DFMA-The best tool in the designers toolbox

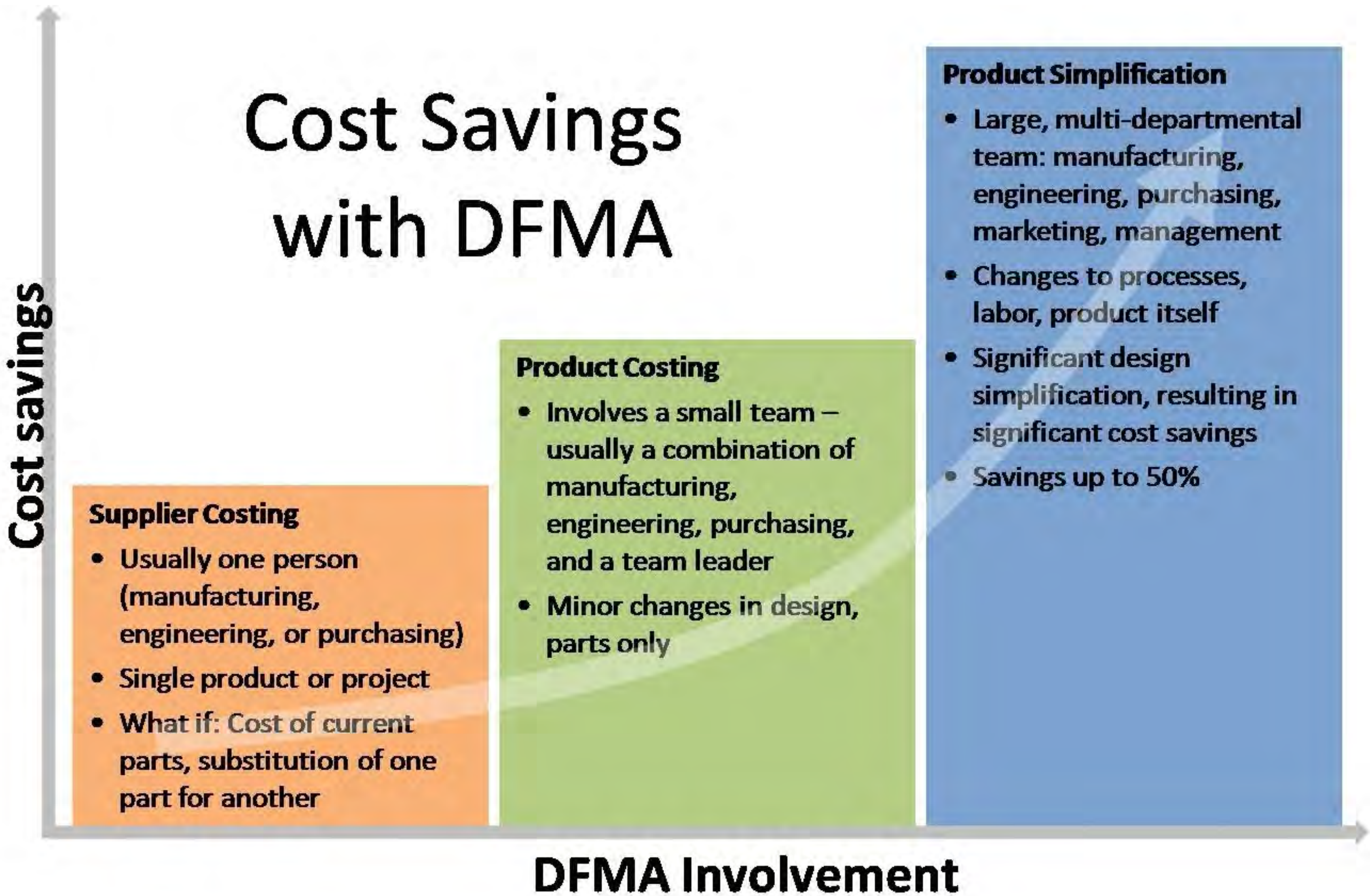
David Meeker
Nick Dewhurst

Boothroyd Dewhurst, Inc.

- Methodology & databases developed in late '70s with Nat'l. Science Foundation funding
- BDI formed in 1980, first software released in 1983
- Market leader for over three decades, helped by industrial research & user-feedback
- Software in use by more than 850 industrial corporations
- 1991 National Medal of Technology Recipients

"For their concept, development and commercialization of Design for Manufacture and Assembly (DFMA), which has dramatically reduced costs, improved product quality and enhanced the competitiveness of major U.S. manufacturers."

Three Main Uses of DFMA



Product development

DFMA can be used throughout the entire Product Development Process

- Early Product Costing
- Competitive product benchmarking
- Concept / Process selection
- Creation of time standards
- Assembly Instructions
- Deign Simplification
- Cost reduction
- Quality
- Vendor quote verification

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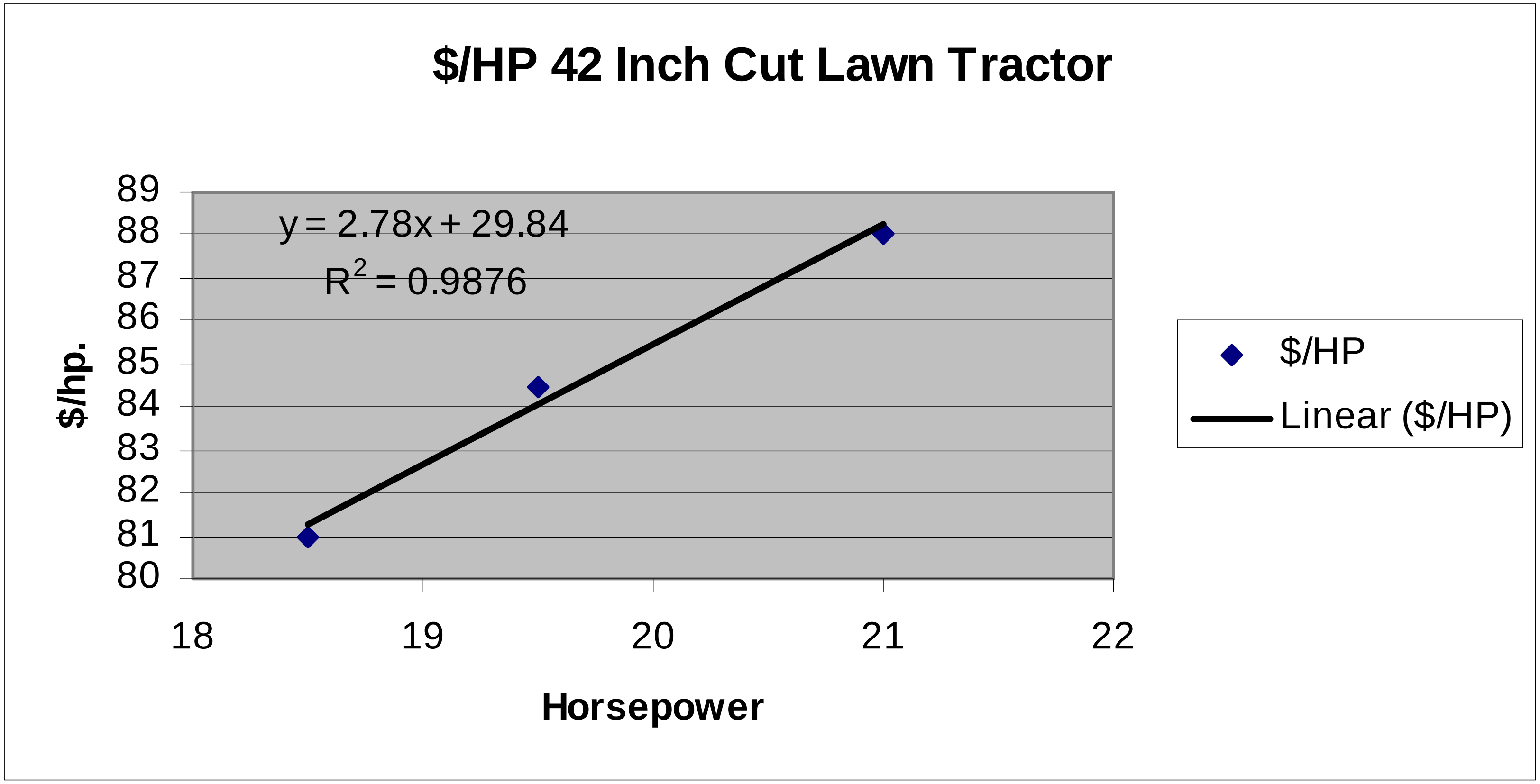
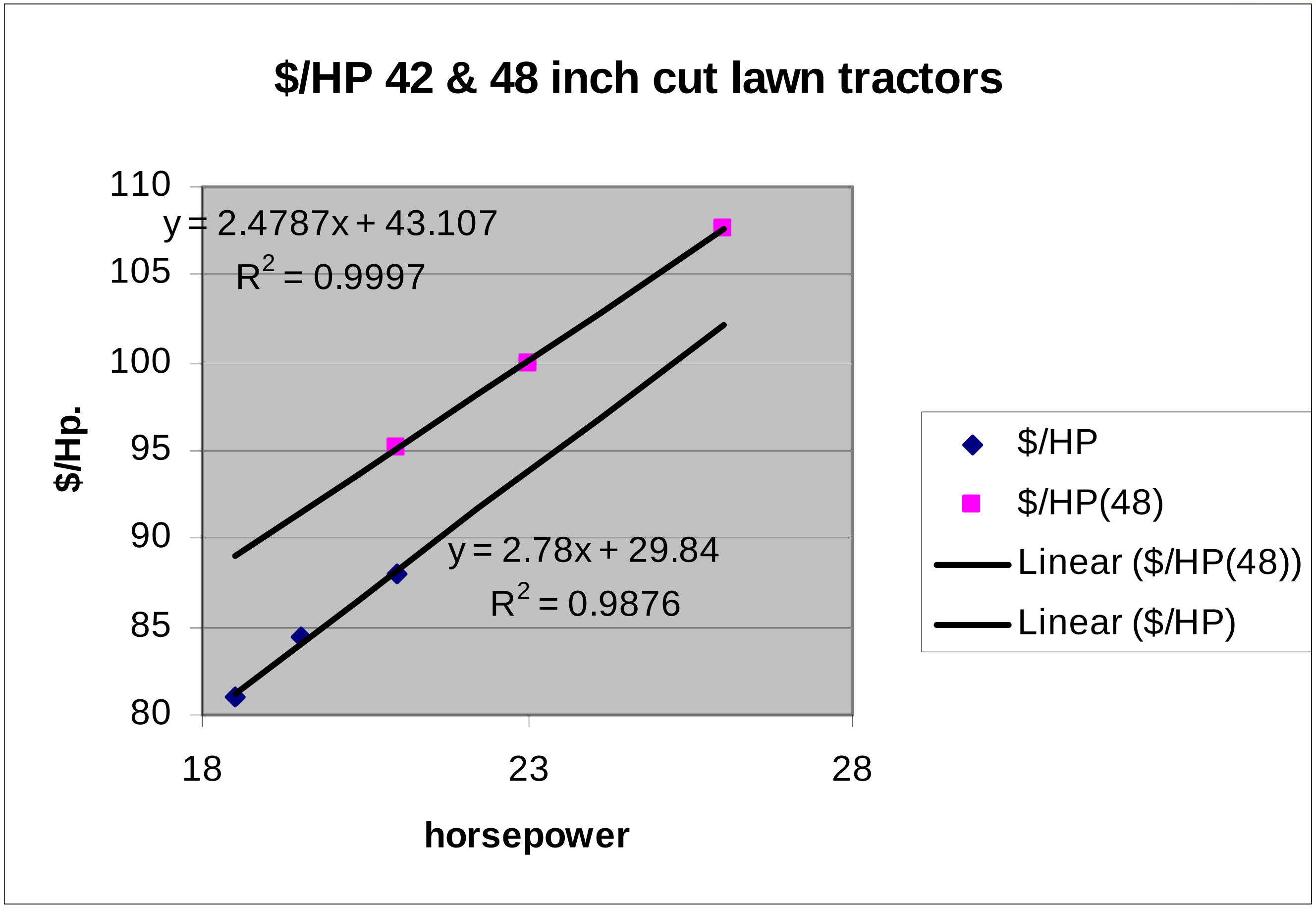
Trend Line Analysis

Tractor example



Trend Line Analysis

Tractor example



Trend Line Analysis

- Next steps:
- Break lawn tractor into major subassemblies
- Project trend lines for each major subassembly
- Next level is to break down material content of each major subassembly, to incorporate material trends.

Best paper on topic is "Controlling New Product Cost Through Trend Analysis" by Terry Ayer Teradyne, Inc. May 2004 B&D conference

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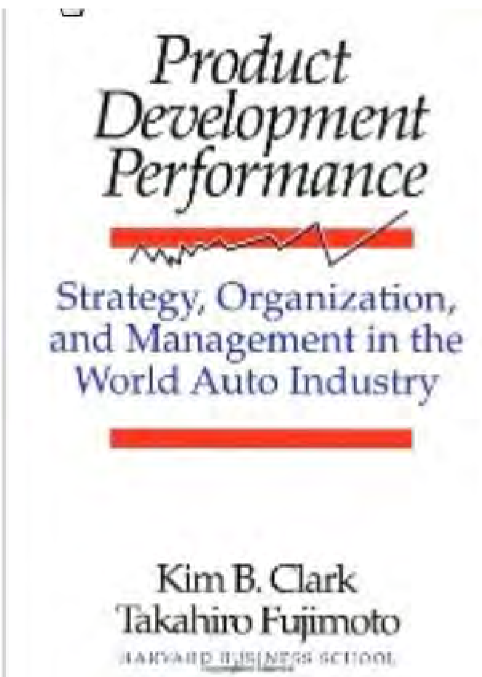
Product Benchmarking

Building better products requires a good comparative perspective about other companies to gain insight into other sources of outstanding performance



Product Development Performance

Kim Clark & Takahiro Fujimoto

Definitions

- **Benchmarking**
  - Is the continuous process of measuring products,services and practices against the toughest competitors or those recognized as industry leaders.

- **Competitive Intelligence**
  - Is the process of gleaming and combining disparate information about a competitor in order to deduce its objectives.

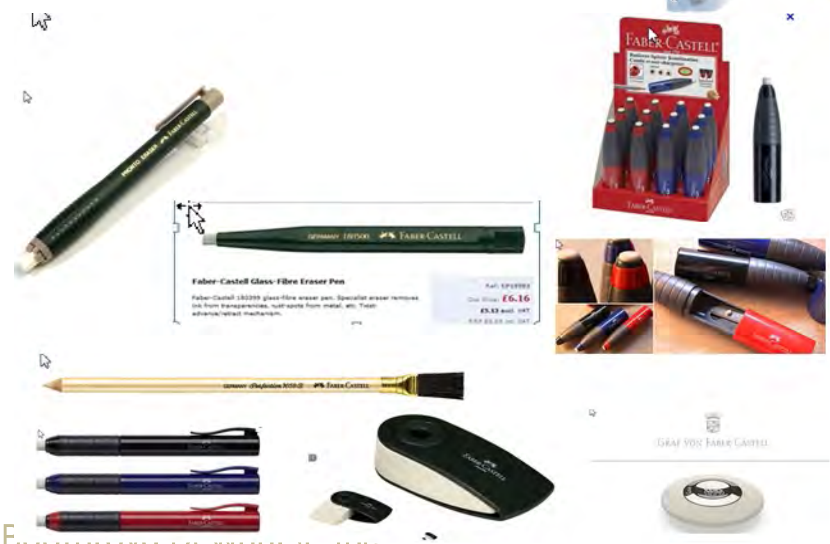
- **Reverse Engineering**
  - Is the systematic dismantling of a product to understand its technology with the purpose of replication.

