Metals Replacement

Alan Federl
Sales Development Leader

Creating Opportunities for Plastics

Market Overview

- Why Metals?
- Benefits of Plastics vs Metals
- Metal Conversion Technology

Execution

- Plastic Material Characteristics
- Designing w/Plastics
- Metal to Plastics Development Process

Translation

- Case Studies
- Market Examples
- Resources & Tools

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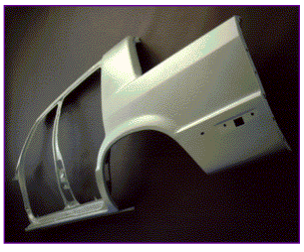
Why Metals?

Comfort level – Wealth of Metals Knowledge
Direct Cost per Pound Comparison
Expectation of One-For-One Replacement
Existing Infrastructure
Strength and Stiffness
Perceived Quality
Electrical Properties – EMI/ESD
Thermal Performance
Thermal Expansion (CTE)
Tolerances & Dimensional Stability
UV Performance
Chemical Resistance



Utilize Resources

Matching Material To End-Use Environment

- Materials Knowledge
- Engineering Analysis
- "System-Solutions"

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Benefits of Plastics vs Metal

Key factors that drive metal replacement

Reduced Systems Cost

Improved Performance

Product Differentiation

Benefits vs. Sheet Metal

- **System-Cost Reduction**
- **Part Integration**
  - **Combining Multiple Parts**
  - **Removal of Fasteners**
  - **Assembly Time Reduction**
- **Functional Integration**
- **Product Differentiation**
- **Weight Reduction**
- **Corrosion Resistance**
- **Dent Resistance**
- **Scratch Resistance**
- **Noise Dampening**
- **Molded-In Color**
- **Eliminate Secondary Operations**
  - **Welding**
  - **Painting**
  - **Laser Marking**

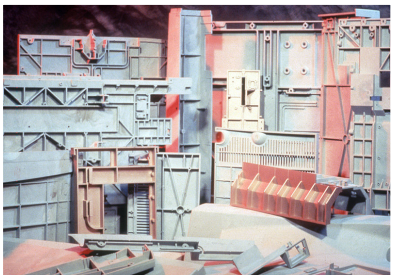
Aesthetics, Quality & System-Cost Reduction
APPLICATION DEPENDENT

Benefits of Plastics vs Metals

Performance Advantages	Plastics	Metal
Weight (stiffness to weight ratio)	X	
Design freedom	X	
Functionality	X	
Styling freedom	X	
Dent resistance	X	
Corrosion resistance	X	
Sound absorption	X	
Structural strength		X
Thin walls		X
Chemical resistance		X
Heat resistance		X
Conductivity (thermal and electrical)		X
Shielding		X

Challenges vs. Sheet Metal

- Expectation of One-For-One Replacement
- Time / Temperature Performance Dependency
- Higher Initial Tooling Costs
- EMI/RFI Shielding and Thermal Management



Systems-Solution Approach Critical

Benefits of Plastics vs Metals

Utilizing Engineering Thermoplastics To Maximize The Benefits…

…While Understanding and Minimizing The Challenges.

The key to success for replacing metal assemblies with plastics is:

=

Successful Conversion Strategy

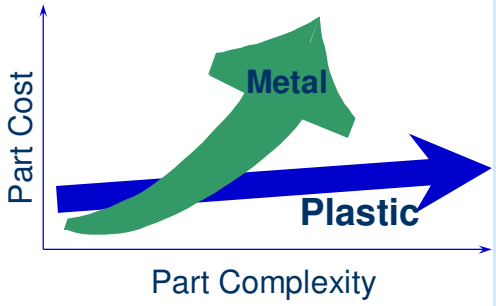
Successful metal replacement is seldom a one-for-one material substitution.

