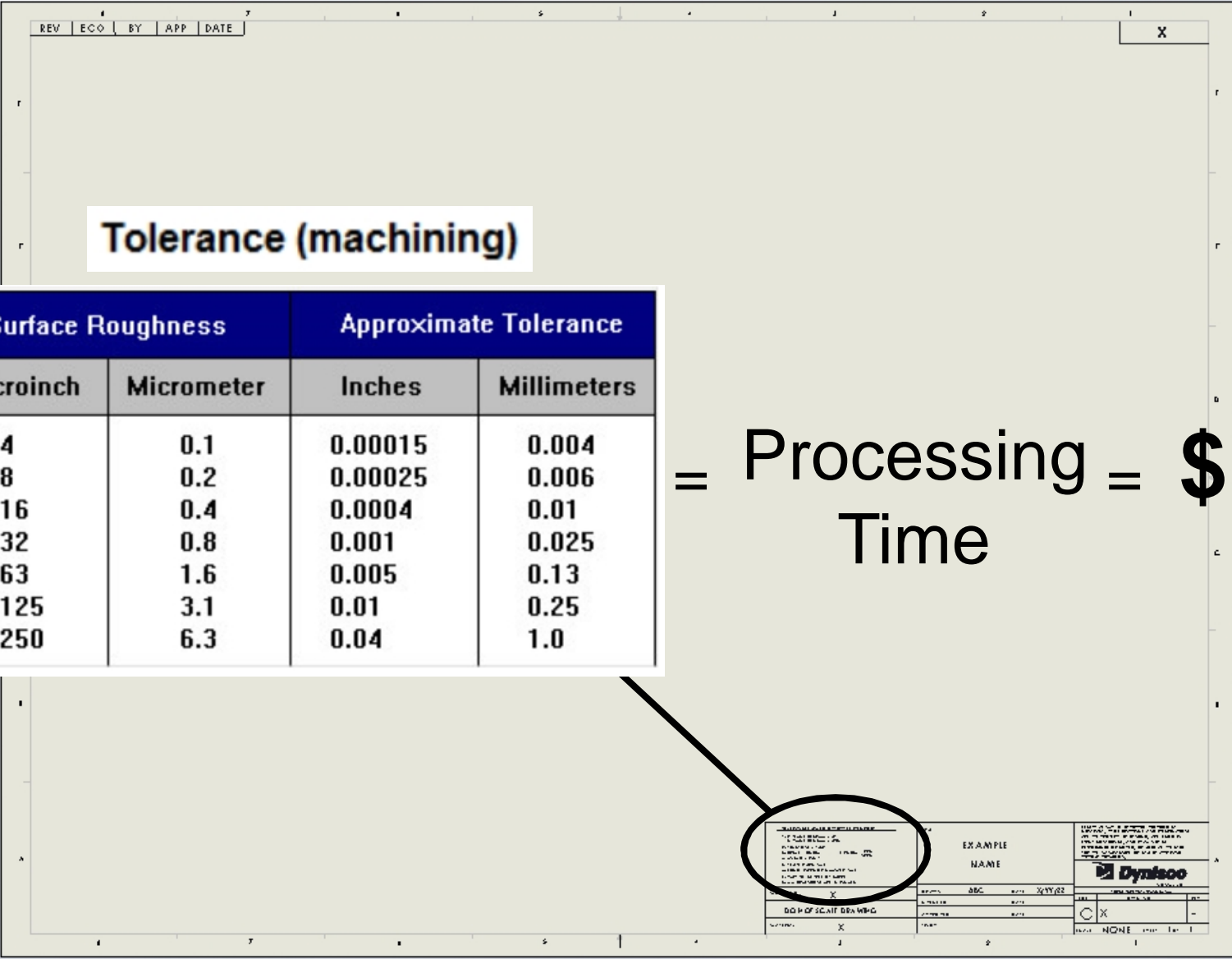
1. TITLE BLOCK 2. PART NAME 3. PART NUMBER 4. PART DESCRIPTION 5. PART DRAWING NUMBER 6. PART QUANTITY 7. PART WEIGHT 8. PART MATERIAL		EXAMPLE NAME ABC 12345 67890 101112 131415 161718 192021 222324 252627 282930 313233 343536 373839 404142 434445 464748 495051 525354 555657 585960 616263 646566 676869 707172 737475 767778 798081 828384 858687 888990 919293 949596 979899 100101 102103 104105 106107 108109 110111 112113 114115 116117 118119 120121 122123 124125 126127 128129 130131 132133 134135 136137 138139 140141 142143 144145 146147 148149 150151 152153 154155 156157 158159 160161 162163 164165 166167 168169 170171 172173 174175 176177 178179 180181 182183 184185 186187 188189 190191 192193 194195 196197 198199 200201 202203 204205 206207 208209 210211 212213 214215 216217 218219 220221 222223 224225 226227 228229 230231 232233 234235 236237 238239 240241 242243 244245 246247 248249 250251 252253 254255 256257 258259 260261 262263 264265 266267 268269 270271 272273 274275 276277 278279 280281 282283 284285 286287 288289 290291 292293 294295 296297 298299 300301 302303 304305 306307 308309 310311 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598599 600601 602603 604605 606607 608609 610611 612613 614615 616617 618619 620621 622623 624625 626627 628629 630631 632633 634635 636637 638639 640641 642643 644645 646647 648649 650651 652653 654655 656657 658659 660661 662663 664665 666667 668669 670671 672673 674675 676677 678679 680681 682683 684685 686687 688689 690691 692693 694695 696697 698699 700701 702703 704705 706707 708709 710711 712713 714715 716717 718719 720721 722723 724725 726727 728729 730731 732733 734735 736737 738739 740741 742743 744745 746747 748749 750751 752753 754755 756757 758759 760761 762763 764765 766767 768769 770771 772773 774775 776777 778779 780781 782783 784785 786787 788789 790791 792793 794795 796797 798799 800801 802803 804805 806807 808809 810811 812813 814815 816817 818819 820821 822823 824825 826827 828829 830831 832833 834835 836837 838839 840841 842843 844845 846847 848849 850851 852853 854855 856857 858859 860861 862863 864865 866867 868869 870871 872873 874875 876877 878879 880881 882883 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17981799 18001801 18021803 18041805 18061807 18081809 18101811 18121813 18141815 18161817 18181819 18201821 18221823 18241825 18261827 18281829 18301831 18321833 18341835 18361837 18381839 18401841 18421843 18441845 18461847 18481849 18501851 18521853 18541855 18561857 18581859 18601861 18621863 18641865 18661867 18681869 18701871 18721873 18741875 18761877 18781879 18801881 18821883 18841885 18861887 18881889 18901891 18921893 18941895 18961897 18981899 19001901 19021903 19041905 19061907 19081909 19101911 19121913 19141915 19161917 19181919 19201921 19221923 19241925 19261927 19281929 19301931 19321933 19341935 19361937 19381939 19401941 19421943 19441945 19461947 19481949 19501951 19521953 19541955 19561957 19581959 19601961 19621963 19641965 19661967 19681969 19701971 19721973 19741975 19761977 19781979 19801981 19821983 19841985 19861987 19881989 19901991 19921993 19941995 19961997 19981999 20002001 20022003
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Design for Manufacture

