

# **Design for Manufacturing and Assembly I: General Principles**

Manufacturing and Product Design  
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# Design for Manufacturing and Assembly

Terminology: Design for... (DFx)

- **Design for Manufacturing (DFM)** refers to design activity that is based on minimizing the cost of production and/or time to market for a product, while maintaining an appropriate level of quality. A primary strategy in DFM involves minimizing the number of parts in a product.
- **Design for Assembly (DFA)** involves making directions and methods for attaching and joining the parts of a product simpler.
- **DFMA** refers to working both of these concepts together.

# Benefits of DFM and DFA

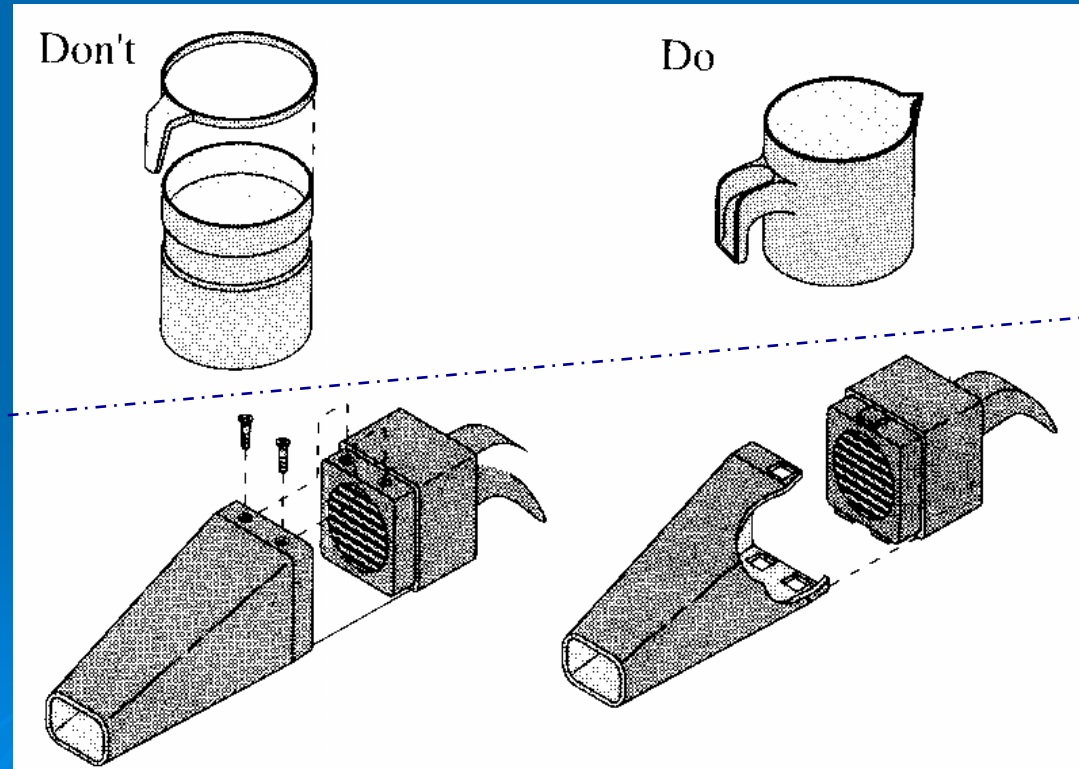
- Reduces part count, thereby reducing cost...  
If a design is easier to produce and assemble, it can be done in less time, so it will be less expensive. Design for manufacturing and assembly should be used for that reason if no other.
- Increases reliability...  
If the production process is simplified, there is less opportunity for errors.
- Generally increases the quality of the product...  
for the same reason that it increases the reliability.

# DFM and DFA

- DFM and DFA start with the formation of a design team which must be multi-disciplinary, including: engineers, manufacturing managers, cost accountants, and marketing and sales professionals.
- The most basic / simplest approach to Design for Manufacturing and Assembly is to apply a set of design guidelines.
- You should use design guidelines with an understanding of explicit design goals. Make sure that the application of each guideline improves the design concept with respect to those goals