Tape Measures

DPV

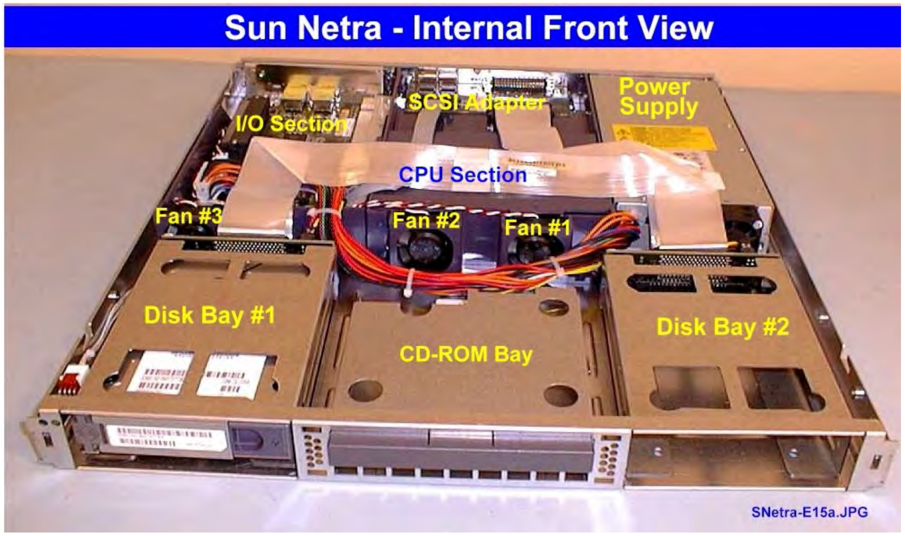

Submerge
Torpedo
Stealth
MAXX
SEA-DOO
SEA-DOO
Paragon
TYGER RAY
BOB

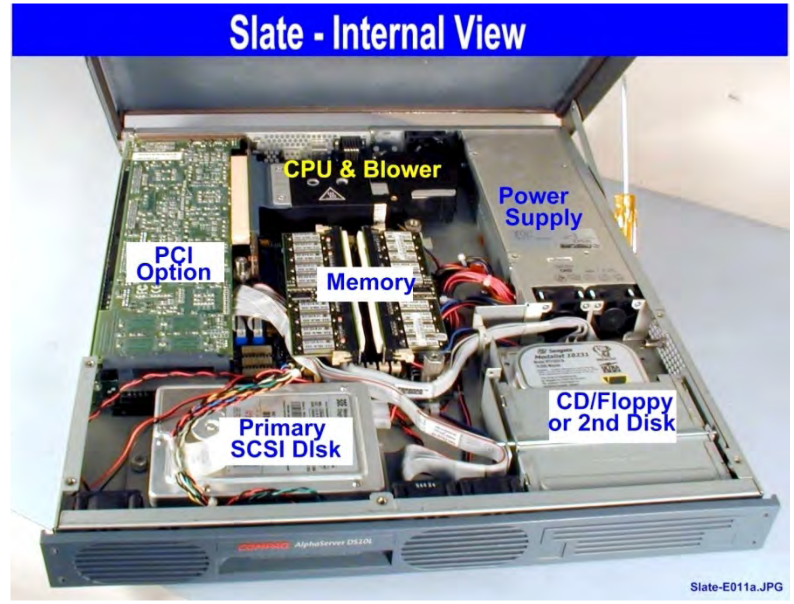
Retractable Erasers

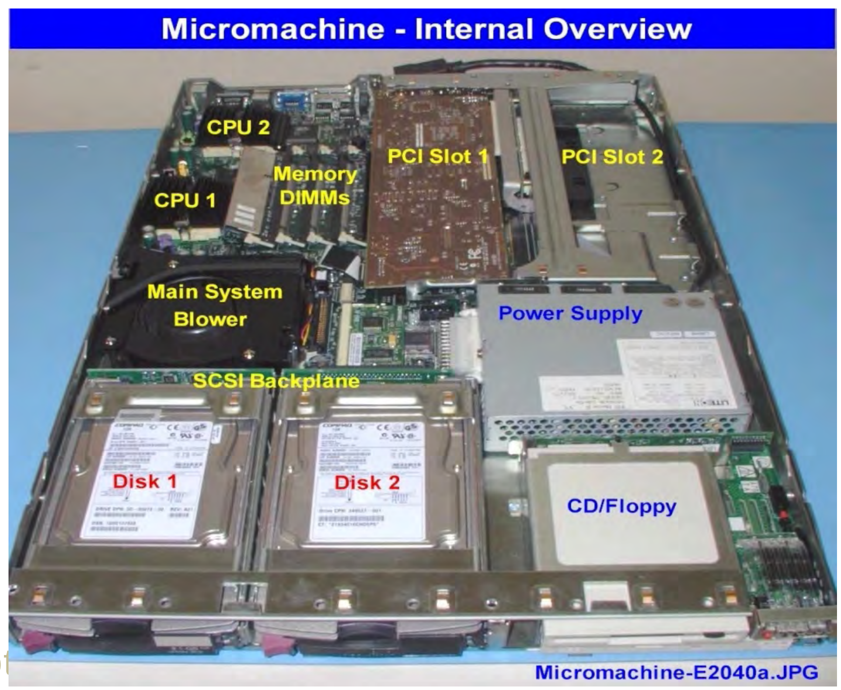


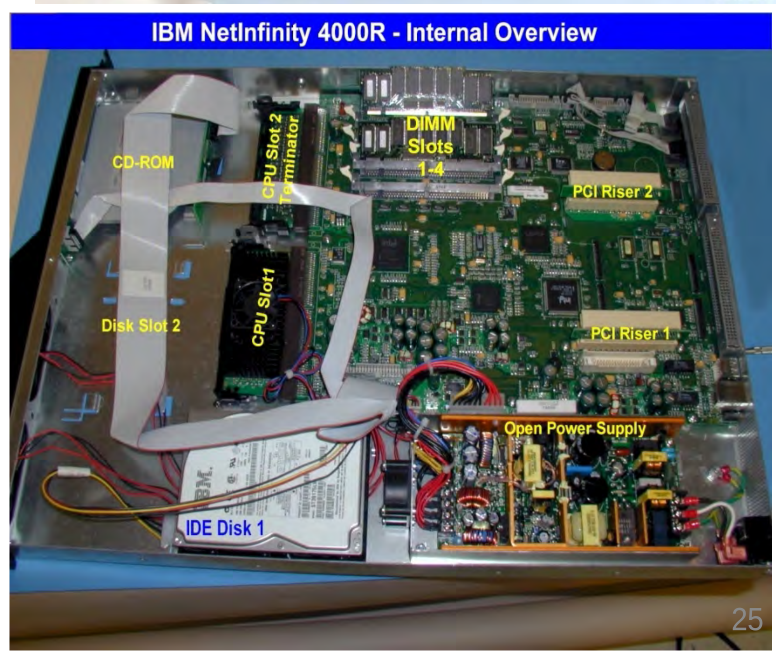
A Comparison of 1U Servers

What's inside

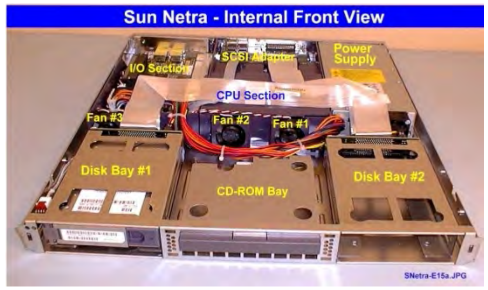


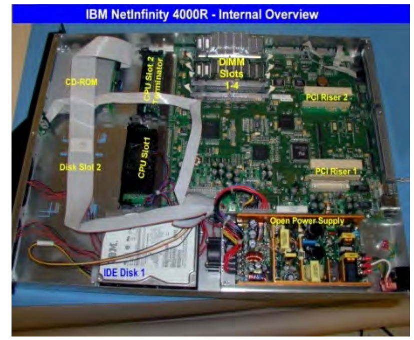






Function Cost Comparison





	Sun Netra t1		IBM NetInfinity 4000R	
	Cost	% of Total	Cost	% of Total
Cooling	$14	0.9%	$9	0.5%
CPU	$675	42.6%	$189	11.2%
Disk	$215	13.6%	$281	16.6%
Enclosure	$50	3.2%	$93	5.5%
I/O	$235	14.8%	$187	11.0%
Memory	$274	17.3%	$410	24.2%
Power	$86	5.4%	$52	3.1%
System	$17	1.0%	$428	25.3%
Pkg/Doc/SW	$19	1.2%	$42	2.5%
Total	**$1,585**		**$1,691**	

Things you can find

MODULE AND SYSTEM LEVEL BENEFITS OF HIGH FLUX HEAT PIPE HEAT SINKS

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ABSTRACT

Higher powers in smaller packages has trended to the point where junction to case resistances are the majority of the overall allowable thermal resistance. This has pressured the sink to ambient resistances to the point where standard cooling solutions are no longer a viable option. Current trends are pushing chip fluxes into the range of 50 to 100 W/cm^2. At these fluxes it is critical to optimize the overall system resistance by studying the tradeoffs between spreading, interface, conduction, and airside resistances.

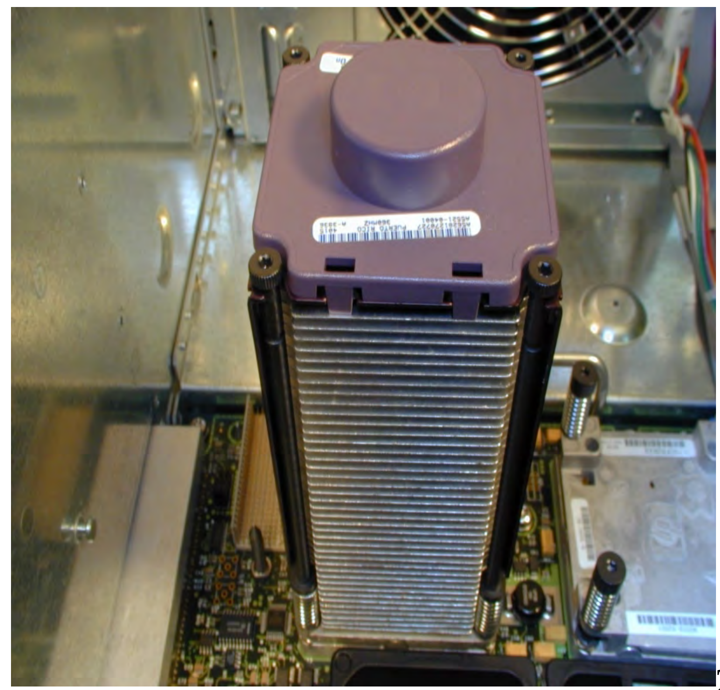
This paper discusses one case study and outlines the module and system levels benefits of heat pipe heat sinks capable of handling high heat fluxes. At the module level the heat pipe uses two phase boiling heat transfer from the large specific surface area of a powder metal wick structure to remove the high heat fluxes generated at the die level. This minimizes conduction and spreading resistances. At the system level, heat pipes isothermalize the entire fin area, allowing designers to make optimum use of fin volume and flow areas to achieve minimum thermal resistances with lower velocity and lower pressure drops.

INTRODUCTION

Although this case study is specific to a single application, the problem solved is typical of current and future processor power levels and fluxes. The approach used to get from problem definition to end solution is applicable to a broad range of applications and the conclusions drawn should expedite solutions for similar applications. The solution selected in this case study a "tower" heat pipe heat sink, was dictated by the allowable fin geometry. The chip level and system level benefits are applicable to a family of heat pipe assisted heat sinks including vapor chambers and towers.

PROBLEM DEFINITION

Figure 1 and the data listed in the Table 1 sufficiently define the requirements and provide enough information to begin the process of evaluating alternative solutions



Don’t have to Buy to Look

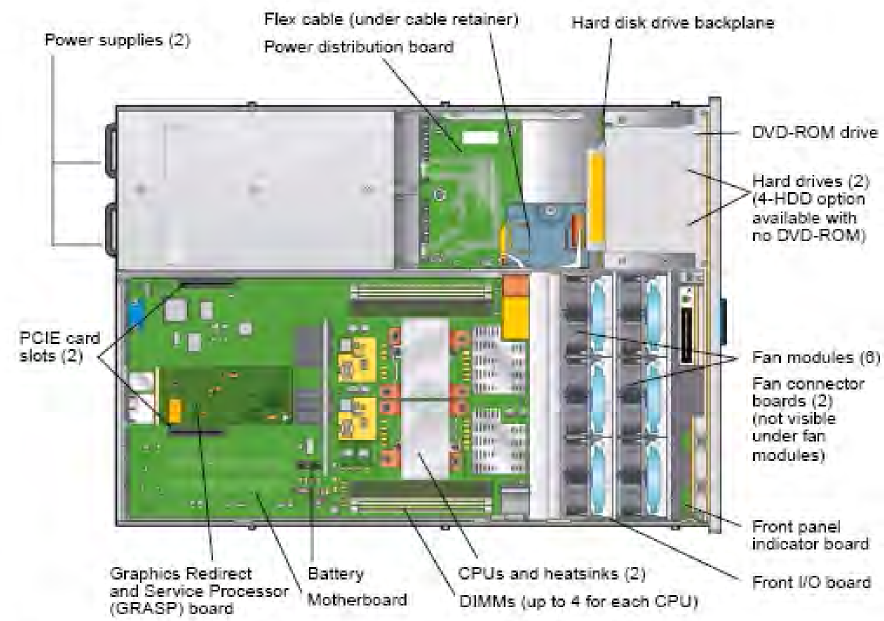
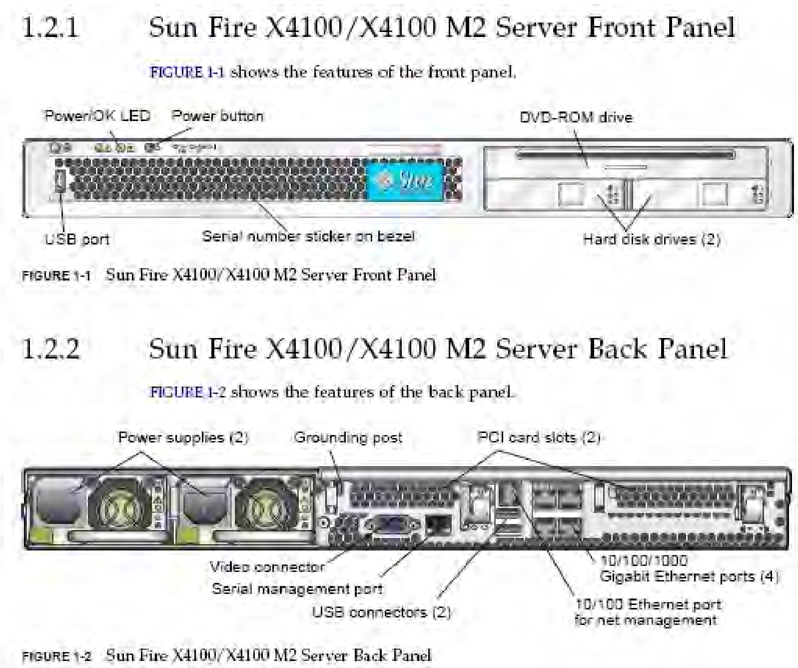


FIGURE 1-4 Sun Fire X4100 M2 Replaceable Component Locations



1.2.1 Sun Fire X4100/X4100 M2 Server Front Panel

FIGURE 1-1 shows the features of the front panel.

FIGURE 1-1 Sun Fire X4100/X4100 M2 Server Front Panel

1.2.2 Sun Fire X4100/X4100 M2 Server Back Panel

FIGURE 1-2 shows the features of the back panel.

