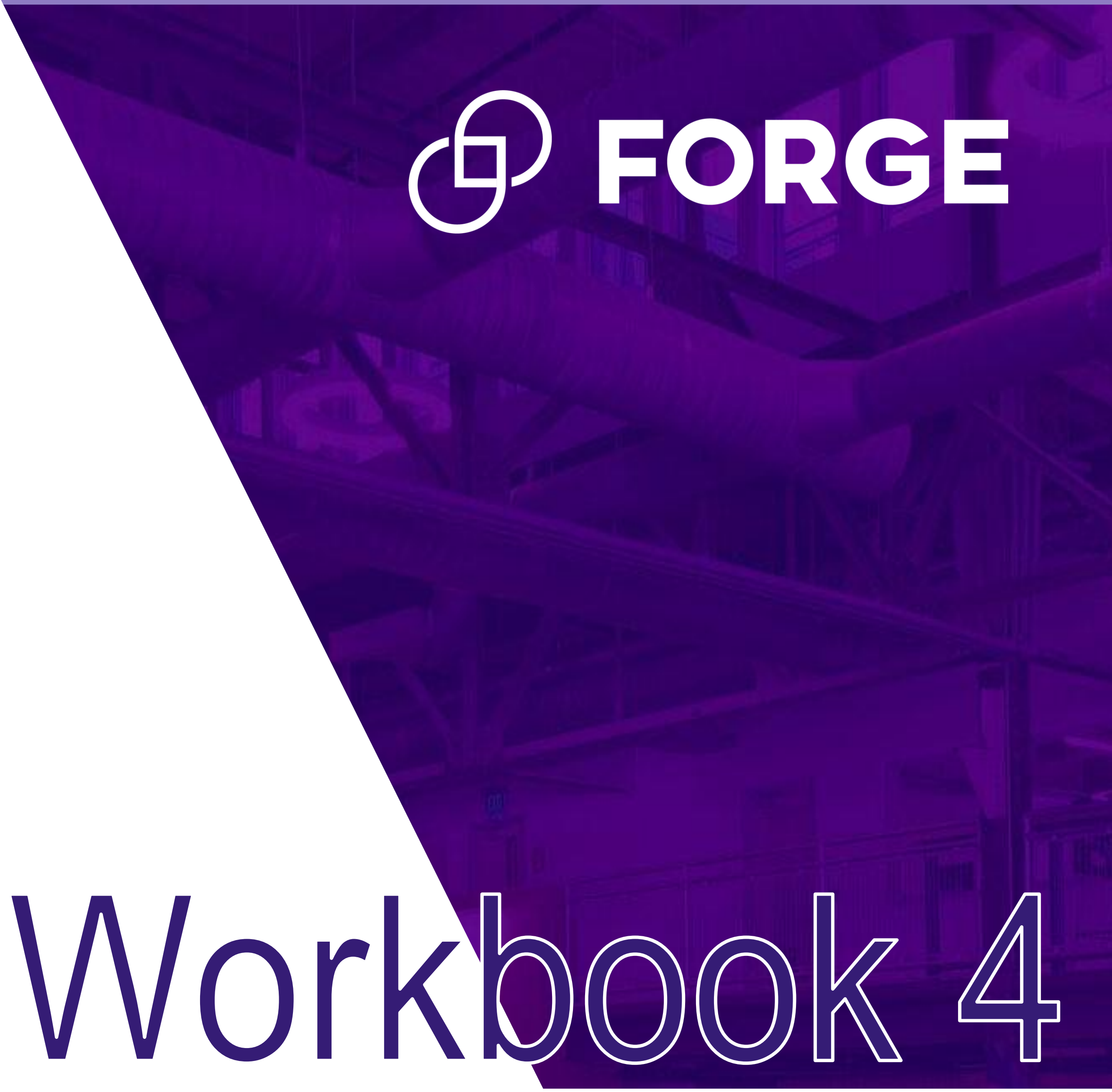

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Workbook 4

Designing for Excellence

Designing for Excellence:

is a systematic approach to achieve a targeted objective.

X represents targeted objectives or characteristics.

What are we designing for? DF(X)	The Approach and/or Focus for DF(X)
1 DF(**M**) Design for ***Manufacturing***	❏ Reduce Bill of Materials ❏ Material Tradeoffs ❏ Cost Reductions
2 DF(**A**) Design for ***Assembly***	❏ Reduce Bill of Process (BOP) ❏ Reduce Labor ❏ Reduce Capital Equipment ❏ Eliminate Tooling Cost ❏ Improve Yields
3 DF(**T**) Design for ***Test***	❏ Validate Functionality ❏ Process Quality ❏ Performance Testing ❏ Issue Management and Mitigation
4 DF(**R&D**) Design for ***Reliability & Durability***	❏ Noise, Vibration and Harshness (NVH) ❏ Loading Conditions ❏ Operating Temperatures ❏ Harsh Environment Conditions
5 DF(**SI**) Design for ***Systems Integrations***	❏ System Operating Dynamics ❏ Form/Fit/Function ❏ Component Connections (Cont.)