Benefits of Plastics vs Metals

Cost Analysis – Part complexity

Plastic
Nominal Impact on Part Cost

Sheet Metal
Significant Impact on Part Cost
- Die Work
- Welding
- Grinding
- Rework



Cost Model Changes Dramatically As Part Complexity Increases

Summary Plastics vs. Sheet Metal

Sheet Metal Provides:

- Quick Prototype Capability
- Chemical Resistivity
- Heat
- EMI Capability
- Structural Strength

The Downside of Sheet metal:

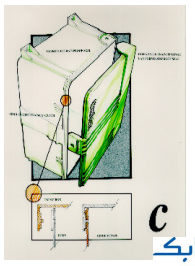
- Corrosion
- Complex parts expensive
- Aesthetics
- High Volume Tooling is expensive

Summary Plastics vs. Metal

Benefits of Replacing Metal With Plastics

Weight Reduction - Plastics have lower density.
Parts Consolidation – Realize productivity gains through reducing part count and inventory
Labor Savings - Reduced assembly and secondary operations, integral color.
Durability – Impact/dent resistant, corrosion resistant.
Balance of Properties – Strength to Weight
Design Freedom – Able to use complex geometry
Product Differentiation
Corrosion Resistance

Plastics have been utilized successfully in replacing traditional materials in applications where they can provide value through improved performance at lower systems cost.



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Designing w/Plastics

For Metal Replacement Maximize Plastic Advantages:

1 ***Part Count Reduction***

Combining Parts
Fastener Reduction

2 ***Part Handling***

Easier Orientation for Assembly
Minimize Added Difficulties

3 ***Assembly Ease***

Decrease Insertion Effort
Minimize Number of Reorientations
Reduce Secondary Operations

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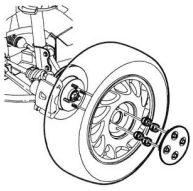
Home

Designing w/Plastics

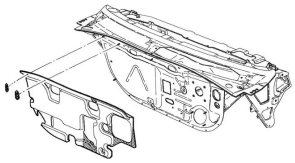
Part Count Reduction

Ask the Following Questions About Each Part . . .

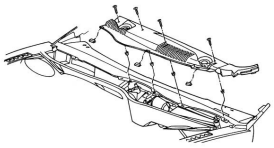
Must Parts Move Relative To Each Other?



Must Parts Be Made of Different Materials?



Would Combination of Parts Prevent Further Assembly or Disassembly?



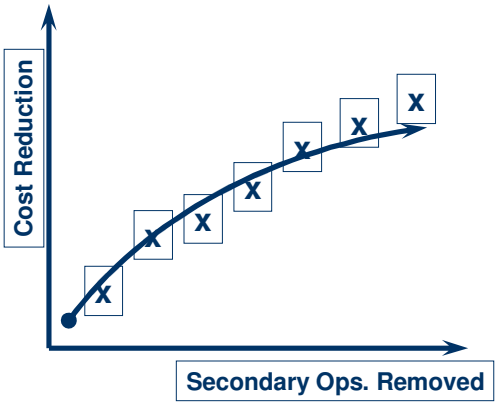
If All Three Answers Are "No", The Part Is a Candidate for Elimination

Designing w/Plastics

Reduce Secondary Operations

Secondary Operations
- Painting
- Assembly
- Machining

Environmental Costs
Equipment Savings
Labor Savings

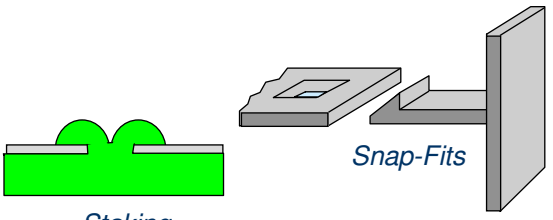


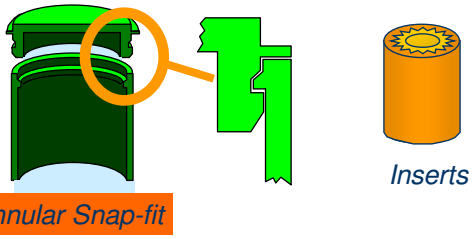
Utilize Advantages To Drive Cost Out Solutions