FIGURE 1-2 Sun Fire X4100/X4100 M2 Server Back Panel

Often service manuals, product reviews provide excellent reference material with enough detail to calculate costs.

Product development

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- **•Concept / Process selection**
- •Creation of time standards
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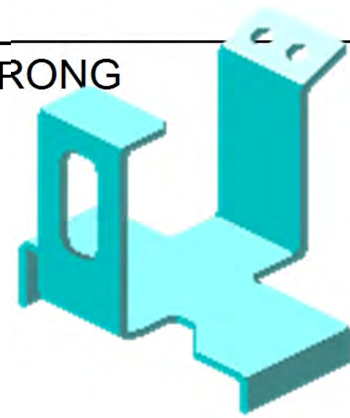
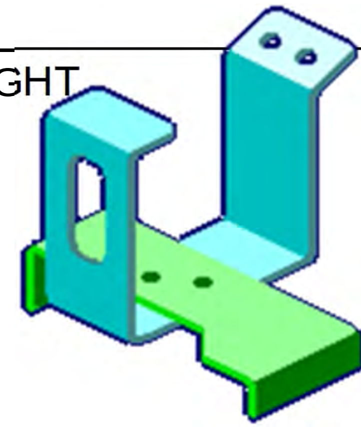
- •Deign Simplification
- •Cost reduction
- •Quality
- •Vendor quote verification

Traditional Concept Selection of Design Alternatives

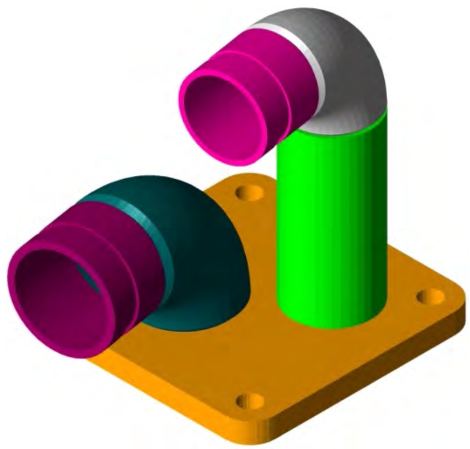
GUIDELINE	WRONG	RIGHT
Avoid complex bent parts (material waste); rather split and join		

(a) Misleading producibility guideline for the design of sheet metal parts

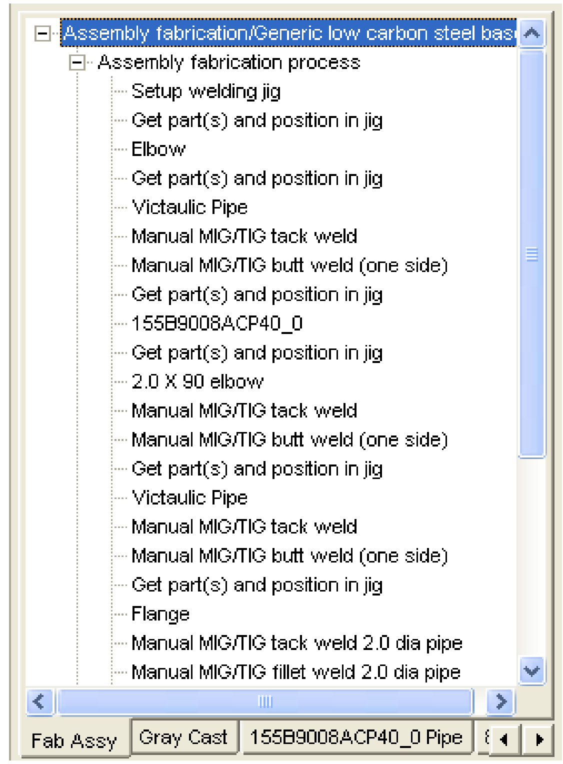
Set-up	0.015	0.023
Process	0.535	0.683
Material	0.036	0.025
Piece part	0.586	0.731
Tooling	0.092	0.119
Total manufacture	0.678	0.850
Assembly	0.000	0.200
Total	0.678	1.050

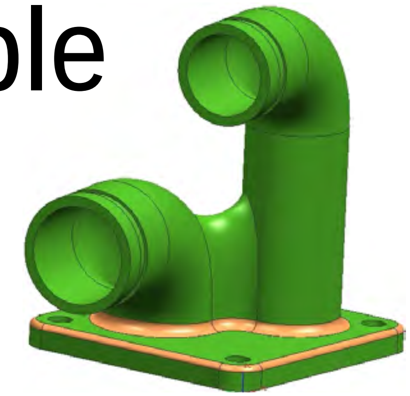
(b) Estimated costs in dollars for the two examples if 100,000 are made

Locomotive fab to cast example



6 Parts
' cost estimate'





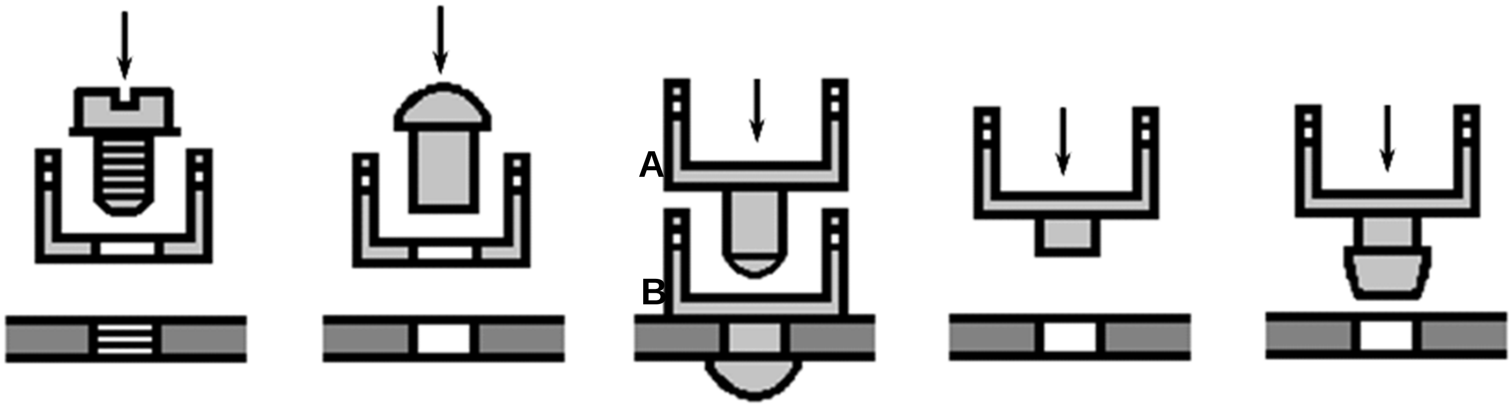
1 Part
'could cost'

- DFMA estimate $84
- Assembly time 1384 sec (23 min)
- Current price $209

Annual Savings = $261k

- DFMA estimate $25
- Assembly time 0 sec
- Expected Price $35

Design improvement example



START:
- 3 parts
- Requires a screwdriver
- Needs careful alignment
- Time-consuming

- 3 parts
- Requires a rivet gun
- Alignment not as delicate
- Assembly time less

- 2 parts
- Integrated fastener & cradle (A becomes B)
- Requires machine to secure the head of the fastener

- 2 parts
- Integrated fastener & cradle
- Requires machine to press part into place

FINISH:
- 2 parts
- Integrated fastener & cradle
- Can be hand-pressed into place—even by end consumer—and can be removed

Concept / Process selection

Machined as designed	**$780- 975 each**
Machined Design changes (DFM)	**$455-650 each**
Investment cast / CNC	**$135 each**
Metal Injection Molded / CNC	**$160 each**

DaTuM 3D

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Time Standard Project

The Challenge

- Needed six time standards in under two weeks
- Update legacy time standards.
- Create new product time standards.
- Low cost and quick creation time

Compaq Time Standard Project

Alternative methods

- MTM, MOST,Lucas,Westinghouse method,Assembly View,SEER,LASeR,XPI….
- When evaluated against time, $$, training, software investment.

Chose B&D

- Established tool for assembly operations
- Some flexibility to capture non assembly operations

DFA Customized Operation Libraries

DFMA Libraries are a storage mechanism for customized-operations.

Category ▾ Add

No.	Type	Name	Comment
1	**Category**	**Example:CORE Operation library**	
2	Misc Op	MTM: Place approximate <= 8 in	MTM:PA1
3	Assembly Op	AA1 g&p_2lbs_easy_app_code1	MTM-AA1 <8 in get and place command
4	**Category**	**Ex: Standard Macro library**	
5	Assembly Op	Typing process function	Macro: Key strokes, looks, reads combined
6	Assembly Op	Detrash operations	Macro: Various detrash operations
7	**Category**	**Ex: Specific Macro library**	
8	Assembly Op	Desk side pick to light procss	Macro: time to pick-to-light all necessary objects
9	Assembly Op	Wrapping machine	Macro: Time to wrap 1 cab using machine
10	**Category**	**Ex: Standard Process Library**	
11	Assembly Op	Deskside Final test time	B&D:sidefinl.dfa Deskside final test time
12	Assembly Op	Deskside Packing process	B&D:sidepack.dfa Deskside drawer packing p

B&D Design Analysis

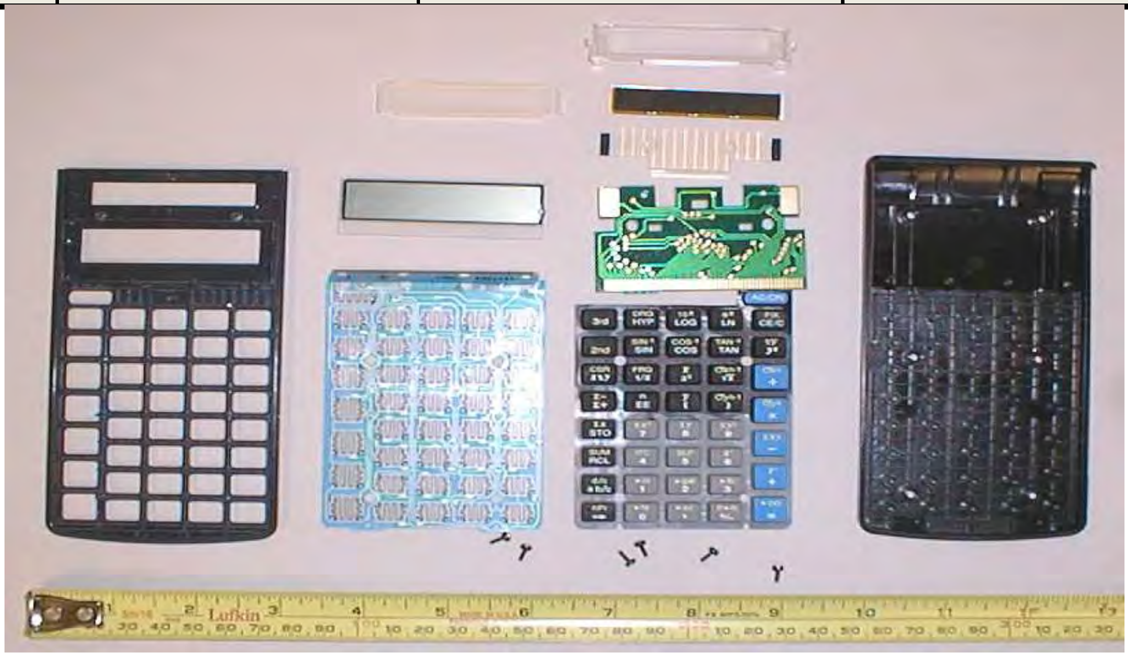
(1) B&D Design Analysis	111.30	
1.1 (2) Assembly	1	
2.1 (3) Photo Cell assembly	1	
3.1 Install plastic cover: PN 1	1	4.60
3.2 Install rubber protector; PN 2	1	4.60
3.3 Install Photo Cell: PN 3	1	6.10
3.4 Inst. Back rubber protect PN 4	1	4.60
2.2 Install LCD: PN 5	1	4.60
2.3 Install PCA board: PN 6	1	14.40
2.4 Install Key pad: PN 7	1	4.60
2.5 Install flex cable: PN 8	1	6.10
2.6 Install flex cable support:PN9	1	4.60
2.7 (4) Install Back of unit	1	
4.1 Place back on unit PN 10	1	6.80
4.2 Screw down back PN 11-17	6	50.30

B&D Time Standard Tool

(1) Calculator Assembly	235.52	
1.1 (2) Kitting Operation	1	
2.1 Get tote	1	1.80
2.2 Walk to pick face	1	2.88
2.3 Pick part & place in tote	17	21.42
2.4 Check off on paperwork	11	17.82
1.2 (3) Deliver units to assembly area	1	
3.1 Walk to assembly bench	1	3.78
1.3 (4) Assembly	1	
4.1 (5) Photo Cell assembly	1	
5.1 Install plastic cover: PN 1	1	3.4
5.2 Install rubber protector; PN 2	1	3.4
5.3 Install Photo Cell: PN 3	1	4.9
5.4 Inst. Back rubber protect PN 4	1	3.4
4.2 Install LCD: PN 5	1	3.45
4.3 Install PCA board: PN 6	1	7.45
4.4 Install Key pad: PN 7	1	3.45
4.5 Install flex cable: PN 8	1	4.95
4.6 Install flex cable support:PN9	1	3.45
4.7 (6) Install Back of unit	1	
1.4 (7) Close out paperwork process	1	
7.1 Scan serial number	1	5.40
2.1 Get paperwork	1	1.80
7.3 Sign complete name	1	7.92
7.4 Turn page	1	1.51
7.5 Initial paperwork	1	3.96
1.5 (8) Test	1	
8.1 Check Add button	1	3.37
8.2 Check off on paperwork	1	2.52
8.3 Check Subtract button	1	3.37
8.4 Check off on paperwork	1	2.52
8.5 Check Divide button	1	3.37
8.6 Check off on paperwork	1	2.52
8.7 Check Multiply button	1	3.37
8.8 Check off on paperwork	1	2.52
8.9 Sign off on test	1	7.92
1.6 (9) Pack	1	
9.1 Place calculator in bag	1	9.72
9.2 Tape the end of the bag	1	5.40
9.3 Place syrophom sides	2	9.90
9.4 Open box	1	3.96
9.5 Place unit in box	1	2.70
9.6 Close box	1	7.92
9.7 Staple box using foot stapler	1	10.08
1.7 Place paperwork in bin	1	1.80

Calculator Build

	Standard creation time (minutes)	Calculator build standard time (minutes)	Complete assembly Kit, build, test, pack (minutes)
B&D Standard tool	19.94	1.40	3.93
MTM	48.15	1.31	3.54
Time study AVG.	-	1.78	4.42
Time study A	-	1.80	4.58
Time study B	-	1.85	4.34
Time study C	-	1.70	4.33



Historical Statistics

Creation Time Historical Results

B&D tool Historical	3 - 1*
MTM-UAS	10 - 1
Most	10 - 1**
MTM-1	40 - 1**

* Historical data based on total number of systems analyzed over 8 months.

** Historical data: Zjell B. Zandin Most work measurement Systems Book, Marcel Decker Inc. Copyright 1990 pg.14

Process Time Historical Results

B&D standard tool accuracy with generic macros to within 5-15% of MTM-UAS times.