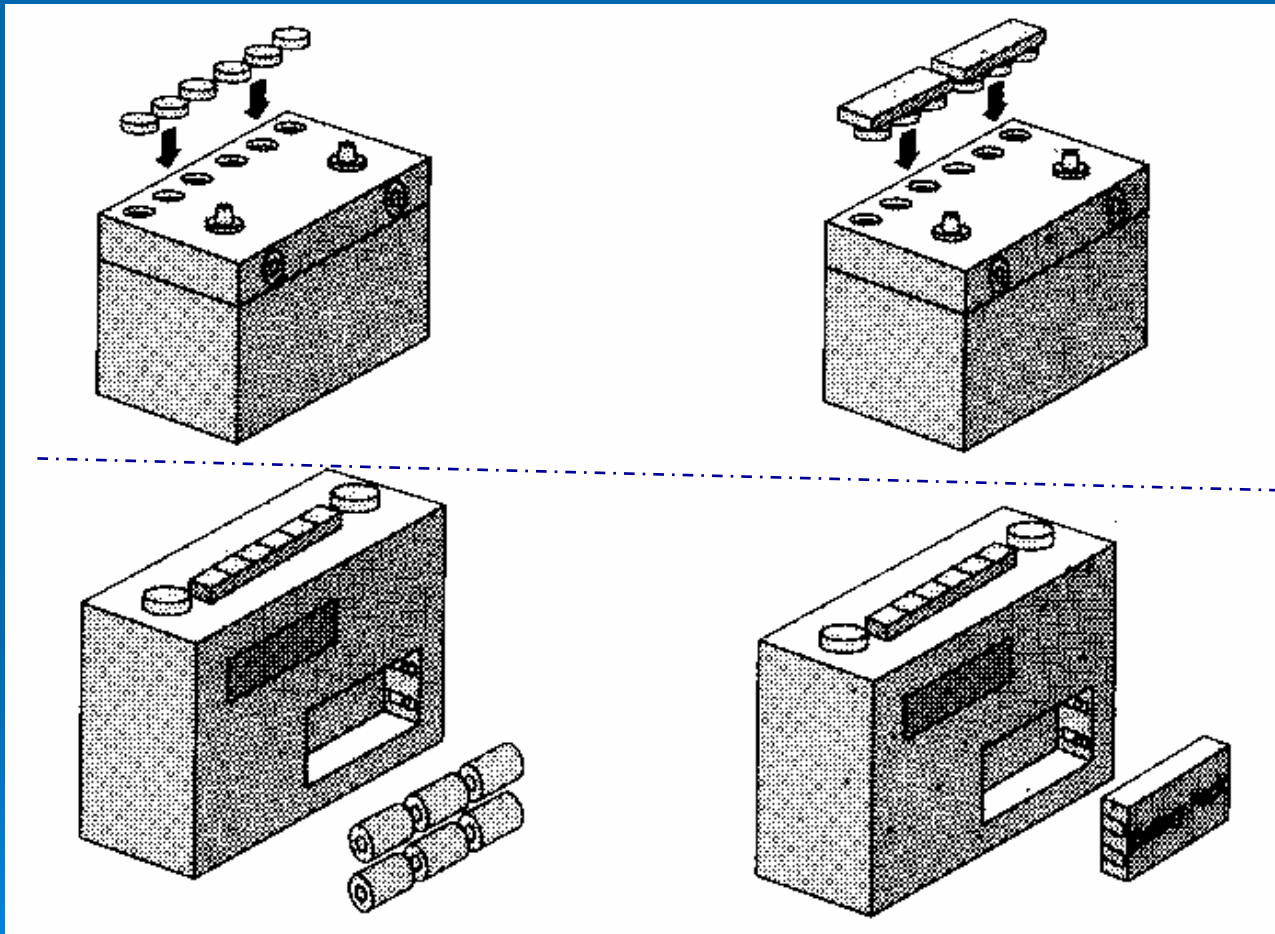
# DFM and DFA Design Guidelines

- **Minimize part count** by incorporating multiple functions into single parts.
- Several parts could be fabricated by using different manufacturing processes (sheet metal forming, injection molding).
- Ask yourself if a part function can be performed by a neighboring part.



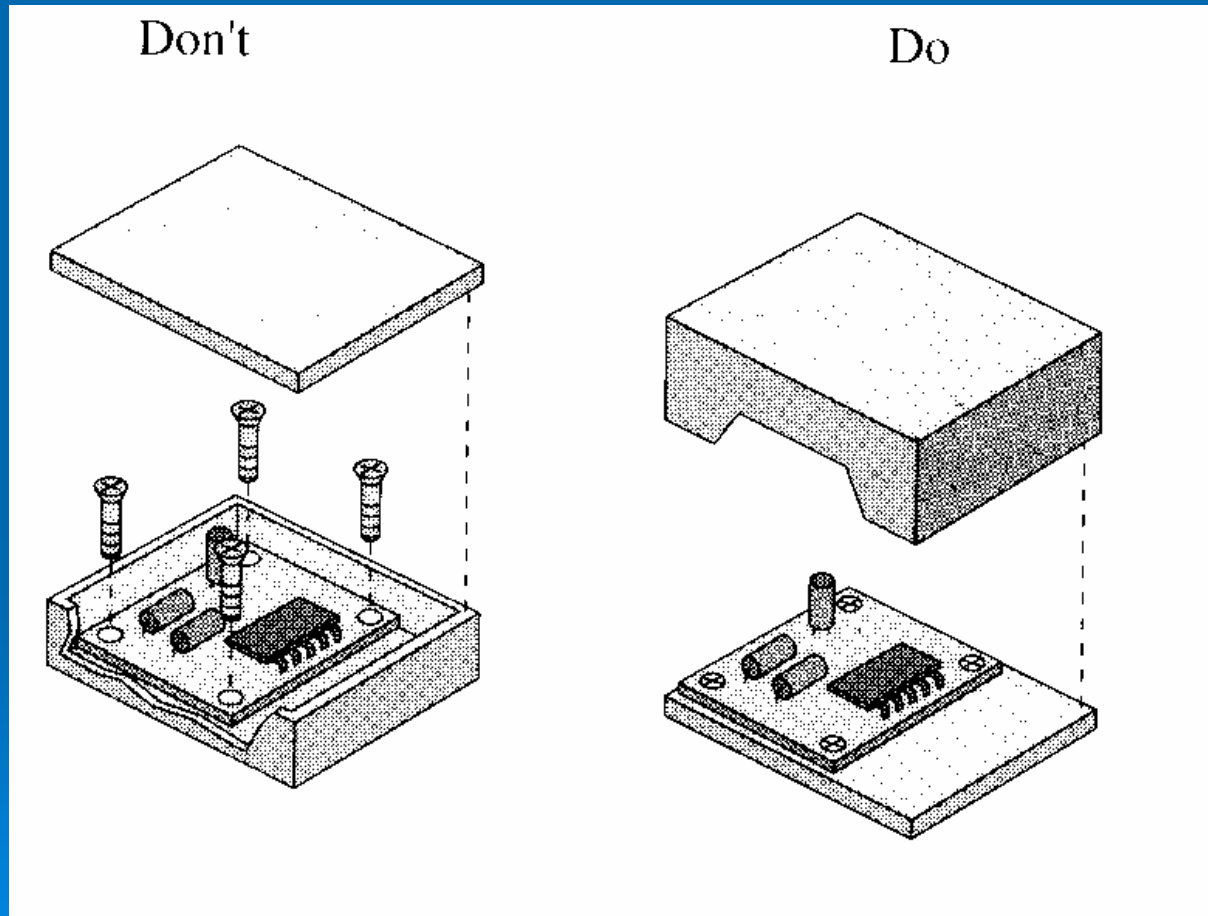
# DFM and DFA Design Guidelines

- Modularize multiple parts into single sub-assemblies.