Designing w/Plastics

Assembly Methods
- Snap-fit/Press-fit
- Ultrasonic Welding
- Staking
- Inserts

Shorter Assembly Time
Fewer Steps
Part Reduction
Reduced Overhead
Labor Savings

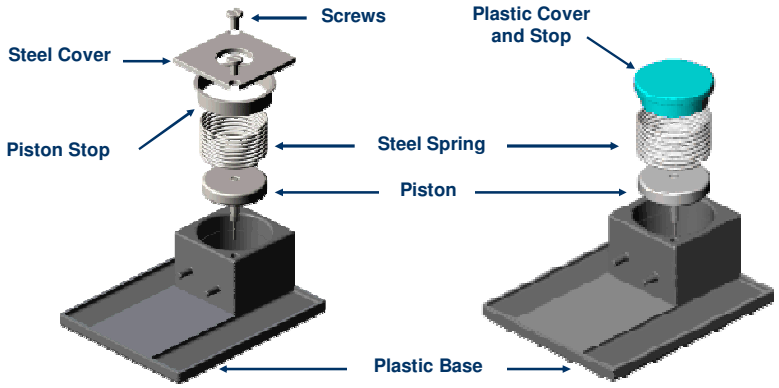




Reduce Costly Assembly Methods

Designing w/Plastics

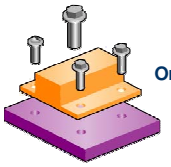
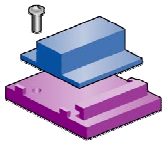
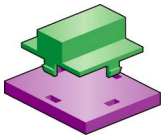
Assembly Ease



Original *Redesign*

Designing w/Plastics

Design Parts With Self-locating Features, Eliminate Re-orientation/ Assembly Adjustments and Use Snap Fits Whenever Possible

Part Needs to Be Held Down, Excessive Use of Separate Fasteners	*Part Is Aligned Upon Release, but Still Uses Separate Fastening Method*	*Part Is Aligned and Secured Upon Release, Integral Fasteners Used*
 Original	 Better	 Best

Consider Ease of Insertion/Assembly in Part Design

Designing w/Plastics

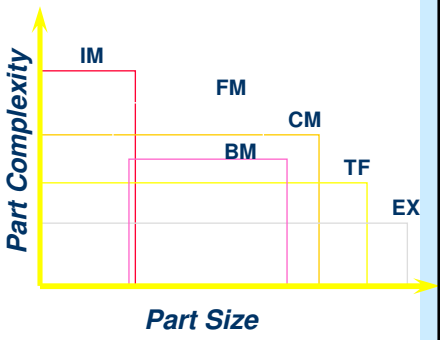
Conversion Process Selection

Common Conversion Processes:

- Injection Molding
  - Structural Foam
  - Gas Assist
- Extrusion
- Compression Molding
- Thermoforming
- Blow Molding

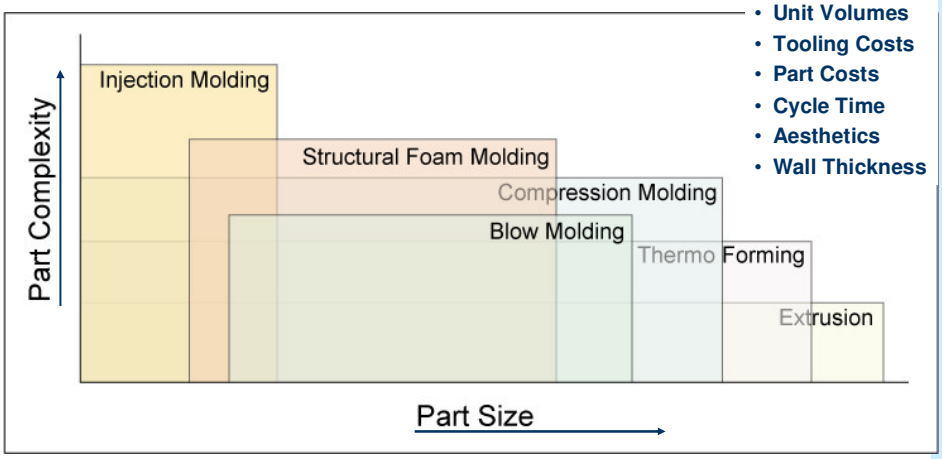
Balance Advantages & Disadvantages:

