

# Workbook 4

Designing for Excellence

Designing for Excellence is a systematic approach to achieve a targeted objective.

*X represents targeted objectives or characteristics.*

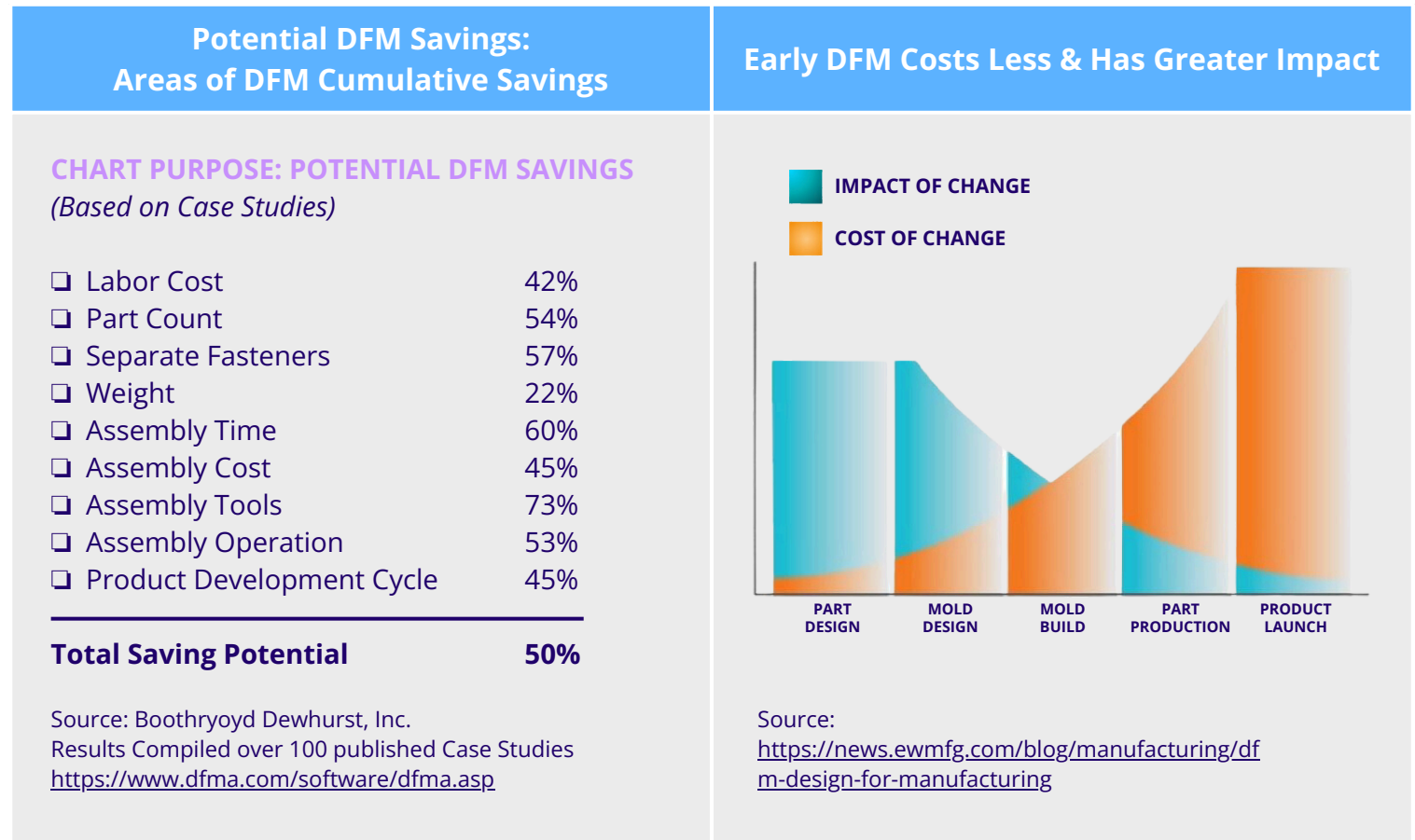
What are we designing for? DF(X)	The Approach and/or Focus for DF(X)
<b>1</b>  <b>DF(M)</b> Design for <b><i>Manufacturing</i></b>	<input type="checkbox"/> Reduce Bill of Materials <input type="checkbox"/> Material Tradeoffs <input type="checkbox"/> Cost Reductions
<b>2</b>  <b>DF(A)</b> Design for 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