# DFM and DFA Design Guidelines

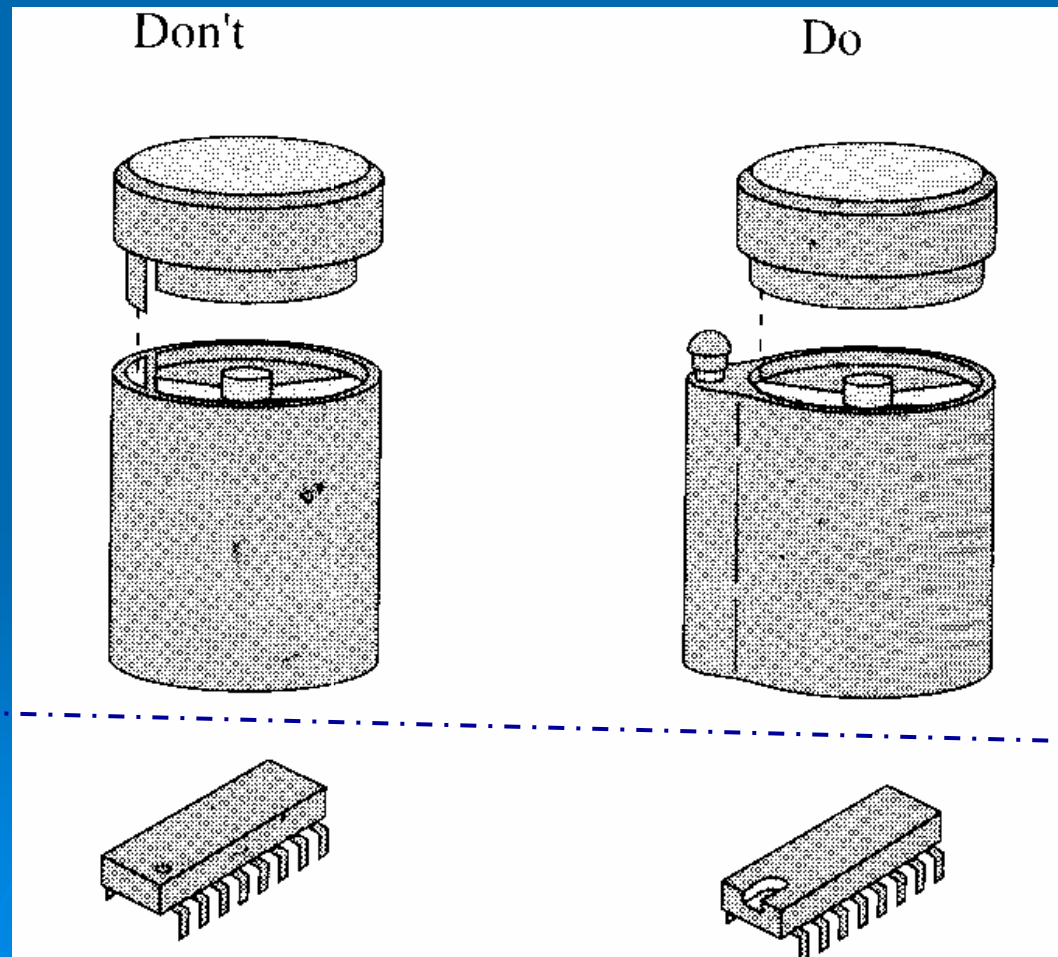
- Design to allow assembly in open spaces, not confined spaces. Do not bury important components.





# DFM and DFA Design Guidelines

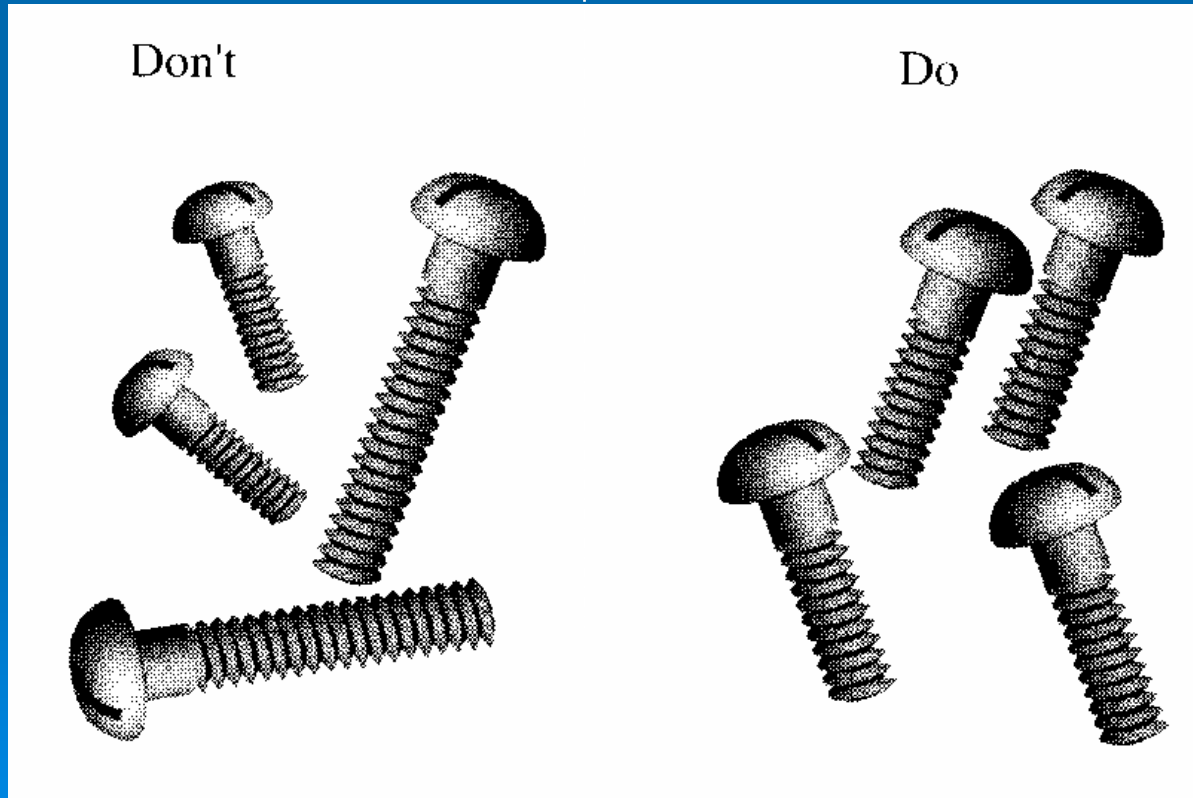
- Parts should easily indicate orientation for insertion.
- Parts should have self-locking features so that the precise alignment during assembly is not required. Or,
- Provide marks (indentation) to make orientation easier.