Tolerance (machining)

Surface Roughness		Approximate Tolerance	
Microinch	Micrometer	Inches	Millimeters
4	0.1	0.00015	0.004
8	0.2	0.00025	0.006
16	0.4	0.0004	0.01
32	0.8	0.001	0.025
63	1.6	0.005	0.13
125	3.1	0.01	0.25
250	6.3	0.04	1.0

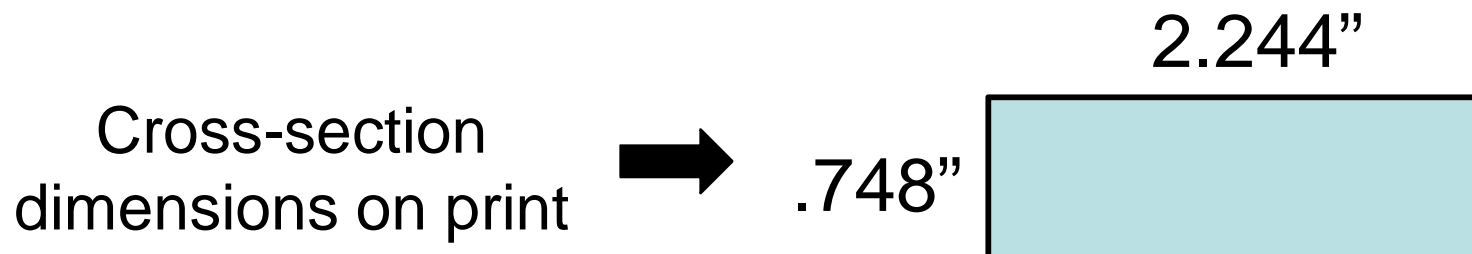
= Processing Time = \$



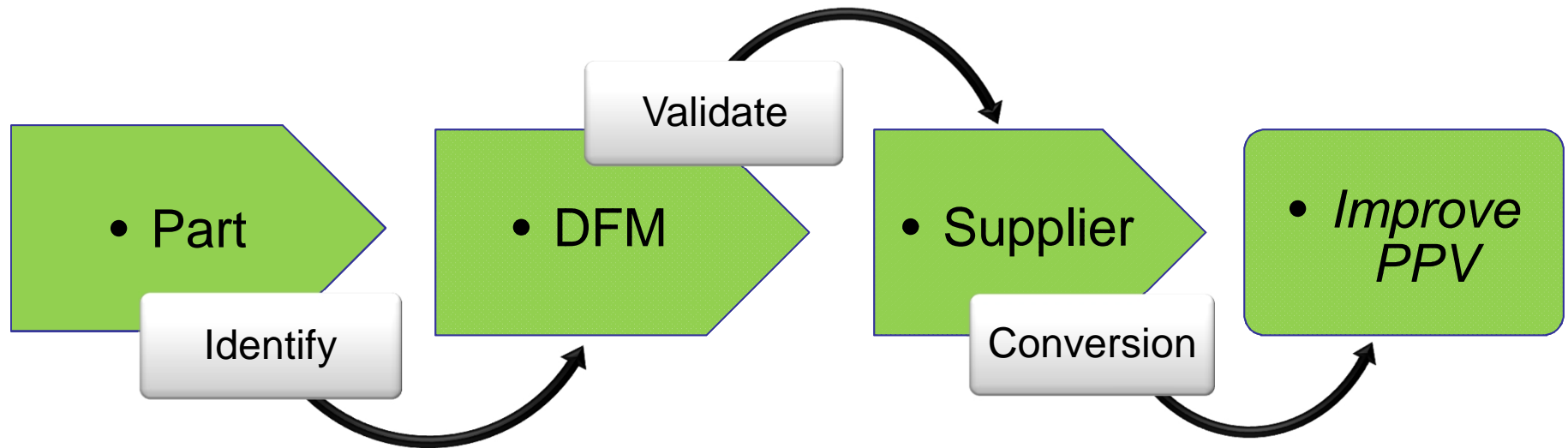
EXAMPLE NAME		
DATE: 08/01/02	DRAWN BY:	
CHECKED BY:	APPROVED BY:	SCALE:
DOW OF SCOTT BRW-0	PART:	NONE

Design for Manufacture

- DFM request on a new product – 51 machined parts
 - Example 1: 19 sheet metal parts
 - 7 different gages of thickness
 - 5 different materials
 - 4 different finishes
 - Example 2: Part made from rectangular bar



DFM Process



- Identify – Size the opportunity, Std. Price vs. DFM Price
- Validate – Accuracy of the DFM model & design cost drivers

Engage Suppliers

- Started with a parts list from Supply Chain
 - Performed DFM analysis
 - Reviewed the design and print specifications
 - Now you have the Data on Pricing
-