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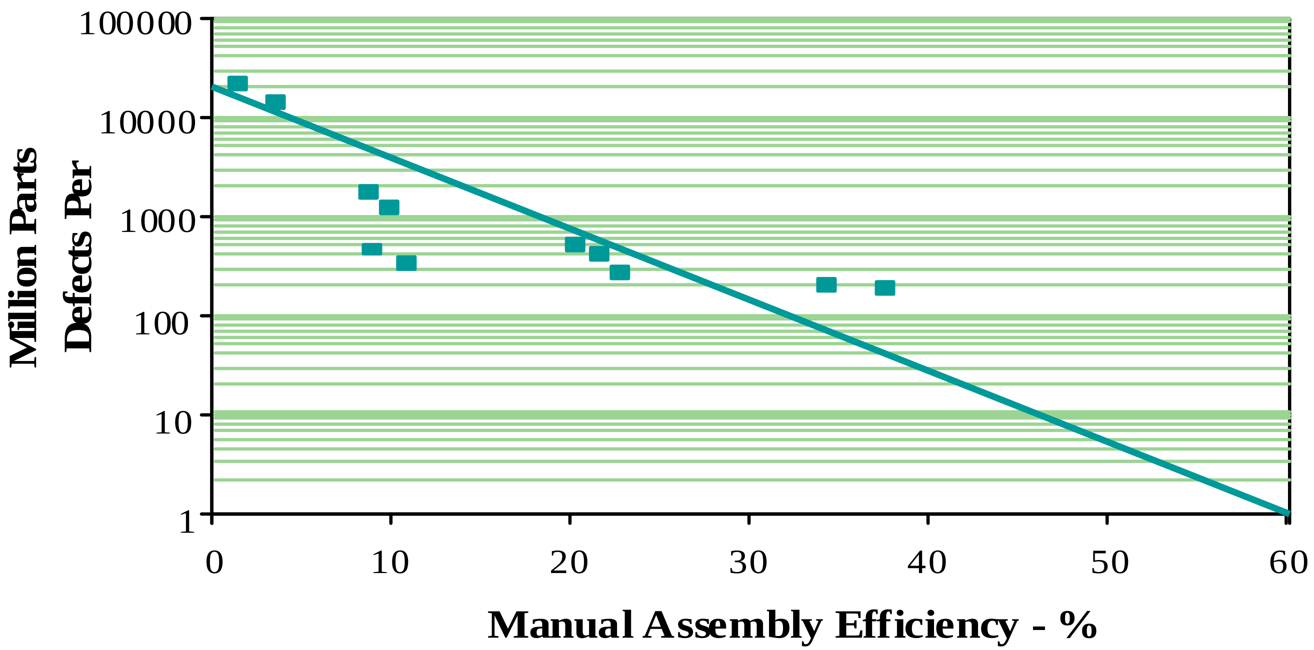
Quality Tool

Design for Assembly

Product Quality/Assembly Efficiency Correlation



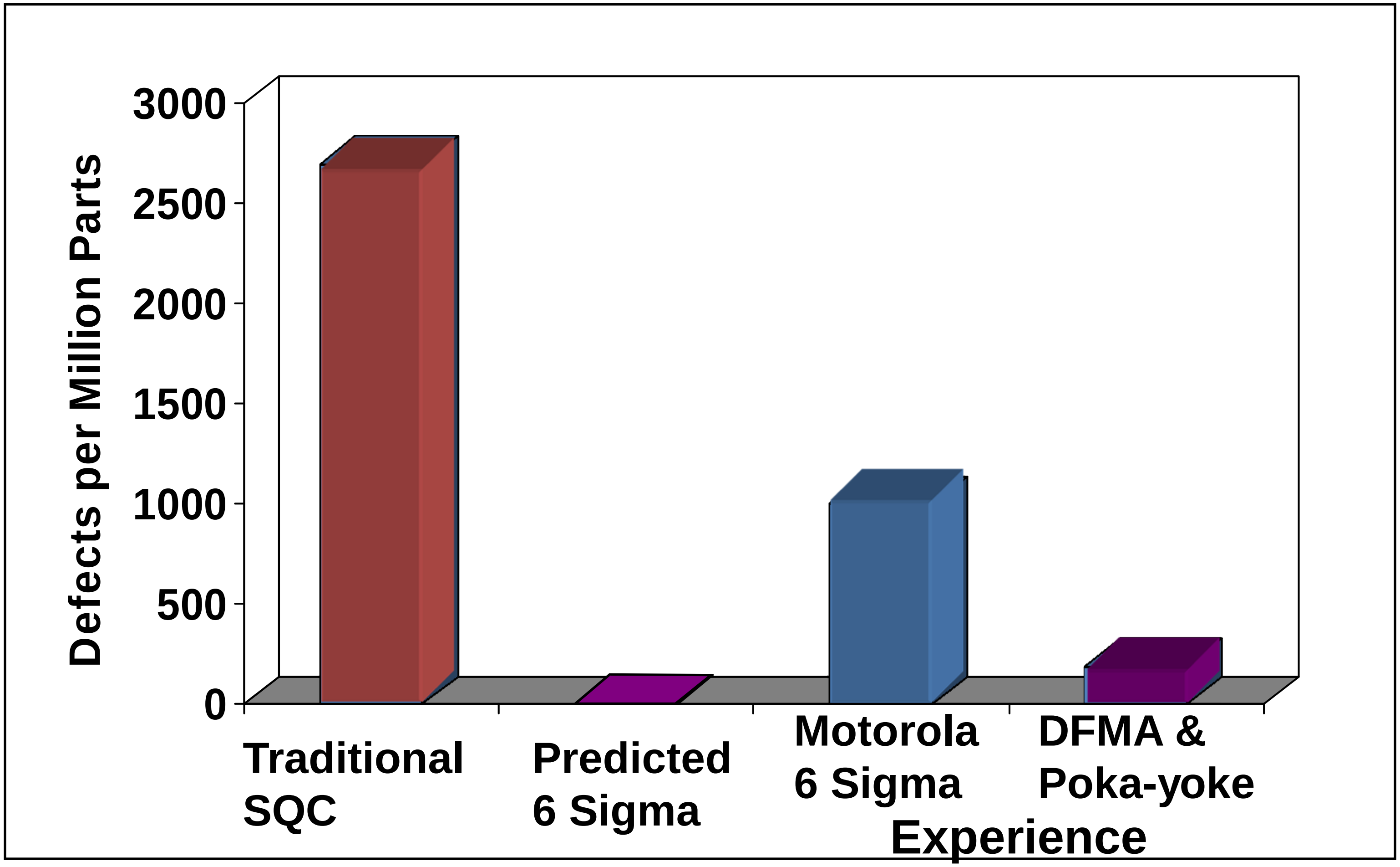
Every one second of assembly penalty time causes an average of 100 DPM

Quality Assessment Conclusions

- **For many corporations part variability is no longer the quality issue; quality problems arise mainly in assembly**
- **Assembly quality problems seem to correlate strongly with assembly difficulties**
- **The key to quality improvement is to reduce both the number of assembly steps, and the average time per operation**

Source Dr. Peter Dehewhurst URI.

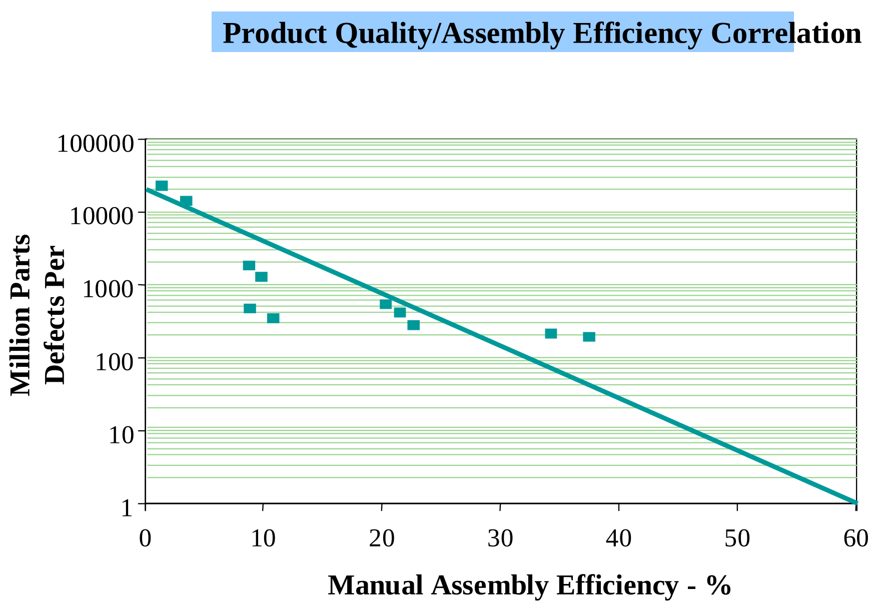
Mistake-proofing achieves superior results, faster, and with less efforts.

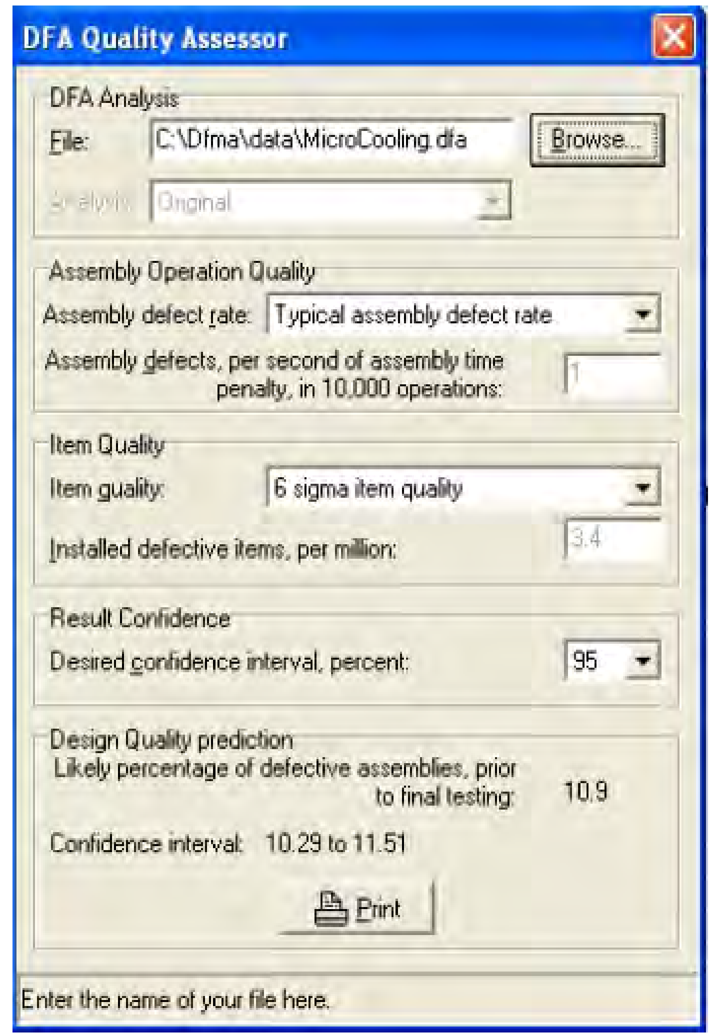


Source: Make NO Mistake – A Mistake – Proofing Methodology C. Martin Hinckley B&D conference June 2003

Quality Prediction

Design for Assembly





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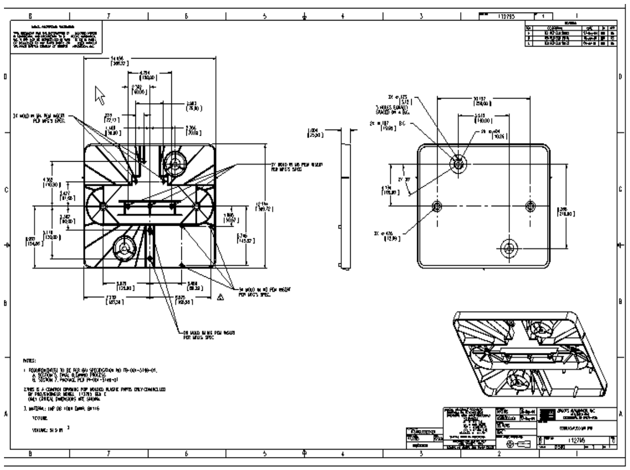
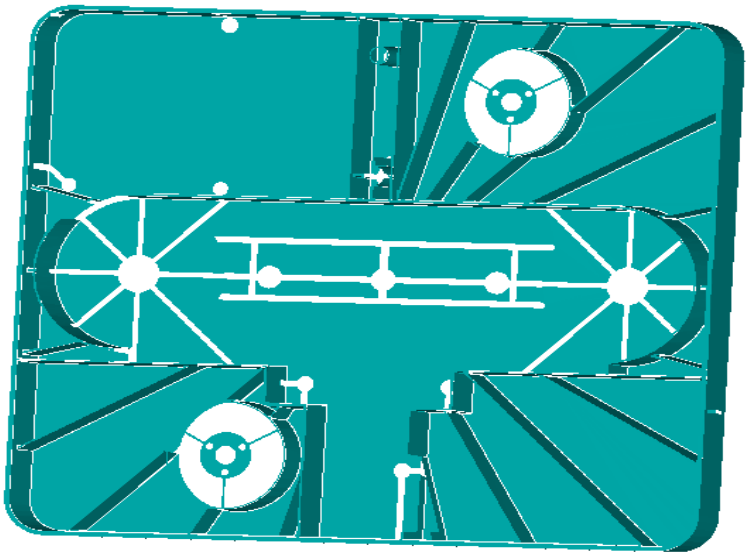
- Assembly Instructions
- Design Simplification
- Cost reduction
- Quality
- Vendor quote verification
- Estimate hard tooling

DFMA Example-Comparing Estimates Against Vendor Quotes

B&D Estimates Against Actual Quotes

Item Description	QTY	Cost	B&D Estimate
DOOR,	1	$22.34	$9.40





DFMA Example-Vendor Quote

Item Description	QTY	Cost	B&D Estimate
DOOR,	1	$22.34	$9.40

112795

		2,500	*1,500*	*1,000*	*500*	*250*
FOUP Door	**$55,000.00**	**$14.17/ea.**	**$15.59/ea.**	**$17.30/ea.**	**$18.74/ea.**	**$22.34/ea.**
Delivery: (8) weeks ARO		Resin: LNP DB 1004 EMMR, BK115				

Tooling Description: Single cavity self-contained *pre-hardened steel mold*, tri-plate gating with (4) pin-point gates, pin ejection, flat parting line, and bead blast cavity finish.

Notes:

- The molding material is a suggestion by our contact at LNP Corporation, based upon the need for optimum flatness. (*20% glass bead filled polycarbonate*)
- The flatness is difficult to predict. We are proposing a "tri-plate" gating design with (4) pin-point gates for help in improving flatness. A flatness specification of .010 cannot be guaranteed. We feel reasonably confident that we could mold between .012" and .020" flatness.
- "Sink" marks may be evident because of the intersecting wall section ratios. Any "sink" mark would not be part of the measured flatness.