# DFM and DFA Design Guidelines

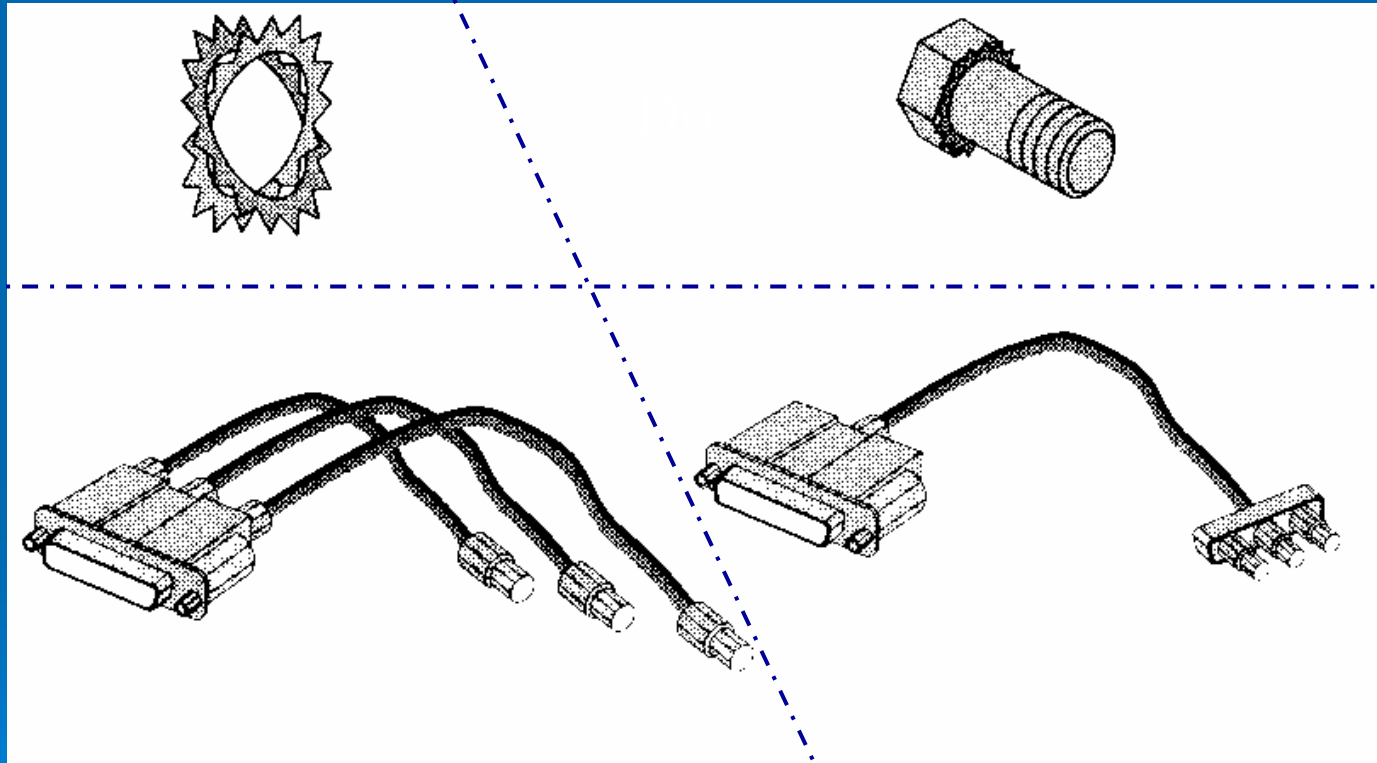
- Use standardized products, and
- Standardize parts to reduce variety of operations, choices, and inventory burden.



# DFM and DFA Design Guidelines

- Design parts so they do not tangle or stick to each other.