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Designing for Excellence:

is a systematic approach to achieve a targeted objective.

X represents targeted objectives or characteristics.

What are we designing for? DF(X)	The Approach and/or Focus for DF(X)
6 DF(**M&S**) Design for ***Maintenance and Serviceability***	❑ Ease of Repair ❑ Access Points ❑ Spare Parts and Tools
7 DF(**P&L**) Design for ***Packing & Logistics***	❑ Product Protection ❑ Materials ❑ Cost
8 DF(**S**) Design for ***Sustainability***	❑ Circularity of Materials ❑ End-of-LIfe Repurposing ❑ Reducing Waste in Operations
9 DF(**C&M**) Design for ***Customer Use and Market Acceptance***	❑ Use and Installation ❑ Customer Interface ❑ Product Certifications ❑ Instructions and Manuals
10 DF(**C**) Design for ***Compliance***	❑ Product Safety ❑ Acceptance by Regulatory Bodies ❑ Industry Standards

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DFE-1.2. Design for (M) - Manufacturing

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Best Practices: Design for X. There is more than just Design for Manufacturing

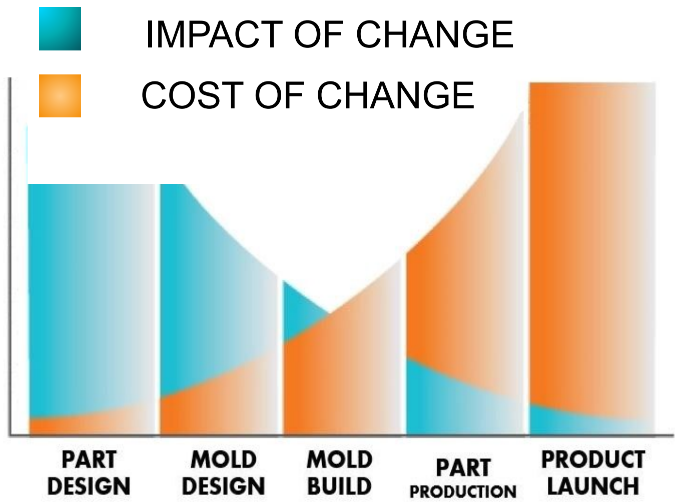
POTENTIAL DFM SAVINGS: AREAS OF DFM CUMULATIVE SAVINGS

CHART PURPOSE: POTENTIAL DFM SAVINGS
(Based on Case Studies)

❏ Labor Cost	42%
❏ Part Count	54%
❏ Separate Fasteners	57%
❏ Weight	22%
❏ Assembly Time	60%
❏ Assembly Cost	45%
❏ Assembly Tools	73%
❏ Assembly Operation	53%
❏ <u>Product Development Cycle</u>	<u>45%</u>
Total Saving Potential	50%

Source: Boothryoyd Dewhurst, Inc.
Results Compiled over 100 published Case Studies
https://www.dfma.com/software/dfma.asp

EARLY DFM COSTS LESS & HAS GREATER IMPACT



Source:
https://news.ewmfg.com/blog/manufacturing/dfm-design-for-manufacturing

5 Principles of DFM

Source: https://news.ewmfg.com/blog/manufacturing/dfm-design-for-manufacturing
East West Manufacturing 404-252-9441

1: Process

Process selection is dynamic and needs to be regularly evaluated.

- Equipment/process alignment with quantity and point in product commercialization
- Quantity needed and potential need for scaling
- Material being used and why
- Complexity of the surfaces
- Tolerances required (unnecessarily high tolerances are costly)
- Secondary processes:
  - Can they be built into first process?
  - Can they provide alternative to more complex first process?
- Time to market

2: Design

Design is essential. The actual drawing of the part or product must conform to good manufacturing principles for the manufacturing process you've chosen.

In the case of plastic injection molding, for example, the following principles would apply:

- Constant wall thickness, which allows for consistent and quick part cooling
- Appropriate draft (1 - 2 degrees is usually acceptable)
- Texture - need 1 degree for every 0.001" of texture depth on texture side walls
- Ribs = 60 percent of nominal wall, as a rule of thumb
- Simple transitions from thick to thin features
- Wall thickness not too small - this increases injection pressure
- Spec the loosest tolerances and consult the trade organization for your manufacturing process on what is reasonable for that process

(Cont.)