- Part Size
- Part Shape & Complexity
- Wall Thickness
- Production Quantity
- Surface Appearance
- Material Selection
- Cost



Gas Assist and Structural Foam Are Most Common

Metals To Plastics – Processing Considerations



Other Factors:

- **Unit Volumes**
- **Tooling Costs**
- **Part Costs**
- **Cycle Time**
- **Aesthetics**
- **Wall Thickness**

Part Size and Complexity Affect Processing Selection

Customer Innovation Process for Metals Replacement

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Customer Needs

Tear-Downs

- Full Product Teardowns
- Benchmarking Best in Class
- Identification of Industry Trends
- Establishment of Baseline Systems
- Establishment of Materials and Manufacturing Processes

CTQ Identification

- Structural
  - Stiffness / Creep
  - Strength
  - Fatigue
  - Containment
- Electrical
- Thermal
  - Max Temperature
  - Dimensional Stability
- Size / Space Limits
- Agency Requirements
- Chemical / Environmental
- Serviceability
- Aesthetic / Branding

Teardown Preparation

TEAR DOWN – PREPARATION LIST

Preparation:
- **Confidentiality Agreement**
- **NDA (Take Pictures)**
- **Ask Engineers to Assist Tear Down**
- **Tear Down Preparation List**
- **Tear Down Data Sheet (*.Xls-file)**

CNM:
- **Main CTQs**
- **Functionality**
- **Opportunity**

Pictures
?? Laptop, mouse, adapter
?? Camera, cables, USB port, Smartmedia cards, batteries + charger, serial port connector, adapter,

Tools (Measurement)
?? Spring rule (rolmaat)
?? Weighing scale
?? Marking gauge (schuifmaat)
??

Tools
?? Notebook, pen, white tape, color markers,
?? Torque- set (green box) + multi handle
?? Storage box for screws, bolts, nut, …
?? Lab coats, hand gloves
?? Magnet
?? Picklock (steeksleutel)
?? Battery Drill
?? Weigh- Beam (unster)

Identification
?? Parts, sub- assemblies?
?? Functionality?
?? Material used?
??

TO DO - Check List
?? Pictures of complete assemblies
?? Pictures of sub- assemblies and how they are retrieved from the complete assembly
?? Place, Position
?? Work from one side to the other
?? Picture all sides if needed
?? Mind connection points / techniques
?? Vertical or horizontal
?? Think of next generation design, write down ideas on improvement.

?? **Per part:** Length, width, depth, height, thickness, distances, flexibility, quality, color, ..
?? **Per sub- assembly:** Product information, volume, modularity or lose parts?

?? Weight
?? Volumes
?? Generic notes
?? Any particular notes..
??
??

?? Functionality of part?
?? Standardization / customization?
?? Connections (snap- fits, screws, weld, etc)
?? EMC shielding, airflow, conductive materials, water, sounds, vibrations, gases,vermin, …
?? Closing mechanisms..