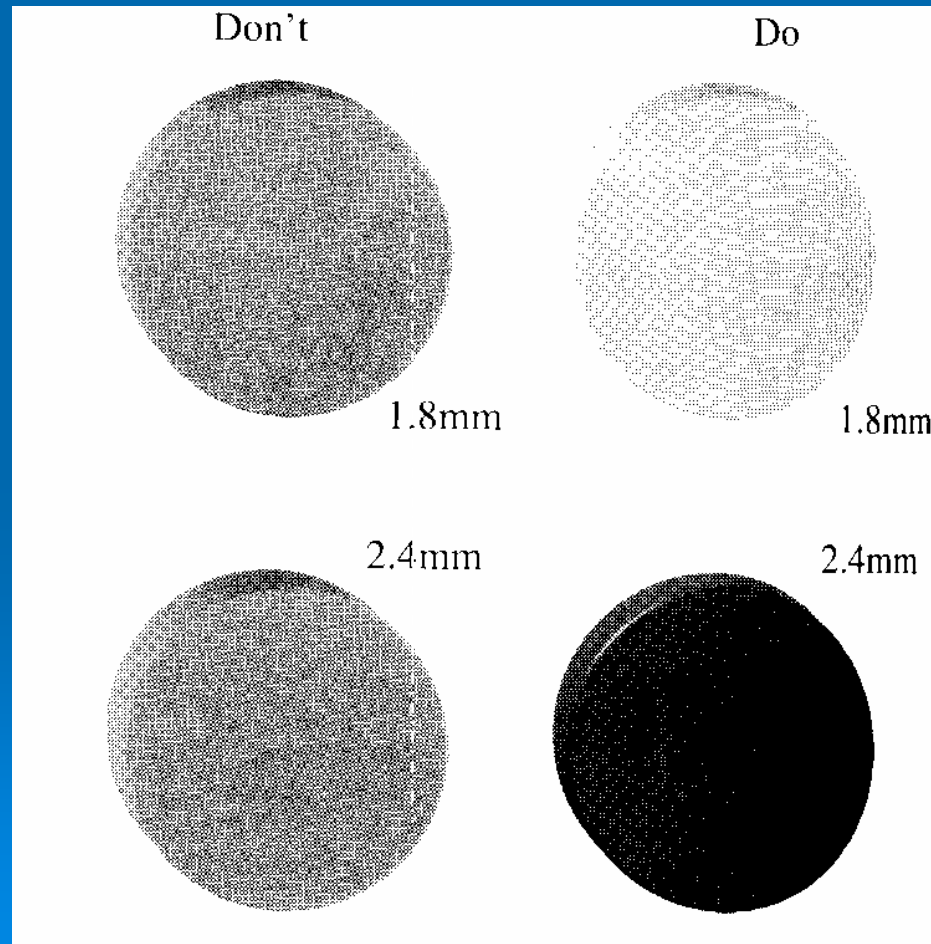
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DO

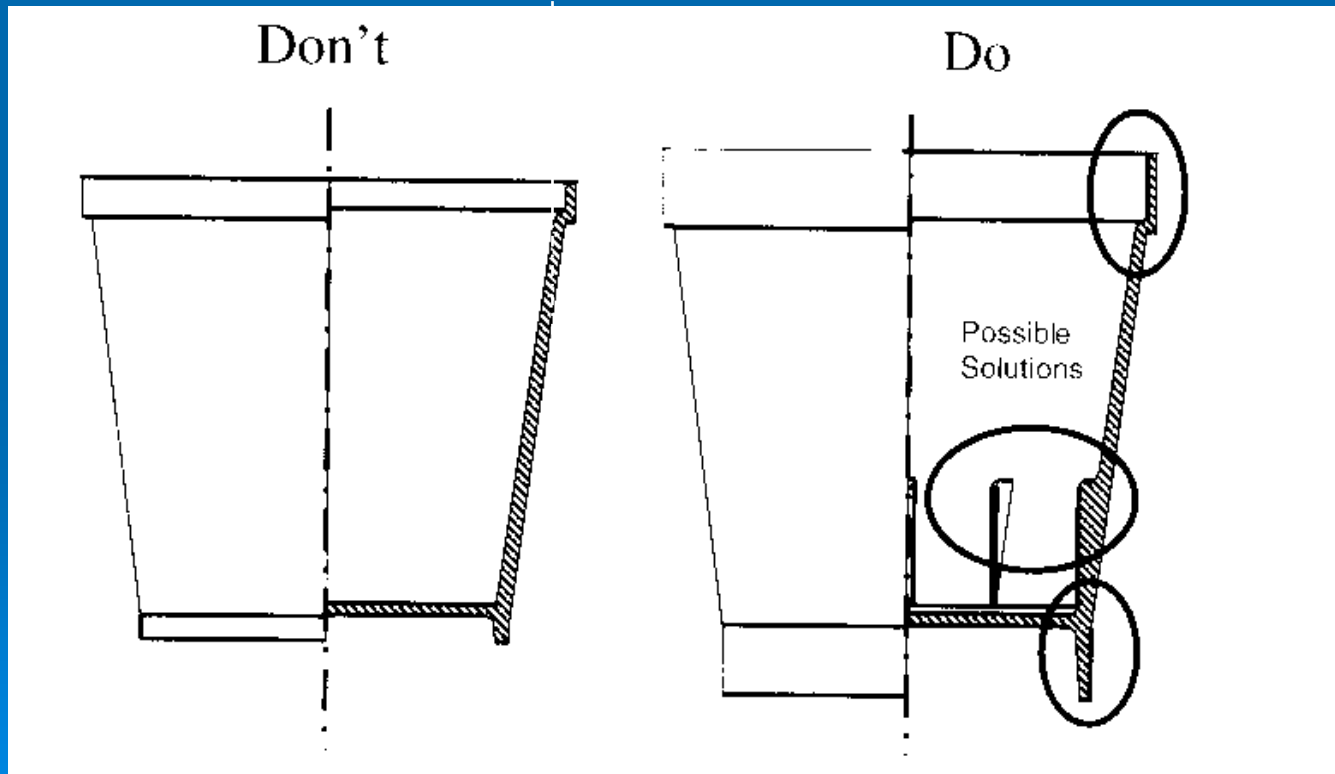
# DFM and DFA Design Guidelines

- Distinguish 'apparently similar' parts
- Distinguish different parts that are shaped similarly, or hard to distinguish, by non-geometric means, such as color coding.