DFE-1.2. Design for (M) - Manufacturing

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Best Practices: Design for X. Design for Manufacturing Example

3: Materials

It's important to select the correct material for your part/product. Some material properties to consider during DFM include:

- **Mechanical properties** - How strong does the material need to be?
- **Optical properties** - Does the material need to be reflective or transparent?
- **Thermal properties** - How heat resistant does it need to be?
- **Color** - What color does the part need to be?
- **Electrical properties** - Does the material need to act as a dielectric (act as an insulator rather than a conductor)?
- **Flammability** - How flame/burn resistant does the material need to be?

4: Environment

Your part/product must be designed to withstand the environment it will be subjected to. All the form in the world won't matter if the part can't function properly under its normal operating conditions.

5: Compliance & Testing

All products must comply with safety and quality standards. Sometimes these are industry standards, others are third-party standards, and some are internal, company-specific standards.

7 Factors that Affect DFM

- Part Minimization
- Define what is "acceptable"
- Modular Assemblies
- Design Interlocking Parts
- Limit Manual Interactions of Parts
- Streamline Operations
- Find Off-the-Shelf Solutions

Source: https://news.ewmfg.com/blog/manufacturing/dfm-design-for-manufacturing
East West Manufacturing 404-252-9441

DFE-1.3. Design for (M) - Outcomes

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Design for Manufacturing principles were developed to help designers decrease the cost and complexity of manufacturing a product. The results of a successful DFM are quantifiable in a variety of ways.

How do these **principles** relate to desired **outcomes** to show a **return on investment**?

		Assessed?	Outcomes (Suggested)
Minimize Number of Production Parts	Limiting the number of parts in your product is an easy way to lower the cost of a product. Why? Because it automatically reduces the amount of material and assembly labor required. Reducing the number of parts also means less engineering, production, labor, and shipping costs.	Y/N	• Reduced Overall Parts by X • Reduced Engineering Hours by X • Shipping Costs Reduced by X
Use Standardized Parts When Possible	Customization is not only expensive, but also time consuming. Standardized parts are already made to meet the same quality metrics, every time. They are already tooled. So, you save costs, and you won't have to wonder whether they'll pass inspection.	Y/N	Off-the-shelf components replaced x customizable components saving me $$ of labor and design. Standardized parts allowed me to purchase from x suppliers resulting in x fewer shipments from x suppliers, reducing shipping costs.
Create a Modular Design	Using modules can simplify any future product redesign and allow for use of standard components and the re-use of modules in other projects.	Y/N	Incorporated x standardized components. Reusing x components from previous builds or projects.
Design Multi-Functional Parts	Simple ways to reduce the total number of parts: design parts with more than one function.	Y/N	Reducing x total parts

(Cont. on next page)

DFE-1.3. Design for (M) - Outcomes

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How do these **principles** relate to desired **outcomes** to show a **return on investment**?

		Assessed?	Outcomes (Suggested)
Design Multi-Use Products	Different *products* can share parts that have been designed for multi-use. Can your product use standardized parts that can be used in multiple products?	Y/N	Do you have multiple product lines that allow for part crossover? Are you able to reduce part count through the design of multiple products?
Design for Ease of Fabrication	Choose the ideal combination between the material and manufacturing process that will minimize production costs. Ridiculously tight tolerances can cause over manufacturing and rework. Avoid expensive and labor intensive final operations such as painting, polishing and finish machining.	Y/N	Through the redesign of the manufacturing process I saved xx hours of labor and minimized parts by x, resulting in total cost savings of xx.
Limit Connectors, Adhesives, and Fasteners	Is it possible for your product to interlock or clip together? Screws add only about 5% to the material cost, but 75% to the assembly labor. Remember: if fasteners are required, try to keep the size, number, and type to a minimum and use standard fasteners whenever possible.	Y/N	Eliminating screws I reduced labor by xx for an overall cost savings of xx.
Design for Minimized Handling	Handling includes positioning, orienting, and fastening the part into place. For orientation purposes, use symmetrical parts wherever possible.	Y/N	By including symmetrical parts, xx labor was eliminated from the handling process saving me x time and x money.
Minimize Assembly Direction	Parts should assemble from one direction. Ideally, parts should be added from above, parallel to the gravitational direction (downward.) This way assembly is facilitated by gravity rather than fighting it.	Y/N	With updating assembly direction of parts, x labor was saved in the assembly process.
Maximize Compliance	Rely on built-in design features like tapers or chamfers, or moderate radius sizes to guide insertion of equipment and to protect the part from damage.	Y/N	Maximizing compliance in the beginning of design and manufacturing saved xx dollars of rework and test on the backend.