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Page 2 of 2

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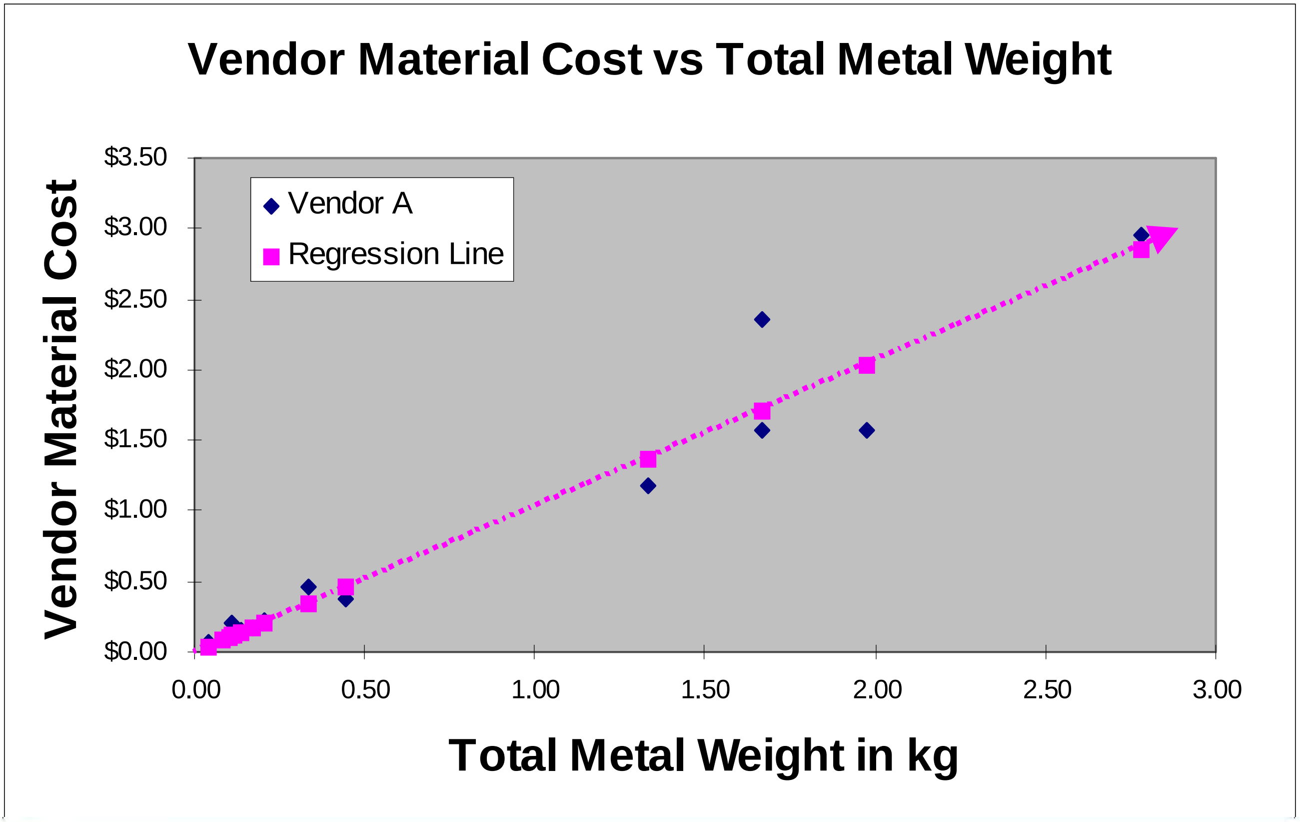
DFMA Example-Data Collection for estimate refinement

- Questions were asked to gather further information
- Material parameters and material cost from vendor, tonnage machine, and process information.
- PTA $7.35/lb GE $7.65/lb PTA is passing their material cost saving.
- New Plastic Material database created
- The cost estimate was revised using the above information.
- New B&D estimate is $23.30 VS. Vendor Quote $22.34

Regression Analysis

Total Weight to Metal Only Material Charge



Regression Coefficient

$r^2 = 86.9\%$

Zero Crossing Slope

$1.026/kg

Standard Error

$0.228/kg

- Indicates Strong Correlation
- Based on believed market rates = a material adder of 30-40%

Supply Chain Transparency

- Elements of ~~Cost~~ *Price*
  - Assembly Costs
  - Material Costs
  - Set-up Costs
  - Process Costs
  - Rejects
  - Tooling, Jigs, & Fixtures
  - *Overhead*
  - *Profit*

Results

	Product
Count	21
Minimum count	4
Labor time, s	210.93
Labor cost, $	4.14
Other op. cost, $	0.00
Assy. tool/fixture, $	0.00
Item costs, $	47.36
Total cost, $	51.50
DFA Index	5.6

Cost results, $

Calculate

	Previous	Current
material	2.04	2.04
setup	0.48	0.48
process	4.02	5.09
rejects	0.55	0.55
piece part	7.09	8.16
tooling	0.58	0.58
total	7.67	8.73
Tooling investment	5,757	5,757

The bottom line – Why DFMA?

- Focusing solely on part costs will do nothing for system reliability

- Focusing on the *functional requirements* of the product leads to
  - overall product architecture analysis
  - designs with fewer parts and therefore lower total cost
  - improved inherent quality & reliability
  - quicker time to market

What is the best part of all ?

The one that is not THERE !

85 % Part count reduction
75 % Assembly time reduction
44 % Reduction in labor cost
65 % Fewer suppliers
No assembly tooling
No fasteners

The bottom line – Why DFMA?

- The way to reduce costs is to simplify product structure
  - Looking at a part and asking how it can be made cheaper isn't going to work
  - Reducing product features and decreasing part quality is not cost reduction and does not work in the long run
  - The "D" in DFMA is for "Design"

- Creating multifunctional parts is 'where it's at'!
  - Costs drop
  - Quality increases
  - Your customer doesn't view it as you 'cheapening' the product
  - DFMA is the only methodology and product that does this

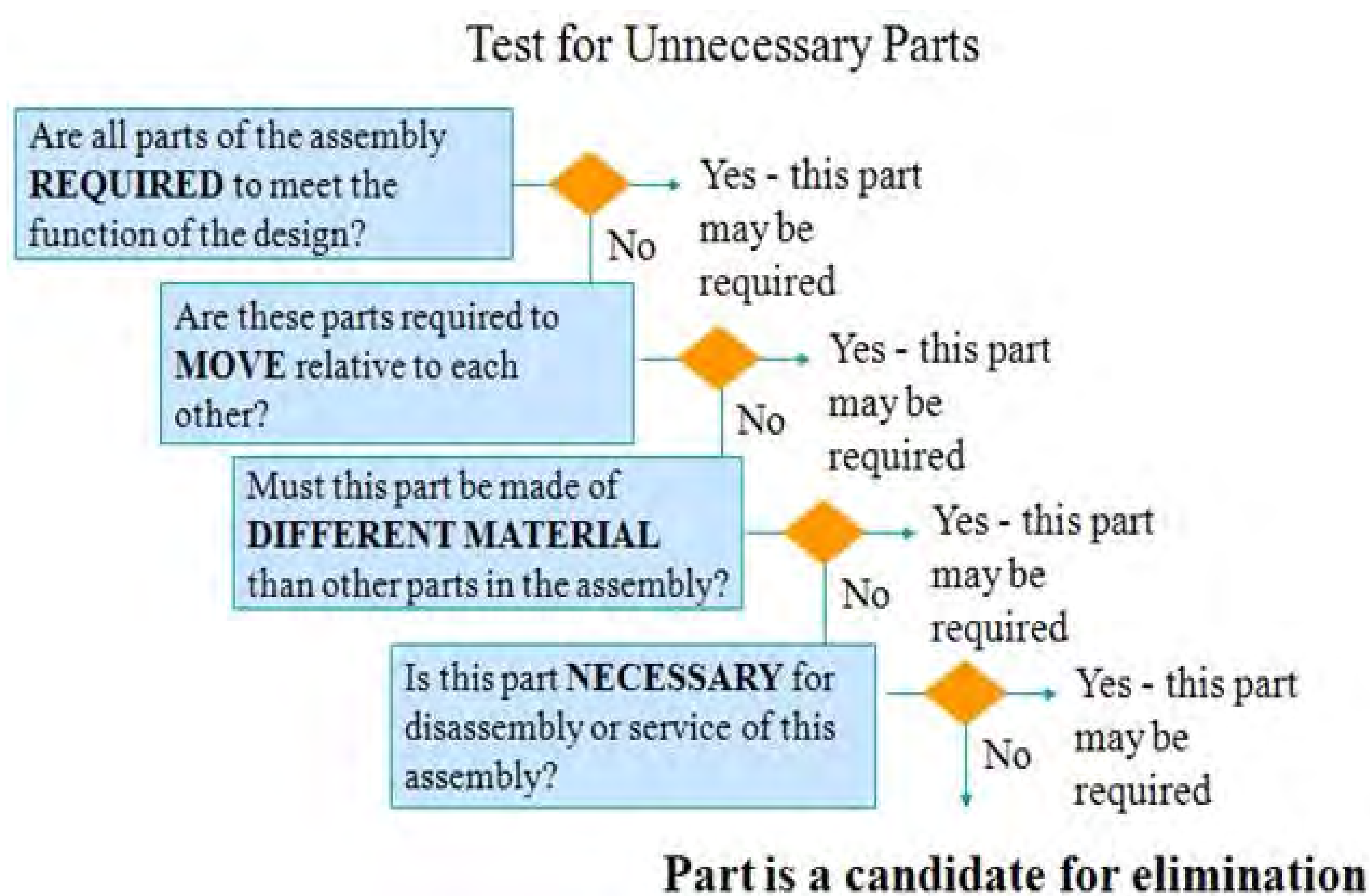
A

Big

Secret

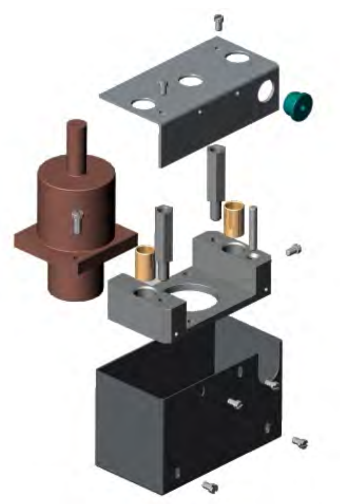
How to get rid of parts

Theoretical Minimum Part Count



Understanding and answering the minimum part criteria questions

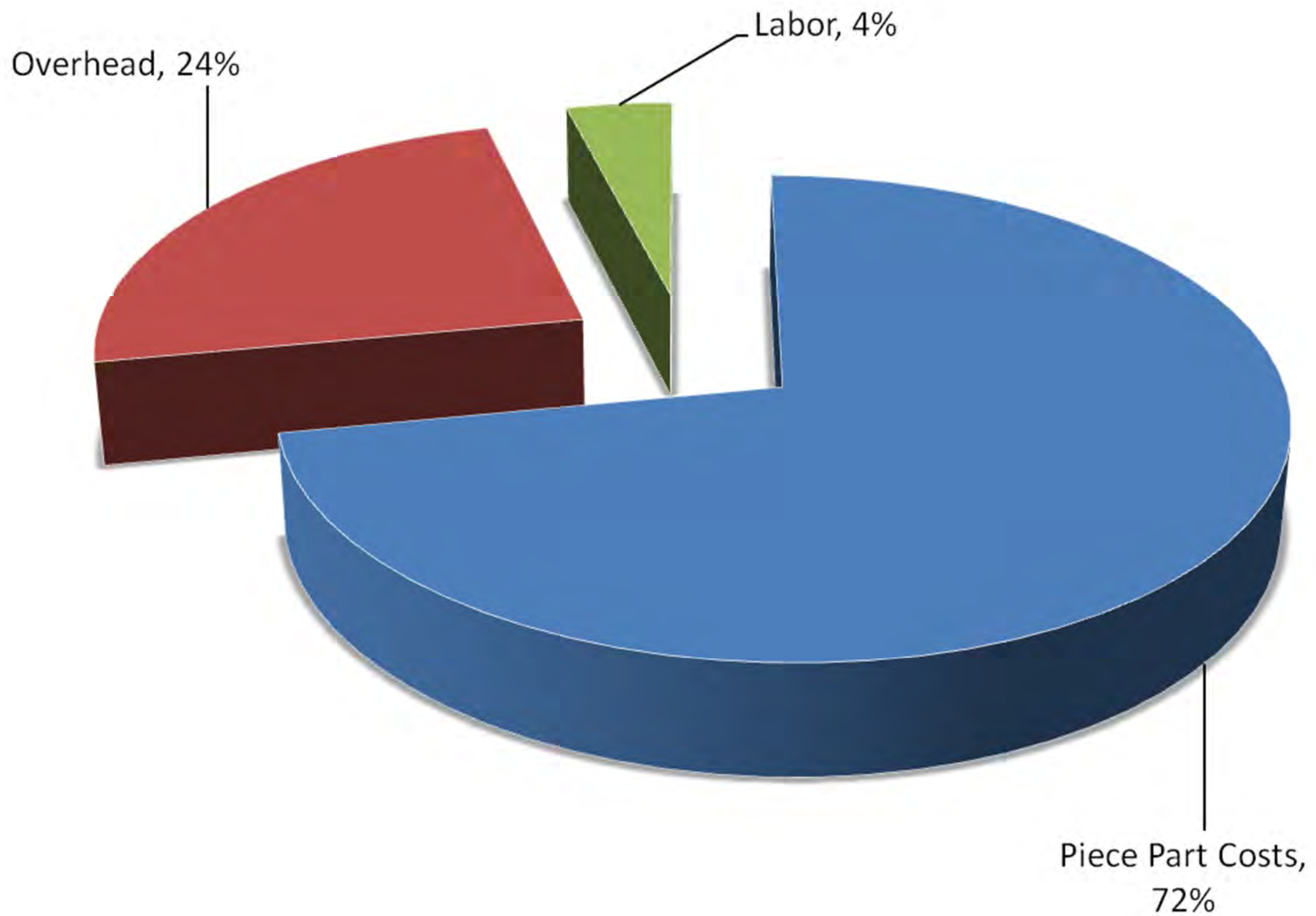
Motor Case Study



Agenda

- What is the minimum part criteria
- How do you answer the questions
- Practical application on sample product
- Results of its application (examples before/after)
- Reviewing the results
- The complete picture (full DFA Analysis)
  - Where costing alone leaves you
  - What does reduced part count mean
- Conclusion