Design Planning

Design Considerations

- **Aesthetic Needs**
- **Shielding Considerations**
- **Impact Requirements**
- **Structural Needs**
- **Agency Requirements**
- **Space Limitations**
- **Thermal Management**
- **Product Life**
- **Secondary Operations**
- **Chemical Environment (e.g. Cleaners)**
- **UV Exposure (Indoor)**

End-Use Determines Product Needs

Manufacture and Assembly Design

Simplification of Manufacturing & Assembly

Parts Consolidation	**- Fastener Elimination** **- Latch Housings** **- Modularization**
Secondary Operations	**- Paint Elimination** **- Molded-In Labels** **- Eliminate Drilling, Grinding, etc.**
Product Life	**- Serviceability** **- Disassembly** **- Scalability**

Design Optimization

Three Main Areas of Design Optimization

1

Part Count Reduction

Combining Parts
Fastener Reduction

2

Part Handling

Easier Orientation for Assembly
Minimize Added Difficulties

3

Assembly Ease

Decrease Insertion Effort
Minimize Number of Reorientations
Reduce Secondary Operations

DFMA – Part Reduction

Part Count Reduction

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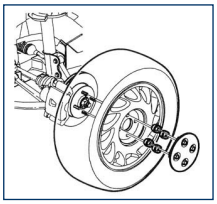

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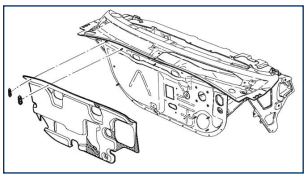

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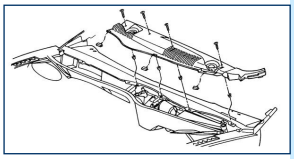

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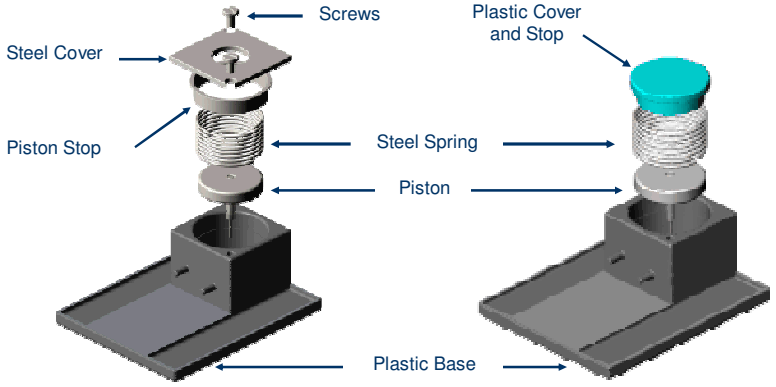
DFMA – Assembly Ease

Assembly Ease



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Insertion and Fastening Guide Assembly Ease

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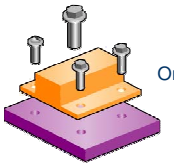
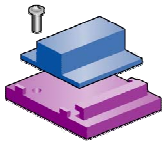


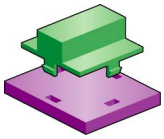
Original

Part Is Aligned Upon Release, but Still Uses Separate Fastening Method



Better

Part Is Aligned and Secured Upon Release, Integral Fasteners Used



Best

Consider Ease of Insertion/Assembly in Part Design

DFMA – Part Handling

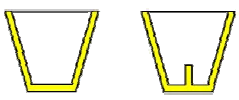
Part Handling

Watch for Parts That Stick Together, Are Slippery, Delicate, Flexible, or Very Small / Large

Design Parts That Will Not Tangle

Will Tangle Will Not Tangle

Eliminate Possibility of Jamming



Will Jam Will Not Jam

If Parts Can Not Be Symmetric, Make Them Obviously Asymmetric

Asymmetric *Pronounced* Asymmetry

Ensure That Parts Can be Easily Handled by Operators

SABIC IP Development Resources:

- Application Development Engineers (ADE)
- Technical Development Engineers (TDE)
- Polymer Processing Development Center (PPDC)
- Performance Characterization
- Predictive Engineering Tools (CAE)
- Internet Resources & Tools