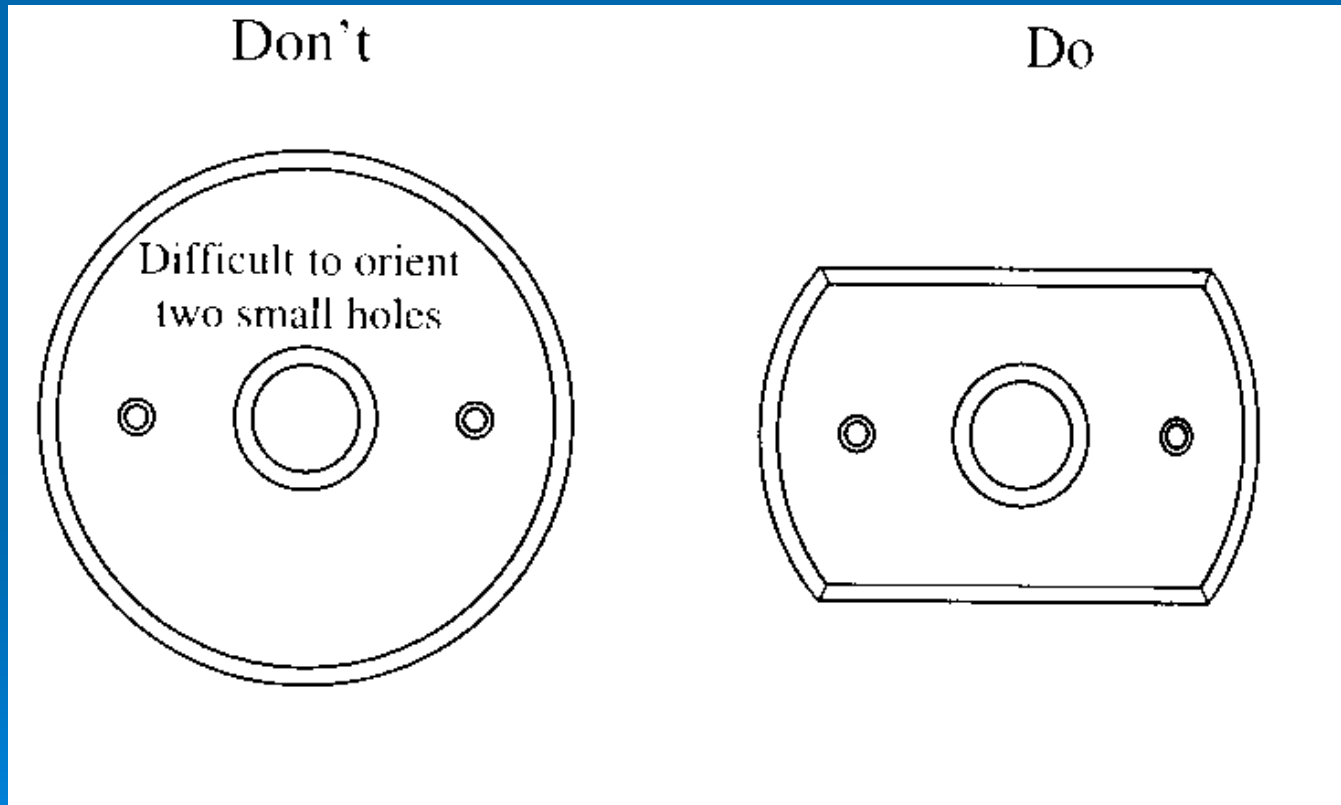
# DFM and DFA Design Guidelines

- Design parts to prevent nesting. Nesting is when parts that are stacked on top of one another clamp or stick to one another, for example, cups and coffee lids



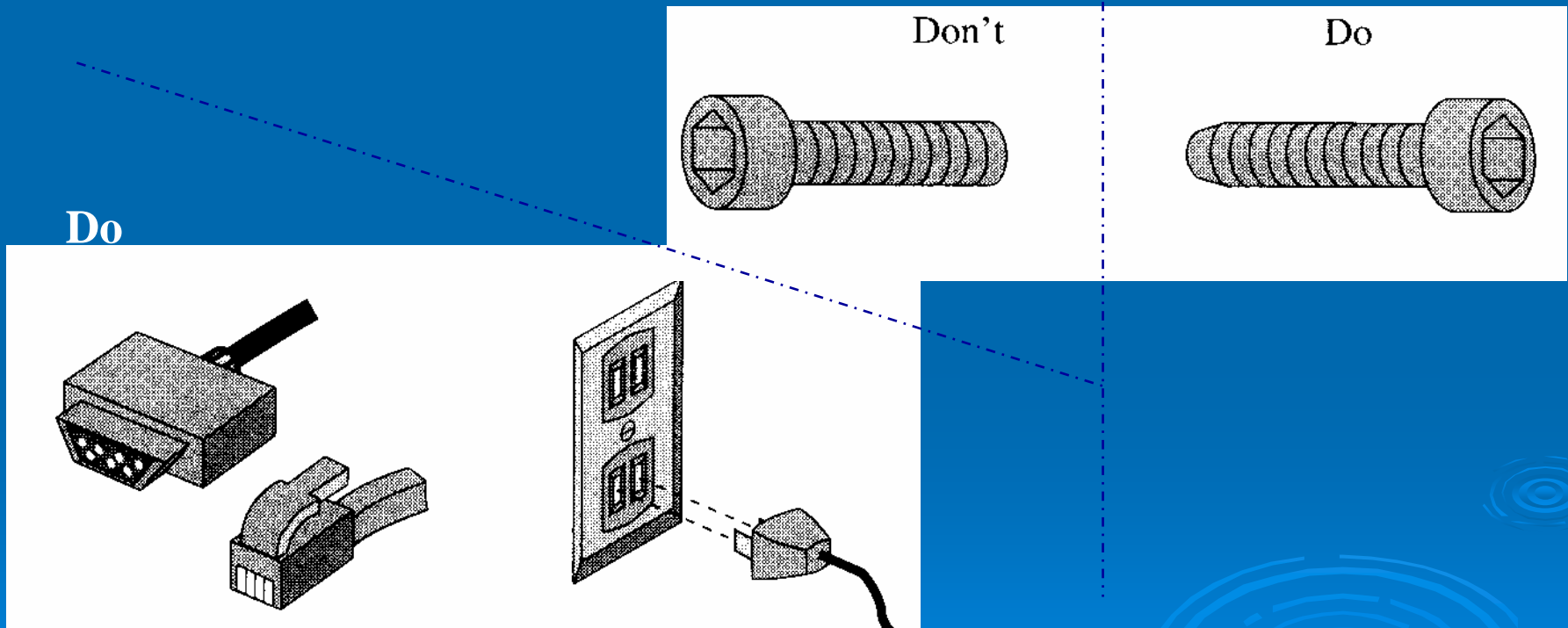
# DFM and DFA Design Guidelines

- Design parts with orienting features to make alignment easier.