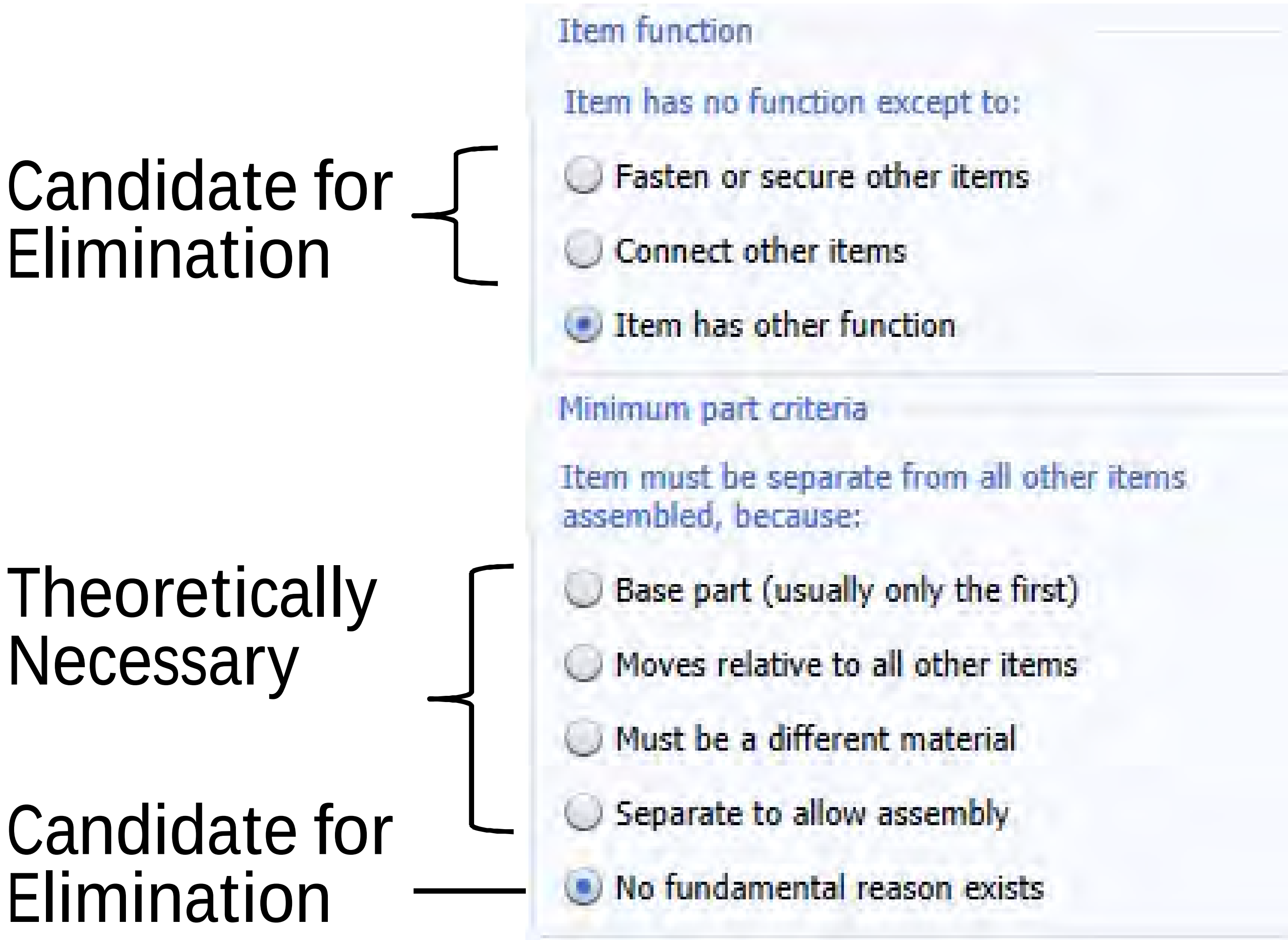
Typical Product Cost Breakdown



The Minimum Part Criteria

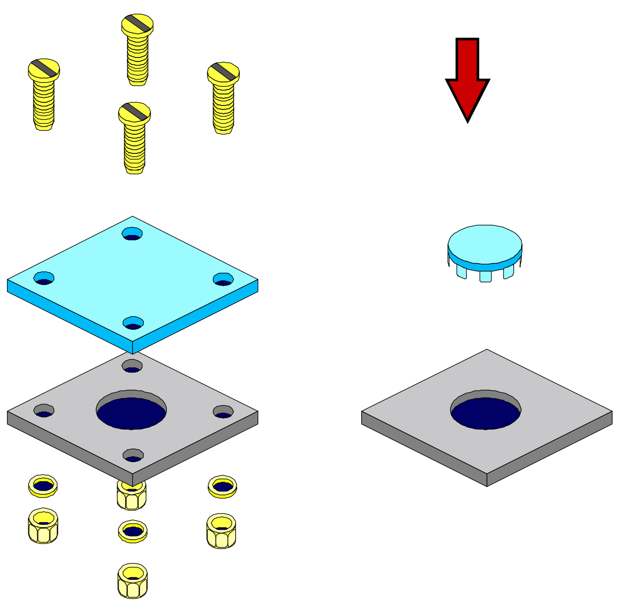
- Purpose:
  - Examine each part for the possibility of elimination or combination with other parts in the product
  - Maximize opportunity for innovation
- While examining parts:
  - Don’t consider technical or economic limitations
  - Evaluate with respect to all parts already assembled

Minimum Part Criteria



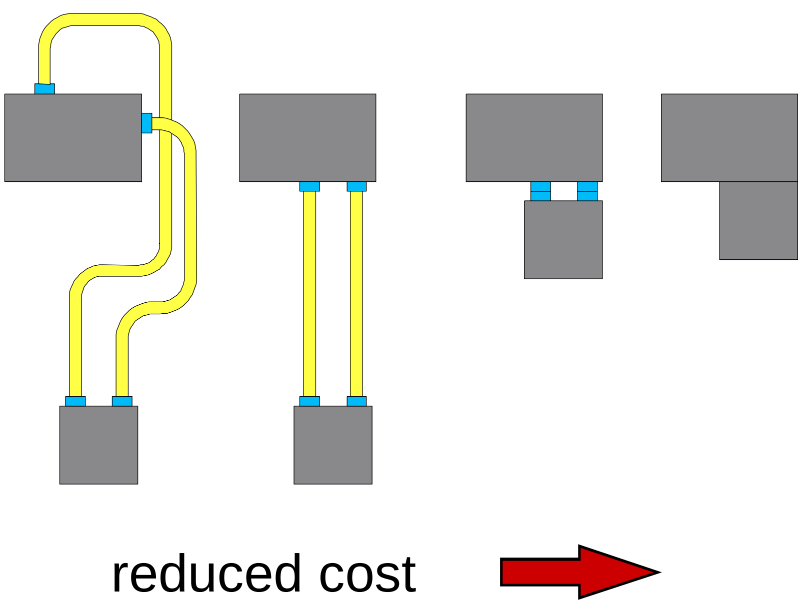
Fastening or securing

- Separate fasteners are always candidates for elimination
- An integral fastening arrangement is always theoretically possible



Connecting other items

- Connectors are always candidates for elimination
- The connected items could theoretically be combined to eliminate the connector

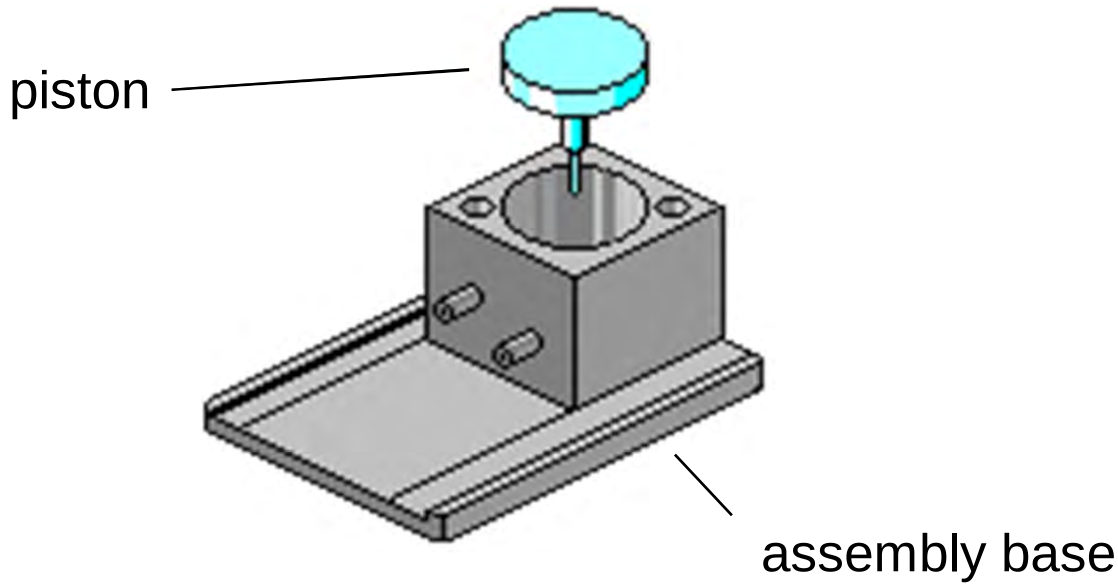


Base Part

- In any given product or assembly, there can be only one base part
  - Chassis
  - Frame
  - Encasement
- In theory, all other parts can be combined with the base

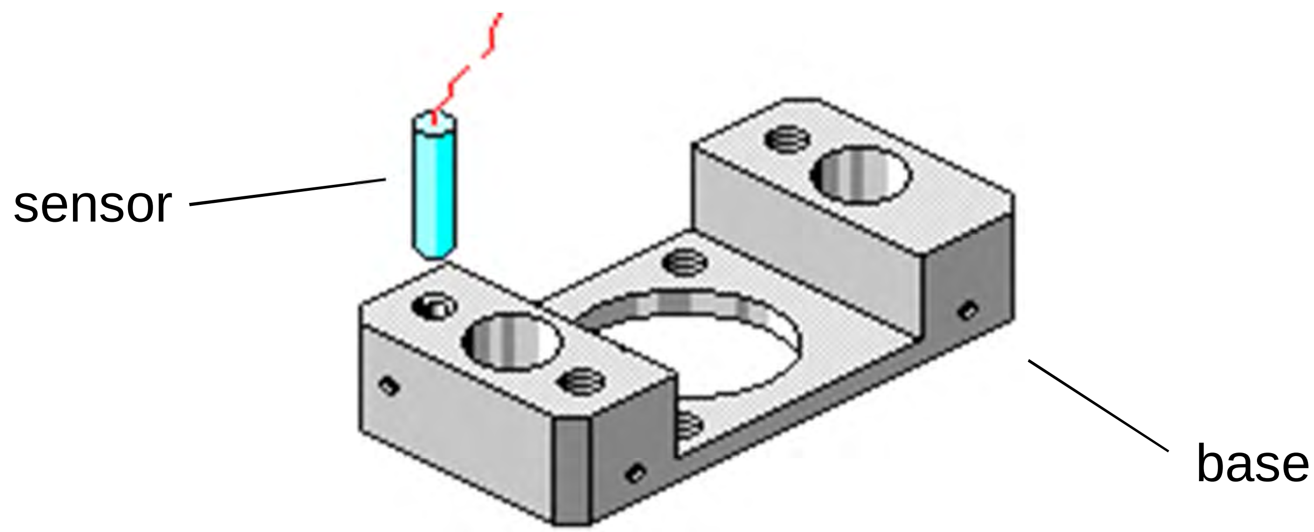
Relative Movement

Consider only large movements that cannot be accommodated by integral elastic elements



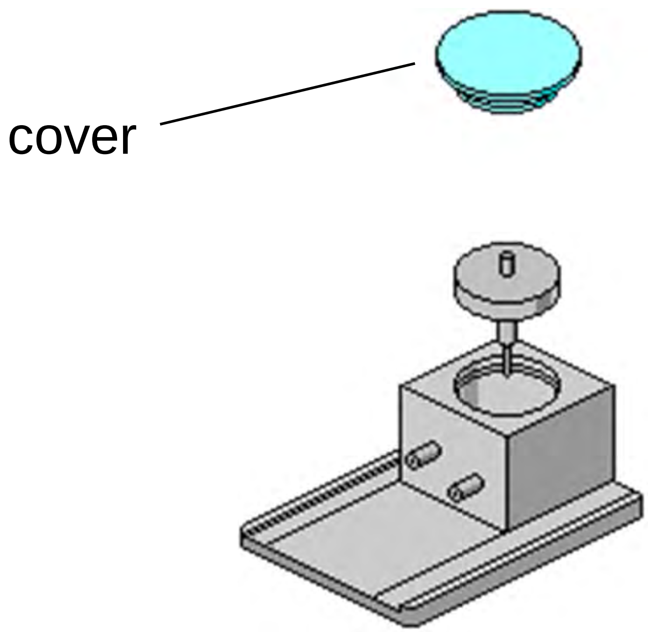
Different Material

Consider only fundamental material properties such as electrical conductivity or light permeability



Assembly of Necessary Items

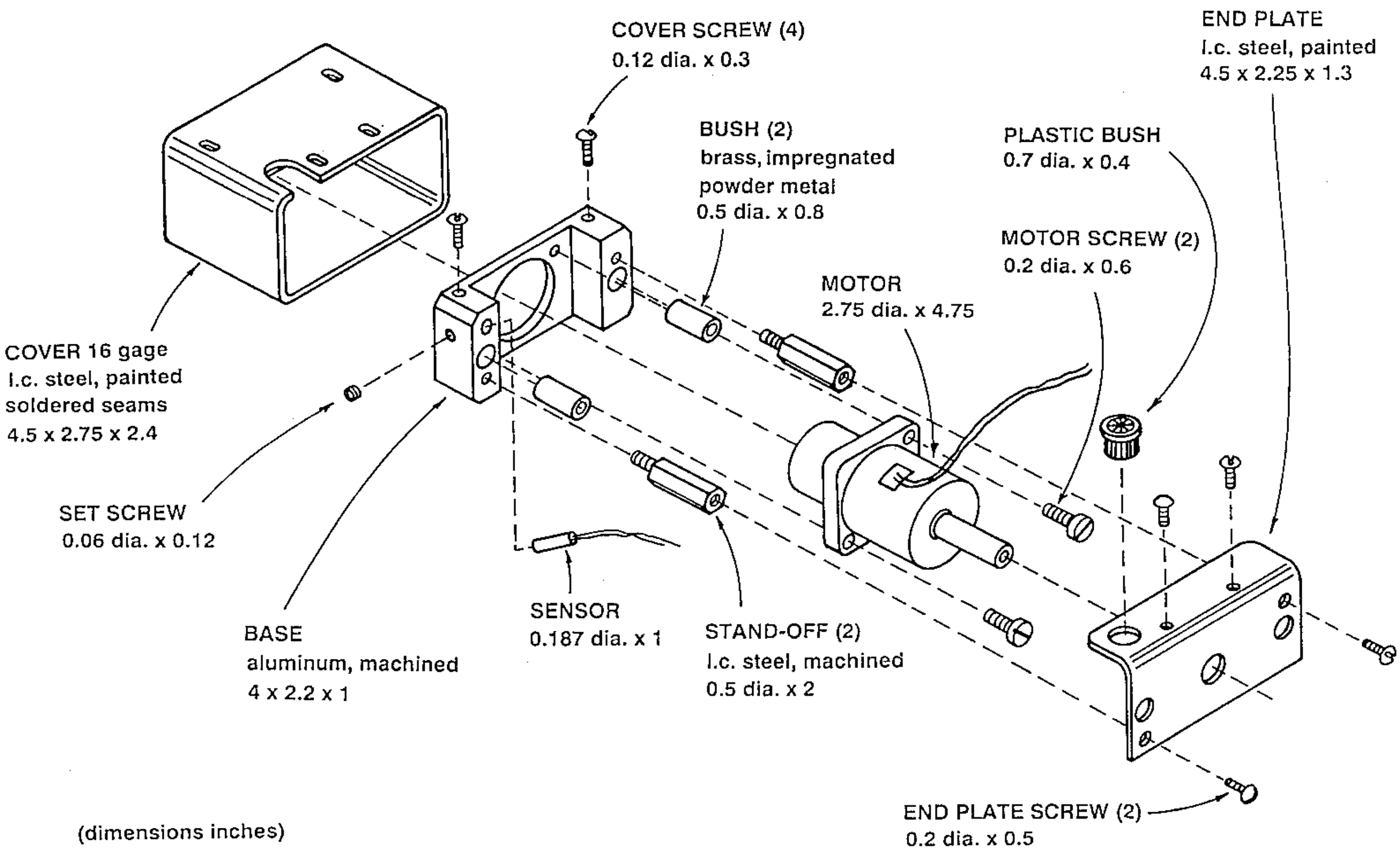
Combining cover with base would make assembly of necessary items impossible



Minimum Part Criteria - Application

- First of all this is NOT a DFA analysis
- What is the assembly sequence for the product
- Once sequence is established answer the questions
- Work from the assembly drawing
- Remember the right mind set to answer these questions is from the perspective of some theoretical redesign of the product
- Include any required operation steps

Motor Assembly Drawing



Minimum Parts Worksheet

Name	**Qty**	**Minimum Part Criteria**
Base	1	Base
Bushings	2	None
Motor	1	Movement
Motor screw	2	Fastener
Standoff	2	None
Sensor	1	Material
Set screw	1	Fastener
End plate	1	Assembly
End plate screw	2	Fastener
Grommet	1	None
Reorientation	1	None
Feed Wires	2	None
Cover	1	None
Cover screws	4	Fastener
Total	22	4 meet theoritical minimum

DFA Index

A simple measure of ease-of-assembly, or assembly efficiency, using a 0-100 scale to give a comparative metric.

$$= \frac{\text{Assembly time of ideal design}}{\text{Assembly time of current design}} = \frac{T \times NM}{TA} \times 100 \; ^{*}$$

T	**=**	**Average time per DFA part**
NM	**=**	**Theoretical Minimum No. of Parts**
TA	**=**	**Assembly Time**