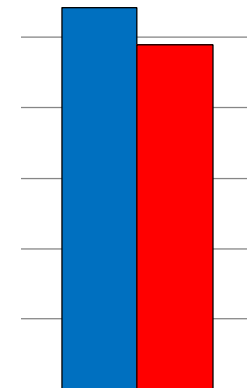
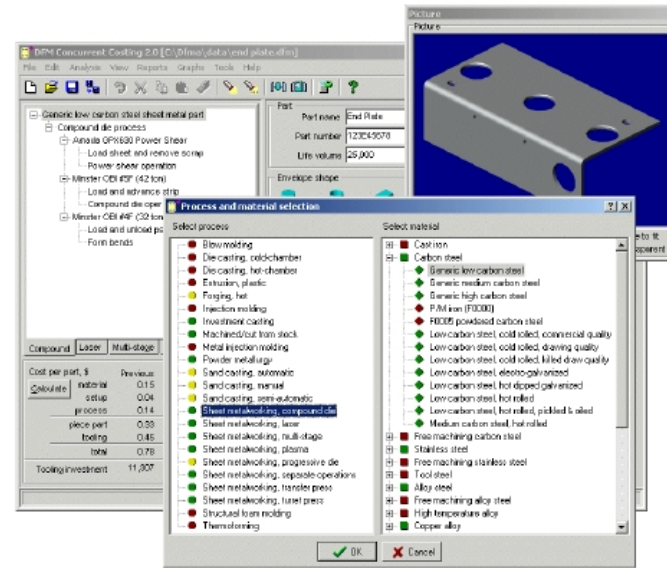
Suppliers:

- “Material Price went up”
- **Red flag:** Price is a “nice, round number” (**\$230**) and a large gap exists when compared to DFM price
- Last time the part was quoted
- \$\$\$

Supplier Example #1

- 150+ parts
- DFM's completed
- Meeting set
- Approach:

- Non-adversarial
- Cost drivers / Machining process
- Show DFM of “their” part
- Supplier suggestions
- Implied message



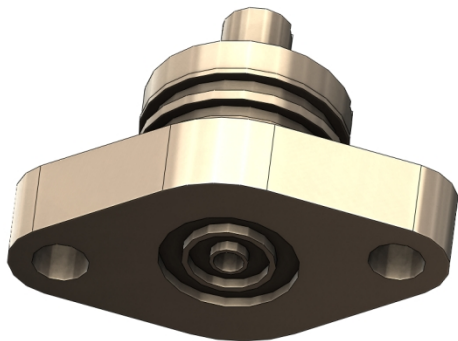
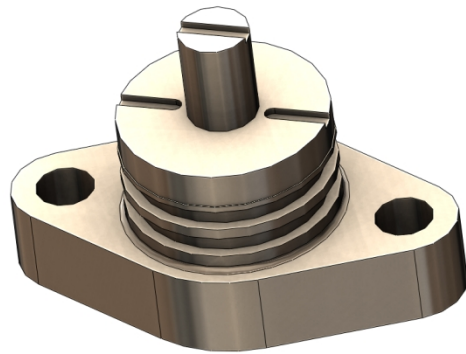
Std. vs. DFM \$

Supplier Example #2



- Mat'l: Inconel
- Intricate part
- Tight tolerances

— Std Price	\$484.81
— DFM #1	\$69.06
— DFM #2	\$95.79
— DFM #3	\$147.79



What was missed?

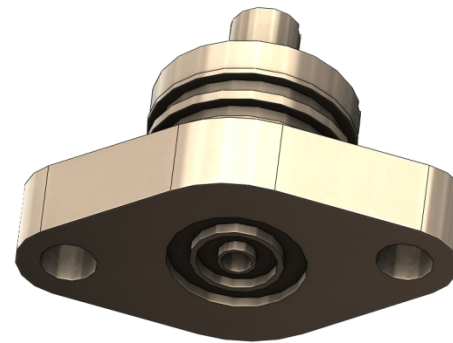
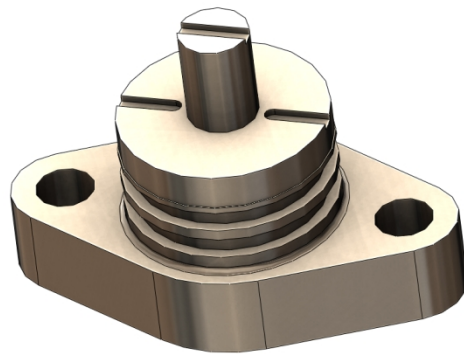
- Lot size
- Reject rate (%)
- \$4200 bar stock, 5 ft leftover
- Actual bar 2.50" dia., DFM used 2.00"
- Special Tooling
- Programming / Debugging
- Best Operator / Best Machine = Higher Rates
- Communication

Supplier Example #2

- Mat'l: Inconel
- Intricate part
- Tight tolerances

Final Production Quote

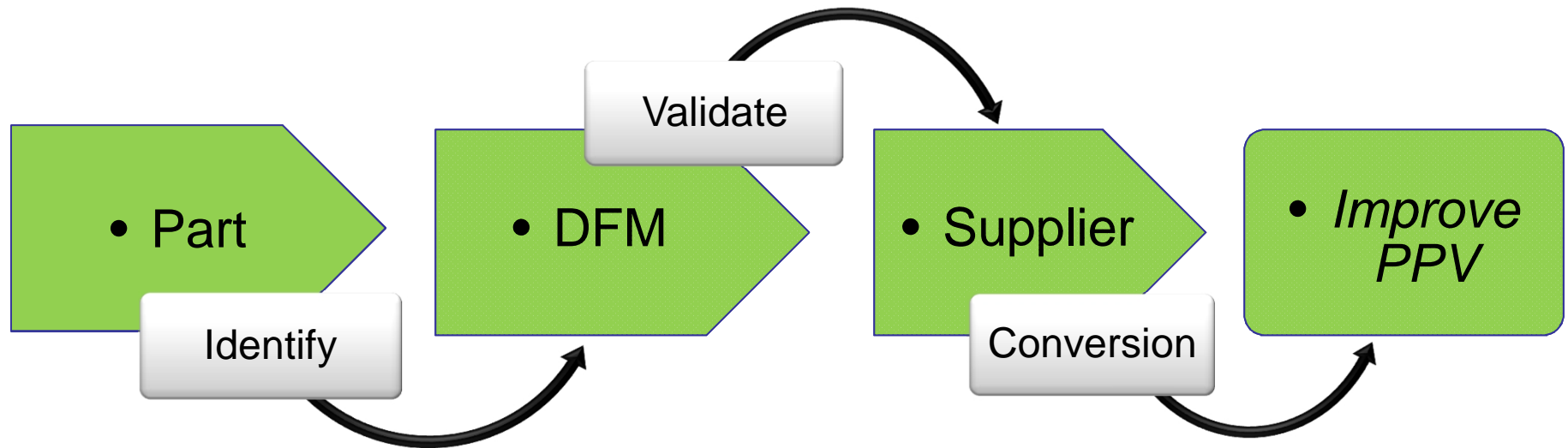
— Std Price	\$180.85
— DFM #4	\$152.16



Final comment from Supplier:

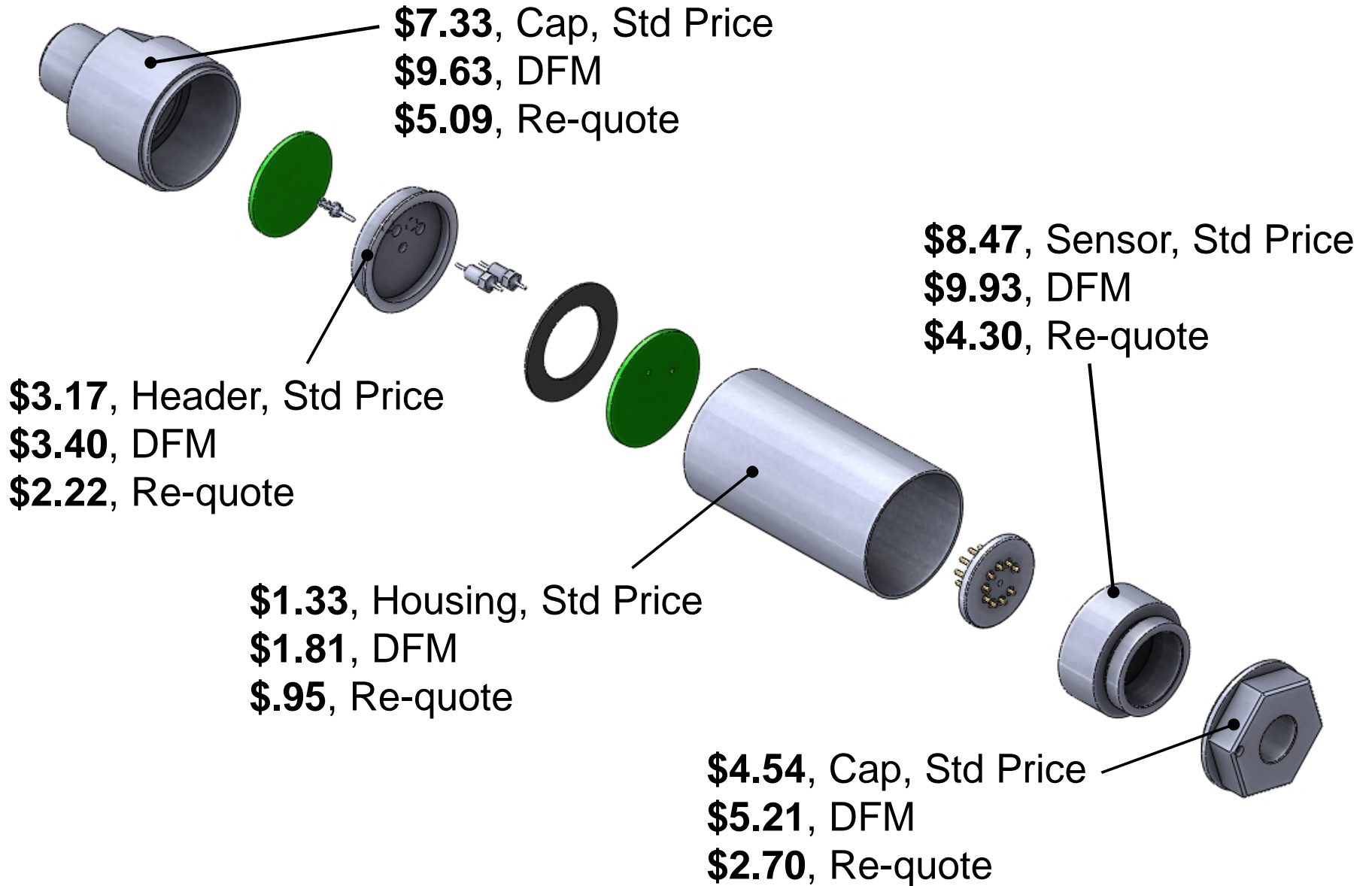
With refinement \$150-165

DFM Process



- Identify – Size the opportunity, Std. Price vs. DFM Price
- Validate – Accuracy of the DFM model & design cost drivers
- Conversion – Engage suppliers