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<b>6</b>  <b>DF(M&amp;S)</b> Design for <b><i>Maintenance and Serviceability</i></b>	<input type="checkbox"/> Ease of Repair <input type="checkbox"/> Access Points <input type="checkbox"/> Spare Parts and Tools
<b>7</b>  <b>DF(P&amp;L)</b> Design for <b><i>Packing &amp; Logistics</i></b>	<input type="checkbox"/> Product Protection <input type="checkbox"/> Materials <input type="checkbox"/> Cost
<b>8</b>  <b>DF(S)</b> Design for <b><i>Sustainability</i></b>	<input type="checkbox"/> Circularity of Materials <input type="checkbox"/> End-of-Life Repurposing <input type="checkbox"/> Reducing Waste in Operations
<b>9</b>  <b>DF(C&amp;M)</b> Design for <b><i>Reliability &amp; Durability</i></b>	<input type="checkbox"/> Use and Installation <input type="checkbox"/> Customer Interface <input type="checkbox"/> Product Certifications <input type="checkbox"/> Instructions and Manuals
<b>10</b>  <b>DF(C)</b> Design for <b><i>Compliance</i></b>	<input type="checkbox"/> Product Safety <input type="checkbox"/> Acceptance by Regulatory Bodies <input type="checkbox"/> Industry Standards

There is more than just 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

## 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?

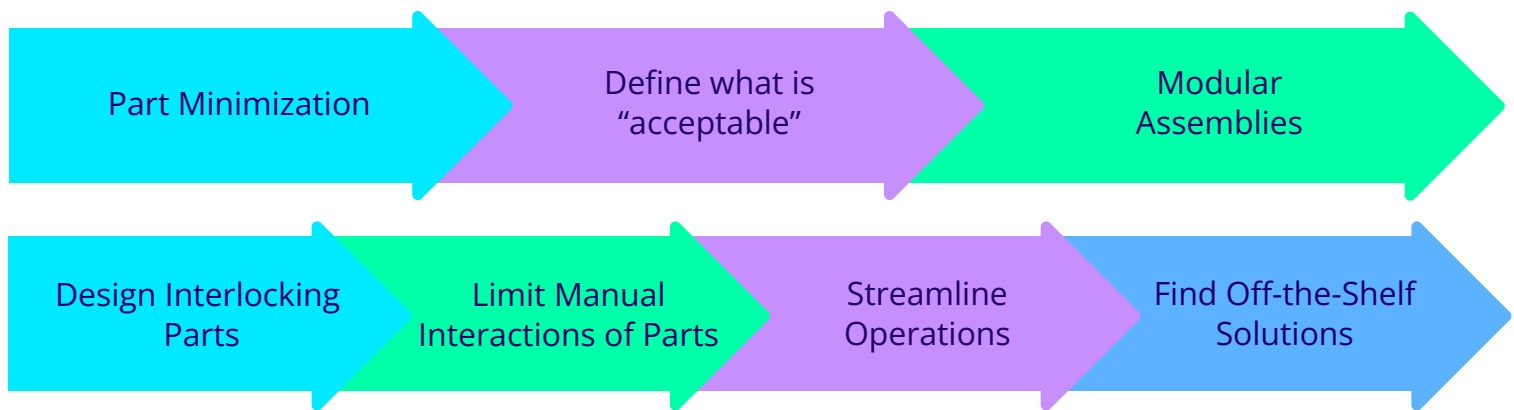
### 4: Environment

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



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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)
<b>Minimize Number of Production Parts</b>	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	<ul style="list-style-type: none"> <li>• Reduced Overall Parts by X</li> <li>• Reduced Engineering Hours by X</li> <li>• Shipping Costs Reduced by X</li> </ul>
<b>Use Standardized Parts When Possible</b>	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	<p>Off-the-shelf components replaced x customizable components saving me \$\$ of labor and design.</p> <p>Standardized parts allowed me to purchase from x suppliers resulting in x fewer shipments from x suppliers, reducing shipping costs.</p>
<b>Create a Modular Design</b>	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	<p>Incorporated x standardized components.</p> <p>Reusing x components from previous builds or projects.</p>
<b>Design Multi-Functional Parts</b>	Simple ways to reduce the total number of parts: design parts with more than one function.	Y/N	Reducing x total parts
<b>Design Multi-Use Products</b>	Different <i>products</i> 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?

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<b>Design for Ease of Fabrication</b>	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.
<b>Limit Connectors, Adhesives, and Fasteners</b>	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.
<b>Design for Minimized Handling</b>	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.
<b>Minimize Assembly Direction</b>	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.
<b>Maximize Compliance</b>	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.