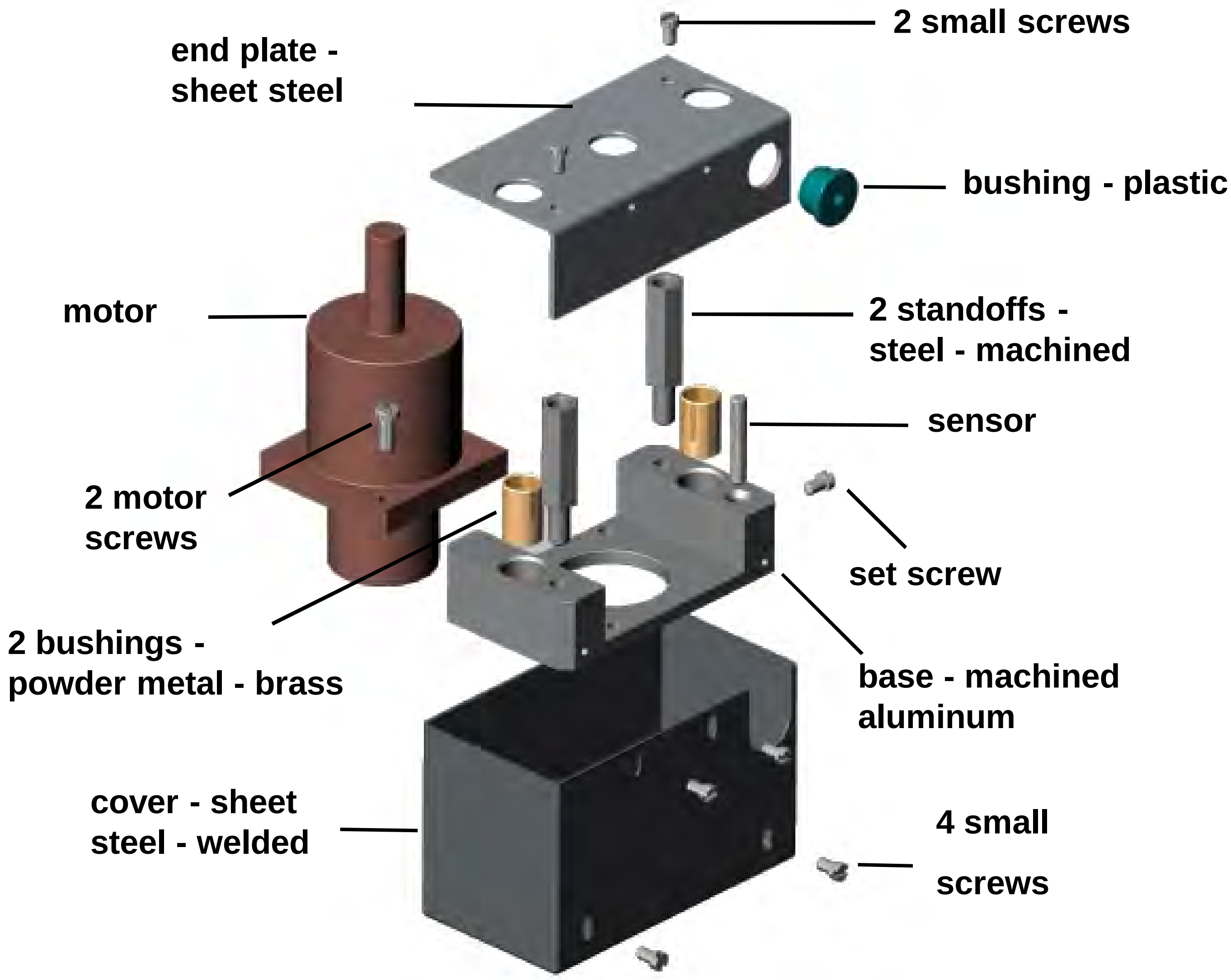
"the DFA Index is a useful way of comparing actual designs with what we ideally should aim for"

*This is the calculation for the simplest case of the minimum part criteria where we have a small assembly and a small part. The calculation changes for large parts and large assemblies

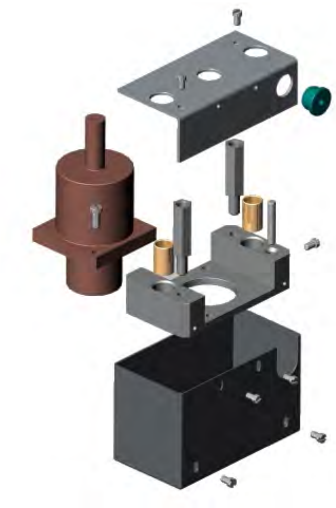
Minimum Part Results

- We have seen how we can question the need for parts being separate
- What impact does this have on various areas of the product?
- What happened to the overall cost?
- Are time and quality impacted?

Where is the cost in this product?

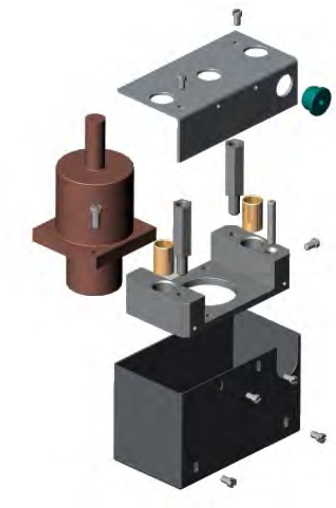


Motor BOM



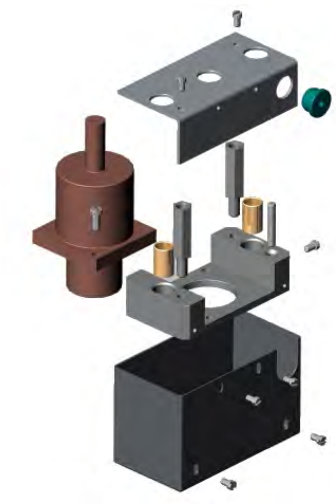
Category	Part Name	Qty	Part Num	Item Cost ($)	Supplier
Purchased Items					
	Motor	1	616-BDI-03	$ 12.55	ACME Motor
	Sensor	1	109-BDI-03	$ 1.58	Sensor-Rama
	Plastic Bushing	1	279-BDI-03	$ 0.22	Bushings R Us
	Brass Bushings	2	643-BDI-03	$ 1.53	Bushings R Us
Manufactured Items					
	Motor Base	1	074-BDI-03	$ 16.38	USA Machine
	Standoffs	2	012-BDI-03	$ 4.87	USA Machine
	End Plate	1	257-BDI-03	$ 1.44	Joe's Sheetmetal
	Cover	1	753-BDI-03	$ 2.08	Joe's Sheetmetal
Hardware					
	Cover Screws	4	975-BDI-03	$ 0.03	Fasteners, Inc.
	End Plate Screws	2	123-BDI-03	$ 0.03	Fasteners, Inc.
	Motor Screws	2	245-BDI-03	$ 0.05	Fasteners, Inc.
	Set Screw	1	097-BDI-03	$ 0.03	Fasteners, Inc.

Motor BOM – with should cost



Part Name	Qty	Part Num	Item Cost ($)	Should Cost	Supplier
Motor	1	616-BDI-03	$ 12.55	$ 12.55	ACME Motor
Sensor	1	109-BDI-03	$ 1.58	$ 1.58	Sensor-Rama
Plastic Bushing	1	279-BDI-03	$ 0.22	$ 0.19	Bushings R Us
Brass Bushings	2	643-BDI-03	$ 1.53	$ 1.23	Bushings R Us
Motor Base	1	074-BDI-03	$ 16.38	$ 13.45	USA Machine
Standoffs	2	012-BDI-03	$ 4.87	$ 1.12	USA Machine
End Plate	1	257-BDI-03	$ 1.44	$ 1.22	Joe's Sheetmetal
Cover	1	753-BDI-03	$ 2.08	$ 1.10	Joe's Sheetmetal
Cover Screws	4	975-BDI-03	$ 0.03	$ 0.03	Fasteners, Inc.
End Plate Screws	2	123-BDI-03	$ 0.03	$ 0.05	Fasteners, Inc.
Motor Screws	2	245-BDI-03	$ 0.05	$ 0.03	Fasteners, Inc.
Set Screw	1	097-BDI-03	$ 0.03	$ 0.03	Fasteners, Inc.

Motor BOM – sorted

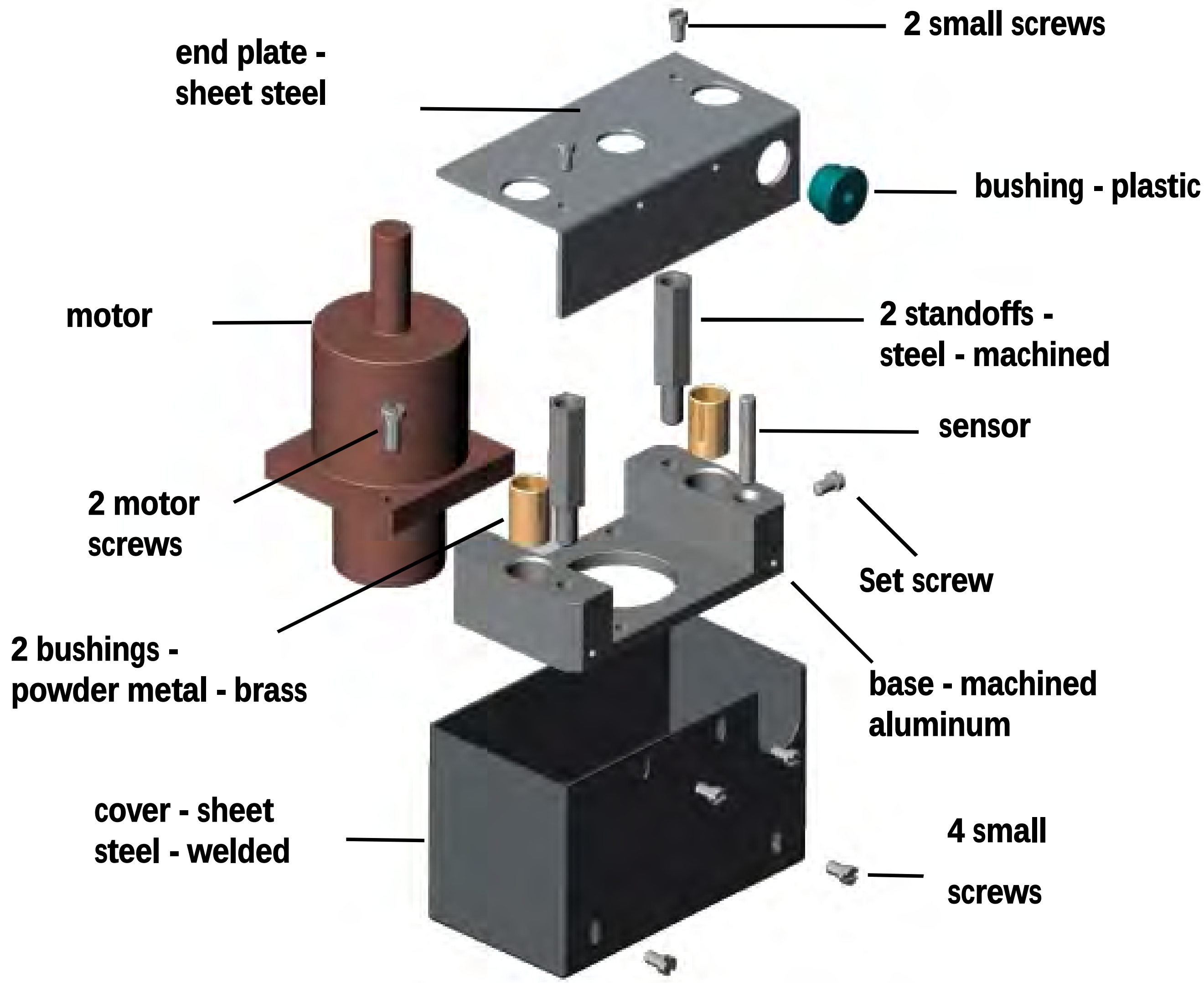


Part Name	Qty	Part Num	Item Cost ($)	Should Cost	Delta
Standoffs	2	012-BDI-03	$ 4.87	$ 1.12	$ 3.75
Motor Base	1	074-BDI-03	$ 16.38	$ 13.45	$ 2.93
Cover	1	753-BDI-03	$ 2.08	$ 1.10	$ 0.98
Brass Bushings	2	643-BDI-03	$ 1.53	$ 1.23	$ 0.30
End Plate	1	257-BDI-03	$ 1.44	$ 1.22	$ 0.22
Plastic Bushing	1	279-BDI-03	$ 0.22	$ 0.19	$ 0.03
Motor	1	616-BDI-03	$ 12.55	$ 12.55	$ -
Sensor	1	109-BDI-03	$ 1.58	$ 1.58	$ -
Cover Screws	4	975-BDI-03	$ 0.03	$ 0.03	$ -
End Plate Screws	2	123-BDI-03	$ 0.03	$ 0.03	$ -
Motor Screws	2	245-BDI-03	$ 0.05	$ 0.05	$ -
Set Screw	1	097-BDI-03	$ 0.03	$ 0.03	$ -

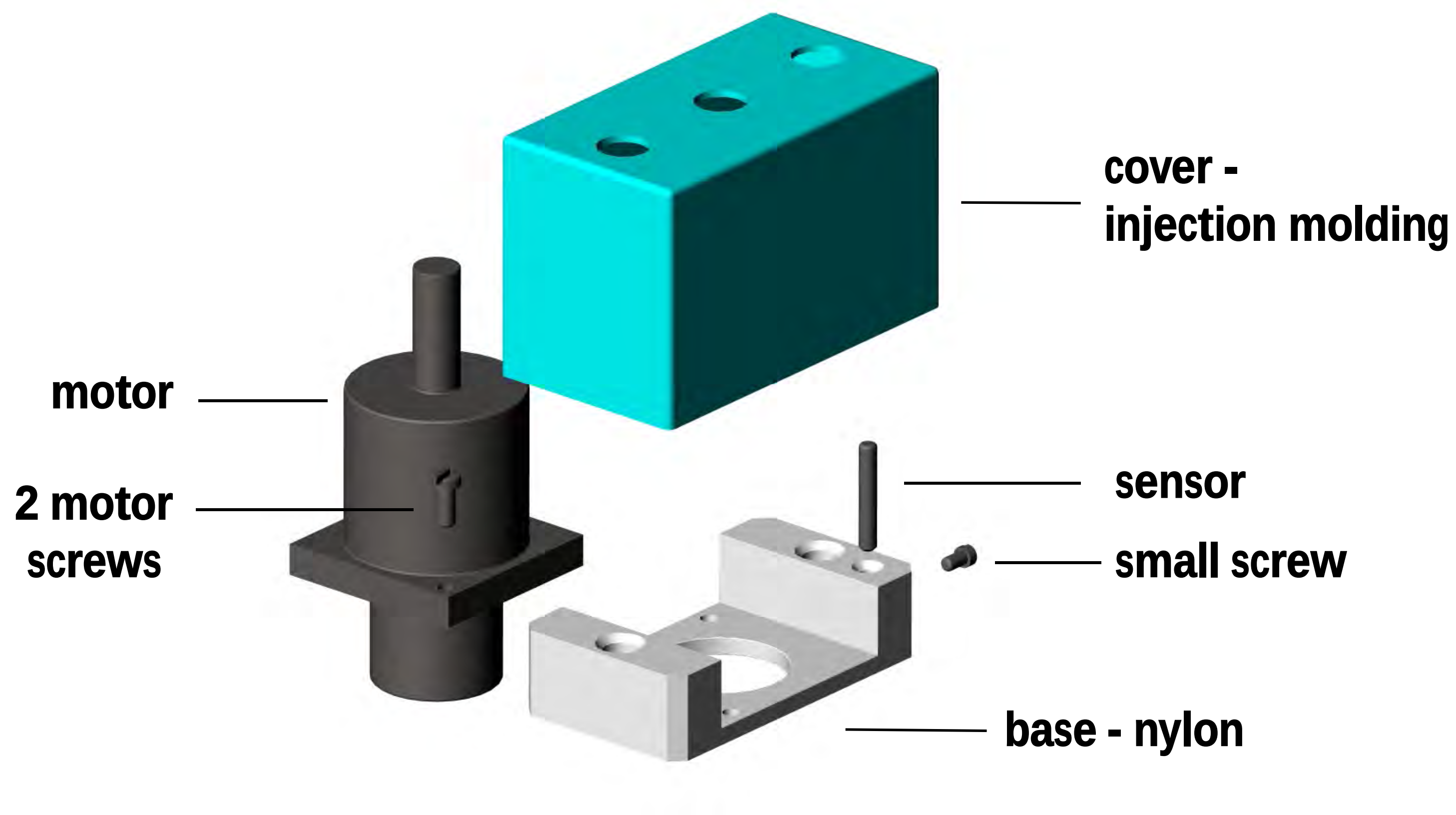
Traditional Cost Reduction Focus

- This helps us save money quickly but its limited
- Helps us focus on where the most cost savings might be (without changing the design)
- Influence of design changes through the min part criteria can have bigger impact