Results – Date of last Quote



\$7.33, Cap, Std Price
\$9.63, DFM
\$5.09, Re-quote

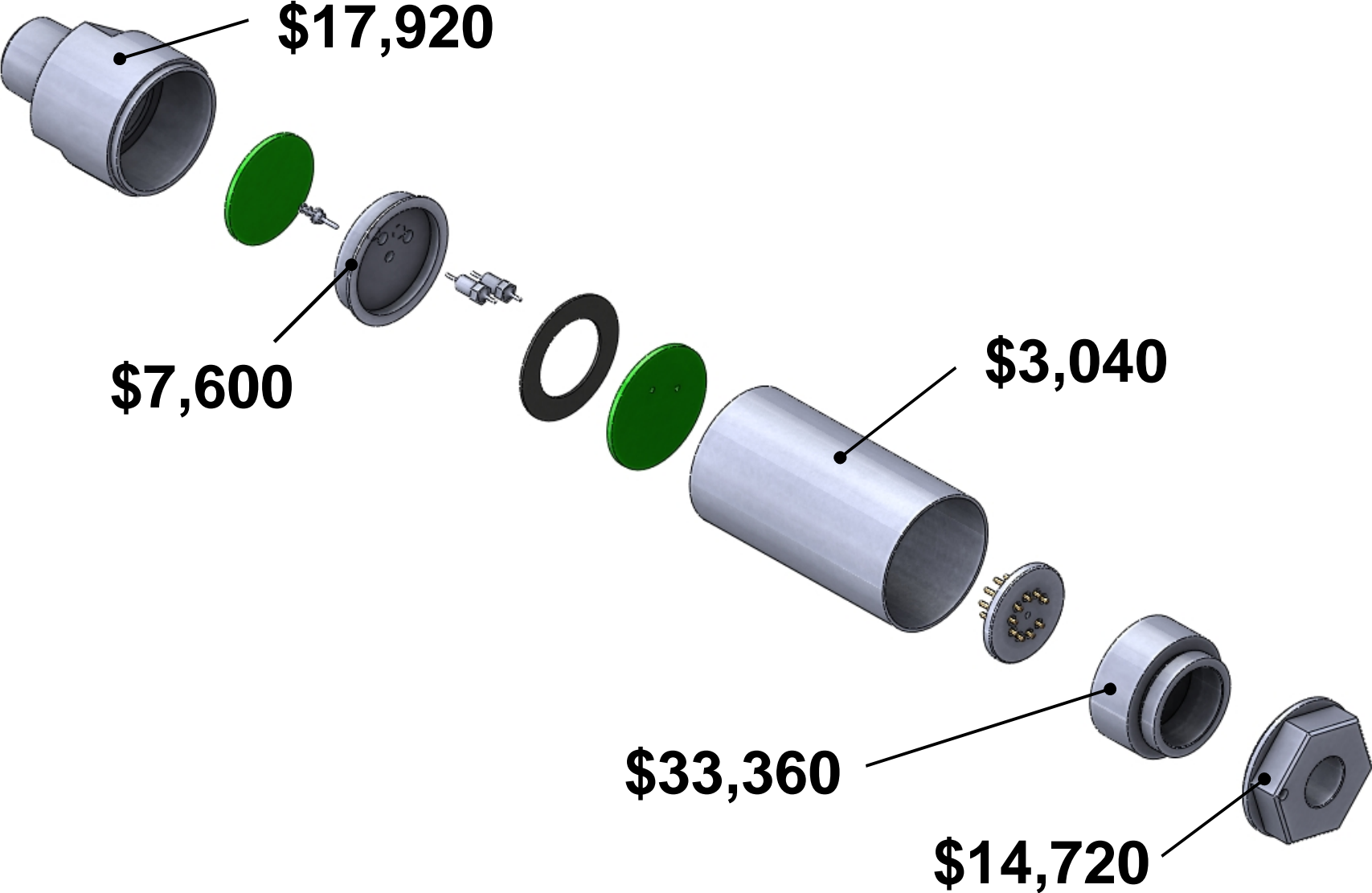
\$3.17, Header, Std Price
\$3.40, DFM
\$2.22, Re-quote

\$1.33, Housing, Std Price
\$1.81, DFM
\$.95, Re-quote

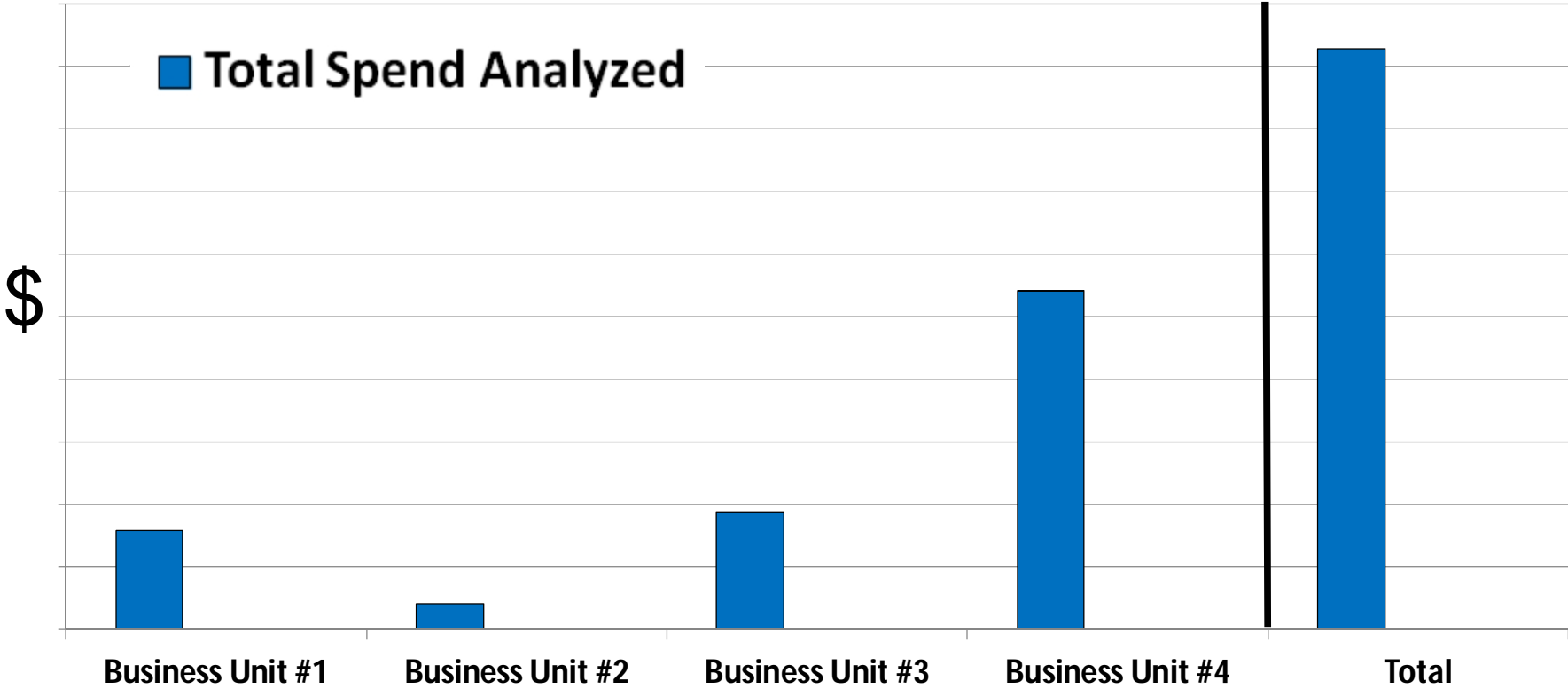
\$8.47, Sensor, Std Price
\$9.93, DFM
\$4.30, Re-quote