# DFM and DFA Design Guidelines

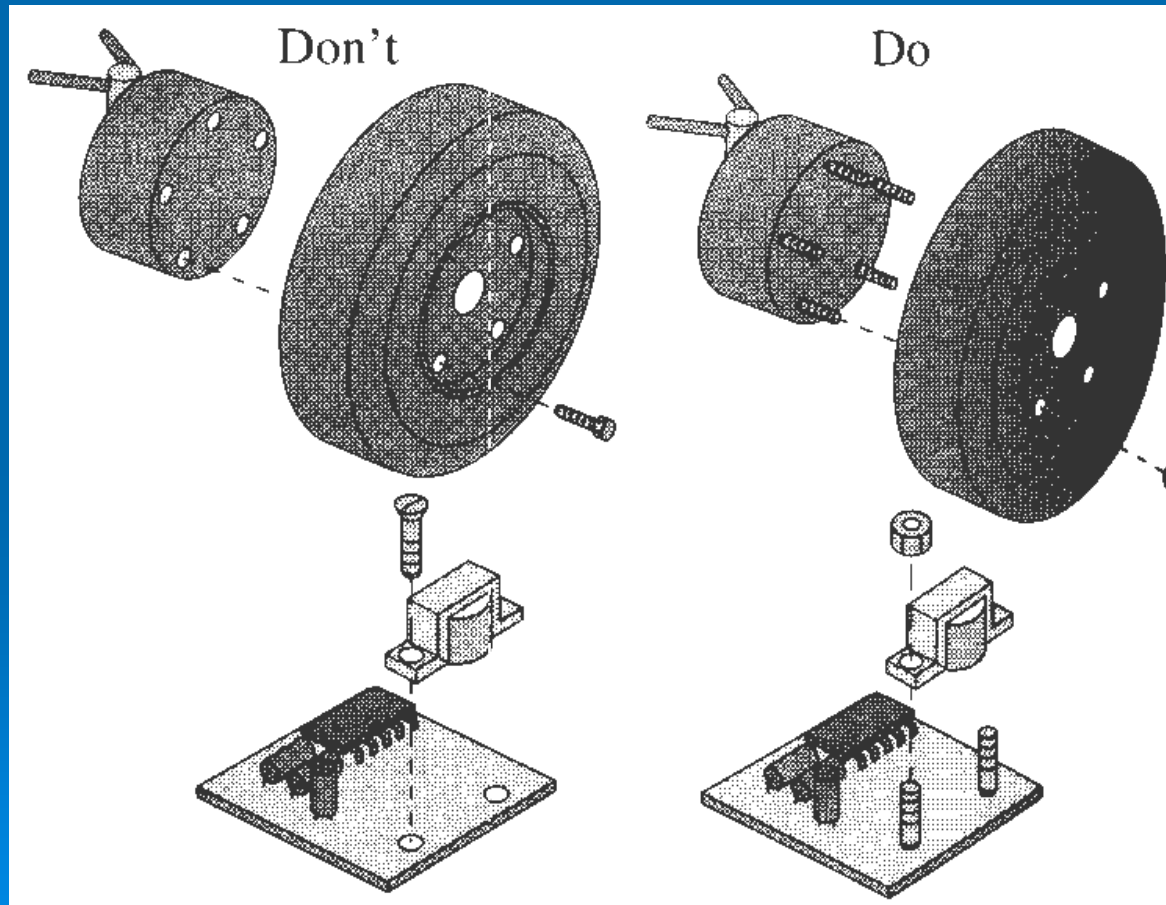
- Provide alignment features on the assembly so parts are easily oriented.



# DFM and DFA Design Guidelines

- Design the mating parts for easy insertion or attachment.
- Provide allowance (tolerance) on each part to compensate for variation in part dimensions.

Case I



Case II

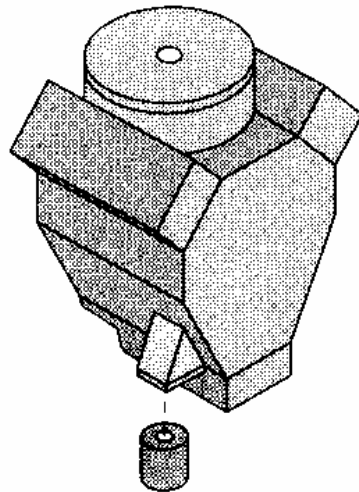


# DFM and DFA Design Guidelines

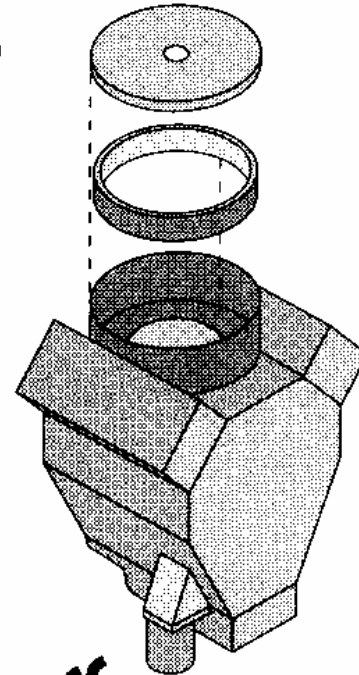
- Design the first part large and wide for stability, then assemble smaller parts on top of it, sequentially.