Influence of Design on Supply Chain



Motor Product Simplification

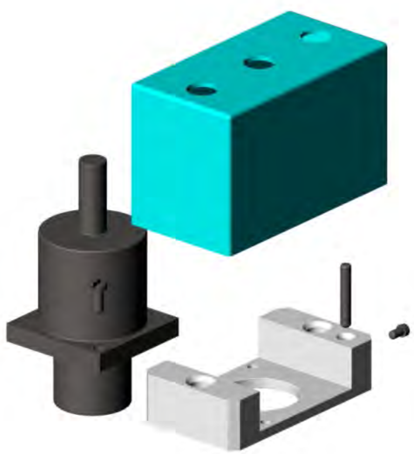


Motor BOM – Design Change

Part Name	Qty	Part Num	Item Cost ($)	Should Cost	Supplier
Motor	1	616-BDI-03	$ 12.55	$ 12.55	ACME Motor
Sensor	1	109-BDI-03	$ 1.58	$ 1.58	Sensor-Rama
Motor Base	1	074-BDI-03	$ 16.38	$ 13.45	USA Machine
Cover	1	753-BDI-03	$ 2.08	$ 1.10	Molds R Us
Motor Screws	2	245-BDI-03	$ 0.05	$ 0.03	Fasteners, Inc.
Set Screw	1	097-BDI-03	$ 0.03	$ 0.03	Fasteners, Inc.

Results

- 63 percent reduction in parts
- 4 suppliers removed from supply chain
- 63 percent reduction in detail drawings
- 74 percent reduction in assembly time
- Equal reduction in labor cost



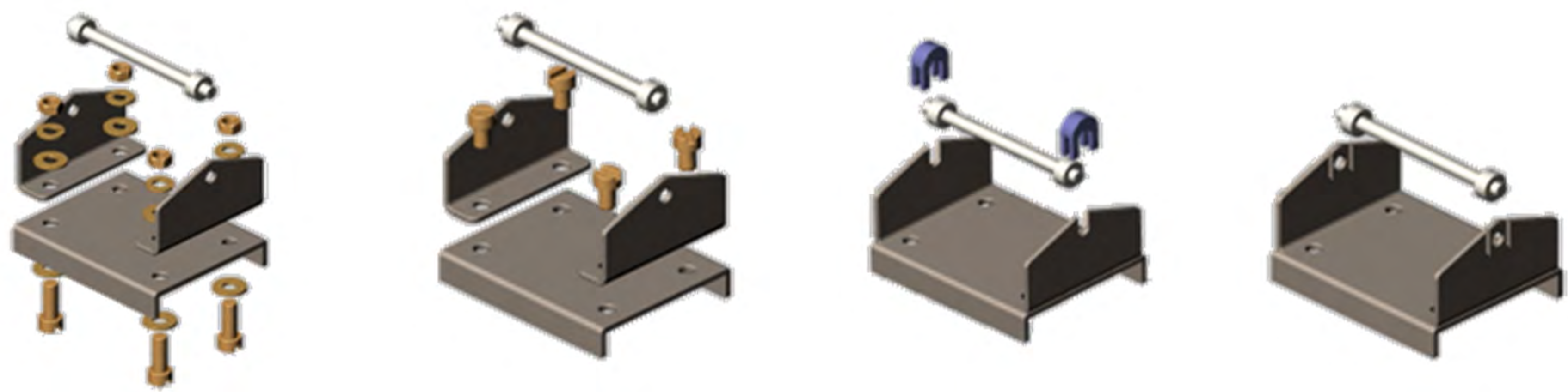
And let's not forget....

46% Reduction in Total Cost of the product

Conclusions

- This was NOT a design for assembly analysis
- Traditional cost reduction efforts are limited
- The design of the product, if questioned, can unlock tremendous potential
- Fewer parts means
  - Less material to order
  - Less inventory
  - Fewer drawings
  - Fewer things to change
- Reducing part count influences much more than cost

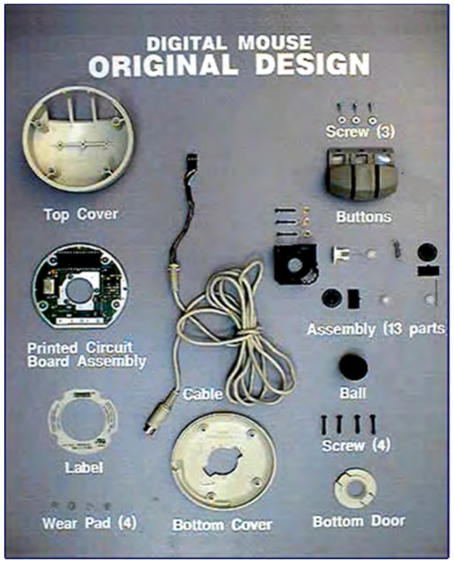
Food for thought

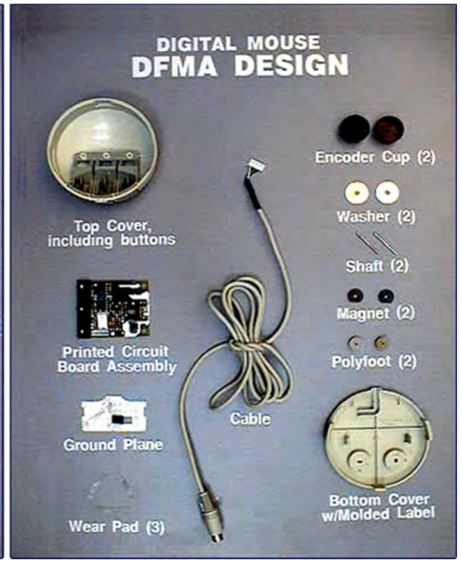


DFMA →

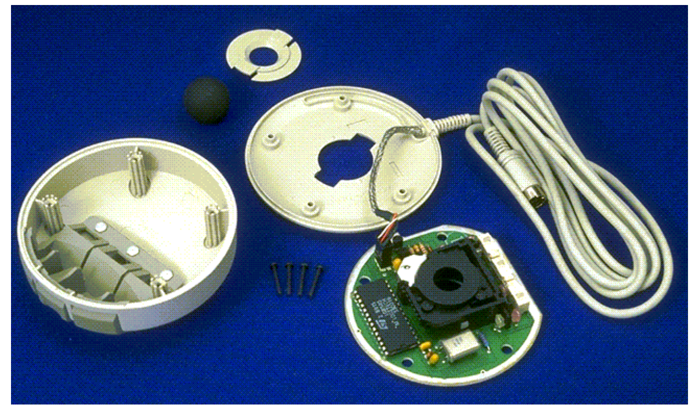
Would ‘Lean’ or other process improvement metrics be the best approach to improving the product on the left or would we be better off looking at DFMA first then applying ‘Lean’ and other process techniques to the product on the right?

DEC Workstation Mouse





Ball Free Workstation Mouse



Assembly time 72% less

Part count down by 50%

The ball-free mouse was developed by Digital as a result of DFMA studies on their traditional, existing design

Intier Automotive Seating

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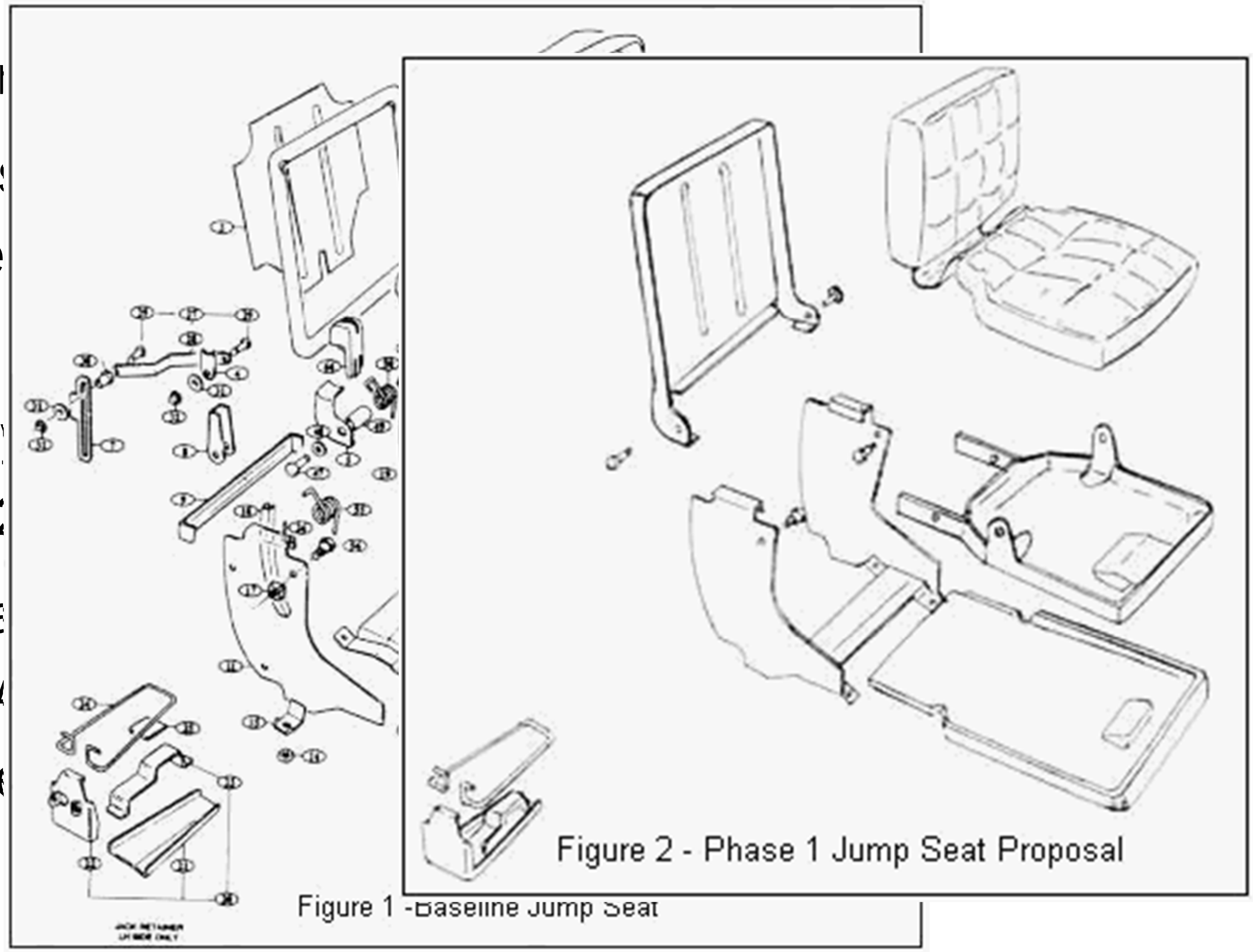
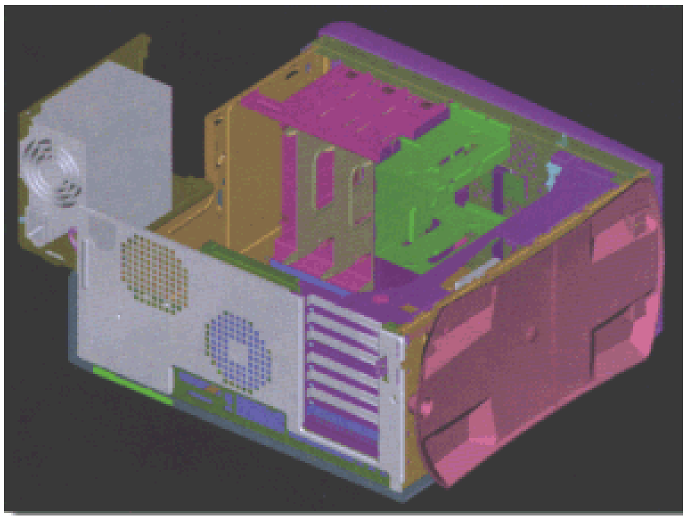


Figure 2 - Phase 1 Jump Seat Proposal

Figure 1 -Baseline Jump Seat

Dell, No New Factories – 1990's



Project Goals

- Reduce part count 17%
- Reduce assy time 25%
- Reduce fastener types 67%
- Reduce service time

Redesigning the Optiframe® chassis saved $15 million in Labor alone

The company saved millions more by increasing throughput and thus postponing facility relocations that otherwise would have been required to boost manufacturing capability.

Case Study – Hypertherm HPR130 Plasma Cutter

Results:

- Over 50% part count reduction
- Over 75% assembly time reduction
- Factory output *quadrupled* without additional floor space
- Better design allows for:
  - Tighter tolerance cutting
  - Unit cuts as fast as some 200 amp units
  - 2/3rds less operating cost per unit
  - 1/10th warranty costs of predecessor
  - Doubled annual sales
  - More reliable unit
- $5 million savings in first 24 months alone

Average reductions in DFMA cases

- Labor Costs 42%
- Part Count 54%
- Separate Fasteners 57%
- Weight 22%
- Assembly Time 60%
- Assembly Cost 45%
- Assembly Tools 73%
- Assembly Operations 53%
- Product Development Cycle 45%
- Total Cost 50%

Organizational benefits of DFMA

Engineering:

- Speed to market: Fewer engineering changes
- Better use of time: Engineering spends more time making products manufacturable, less time making changes to products during manufacturing phase
- "Lessons library": Changes are documented; can be analyzed and improved
- Improved creativity: Engineers can focus on what they do best: exploration and innovation—using a very sophisticated "what if" tool

Organizational benefits of DFMA

Manufacturing:

- Manufacturing contributes more to design: DFMA promotes earlier involvement of manufacturing in design, takes advantage of manufacturing knowledge
- Improved efficiency: Unnecessary steps, tools, and parts are designed out of the production process
- Speed to market: Products are produced more quickly due to streamlined manufacturing processes

Organizational benefits of DFMA

Management:

- Improved cross-team cooperation: Provides metrics for discussion, tools for concurrent engineering
- World-class product development and manufacturing: Product design and production is more structured, measurable, efficient
- Reduced cost: Products cost less to manufacture (fewer tools, fewer parts, fewer steps, best materials)
- More competitive: Marketing staff and salespeople have a better product to take to market and a more compelling story

Top companies depend on DFMA to...

- Determine the least expensive method for producing a high-quality product, at the design stage
- Hold suppliers accountable, using industry-standard data and process alternative analysis
- Give engineering and manufacturing teams the tools they need to optimize their efforts
- Simplify assembly, cutting costs while boosting output and streamlining logistics


LOONEY TUNES
"That's all Folks!"
A WARNER BROS. CARTOON

Thank You!

Please join us next year at the 2015 International Forum on Design for Manufacture and Assembly

June 2nd and 3rd 2015