\$4.54, Cap, Std Price
\$5.21, DFM
\$2.70, Re-quote

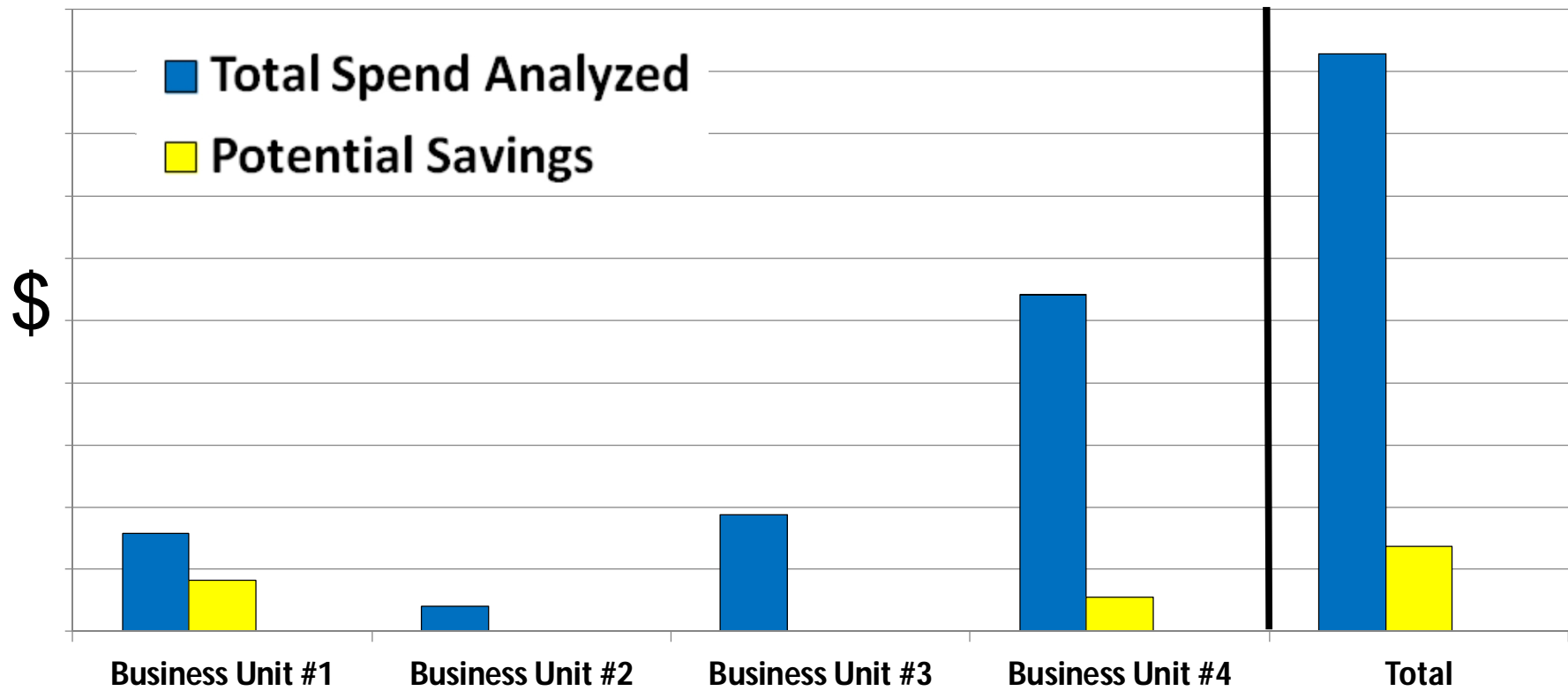
Results – Date of last Quote



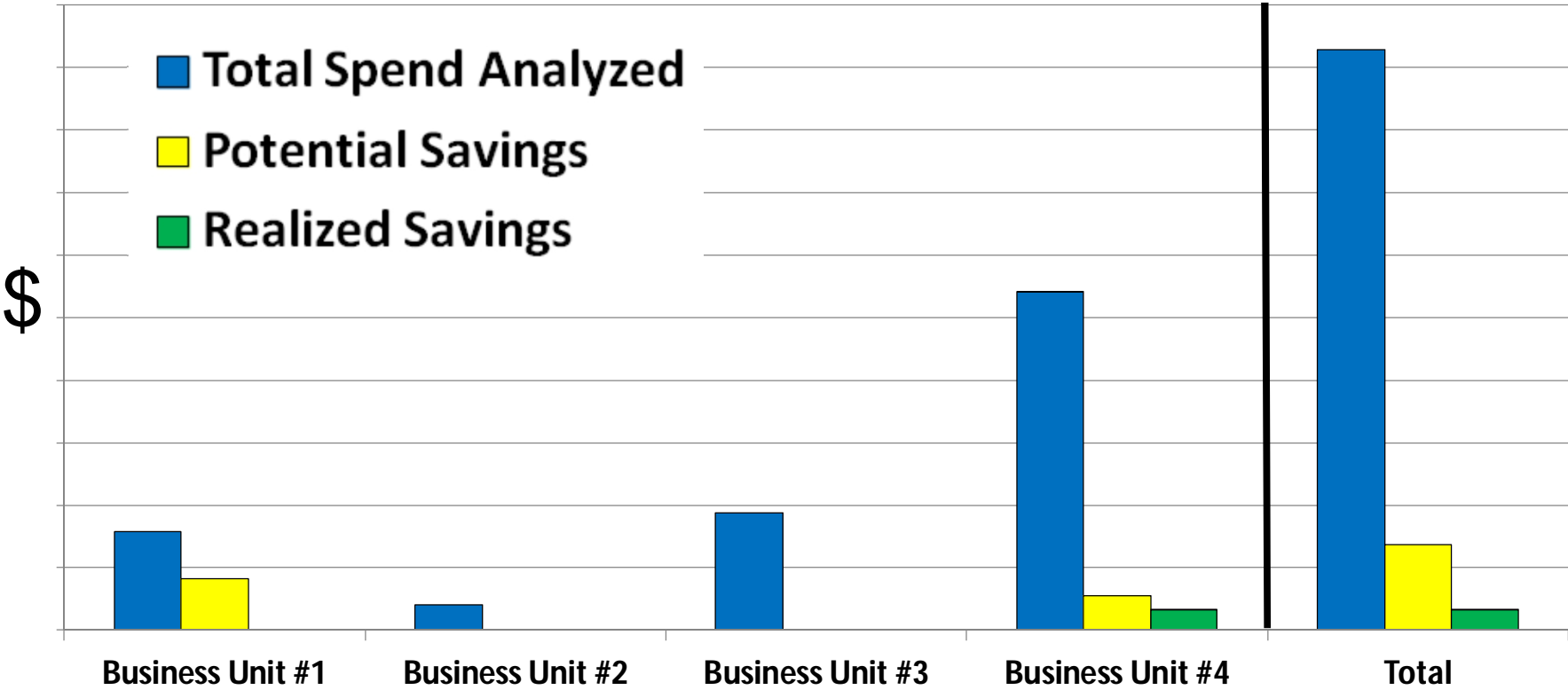
Supply Chain - Spend



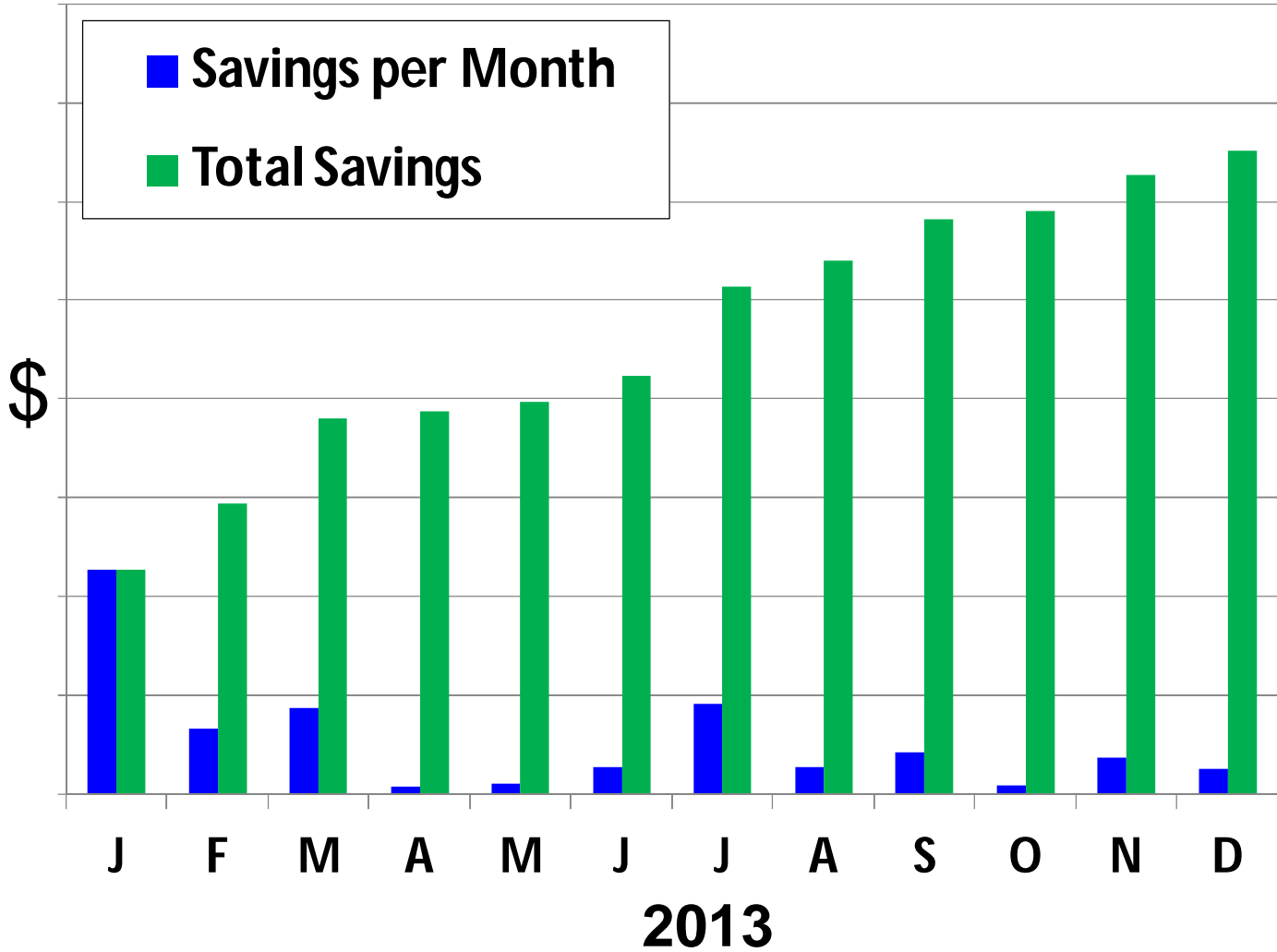
Supply Chain – Potential Savings



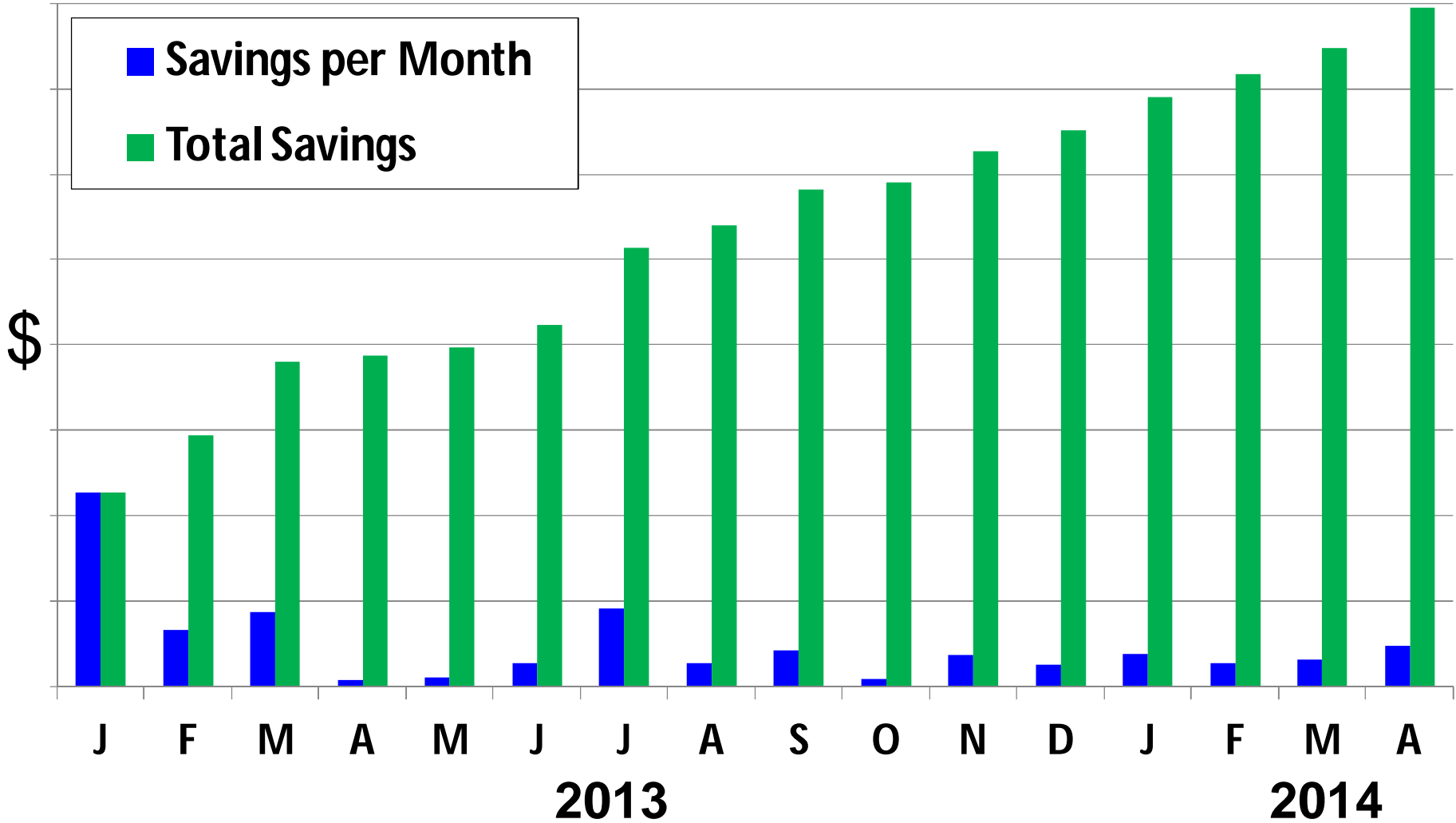
Results - Realized Savings



Results – Business Unit #4

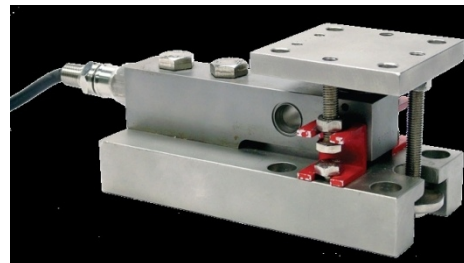


Results – Business Unit #4



Results

- Established cost savings program
- Internal departments
 - Engineering, Supply Chain, Finance
- Business Unit #1 – 52%
 - Supplier meetings, cost savings started
- Business Unit #4 – Key Supplier
 - More opportunities to supply parts

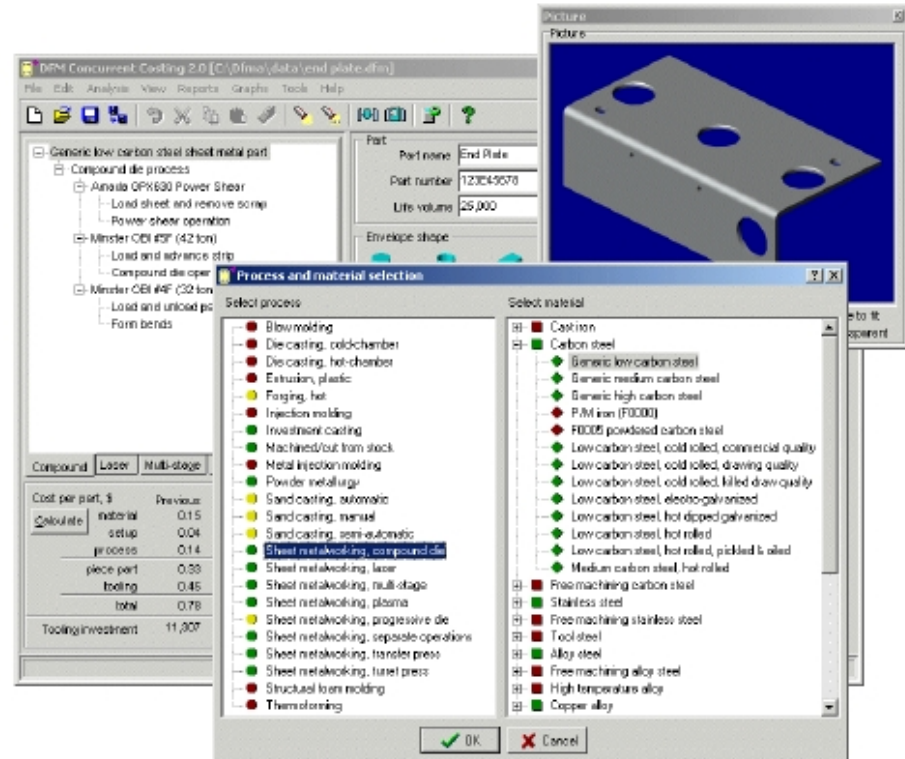


DFM Application



- DFM Process
- Existing parts within the Supply Chain
- New Product Development

Design for Manufacture Early Cost Estimating



Source: Boothroyd Dewhurst, Inc.

Summary

Questions?