Case I

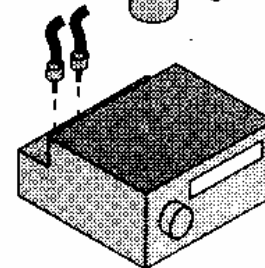
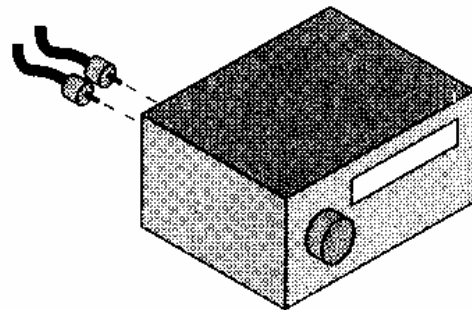
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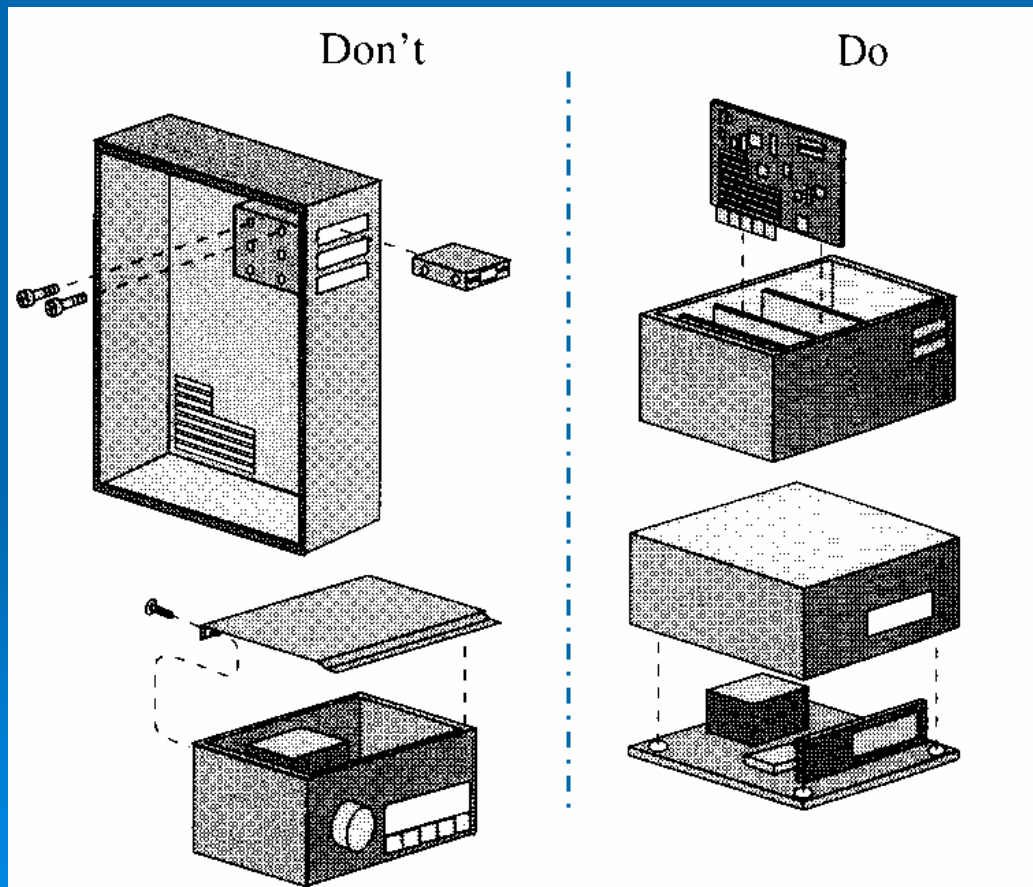
Case II



# DFM and DFA Design Guidelines

- If you cannot assemble parts from the top down exclusively, then minimize the number of insertion directions. Never require the assembly to be turned over.

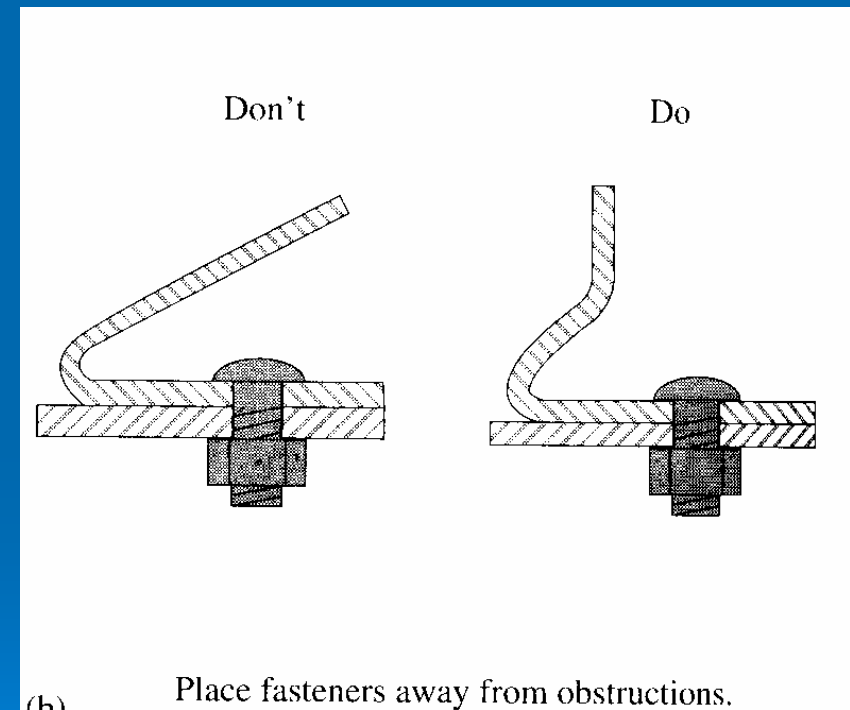
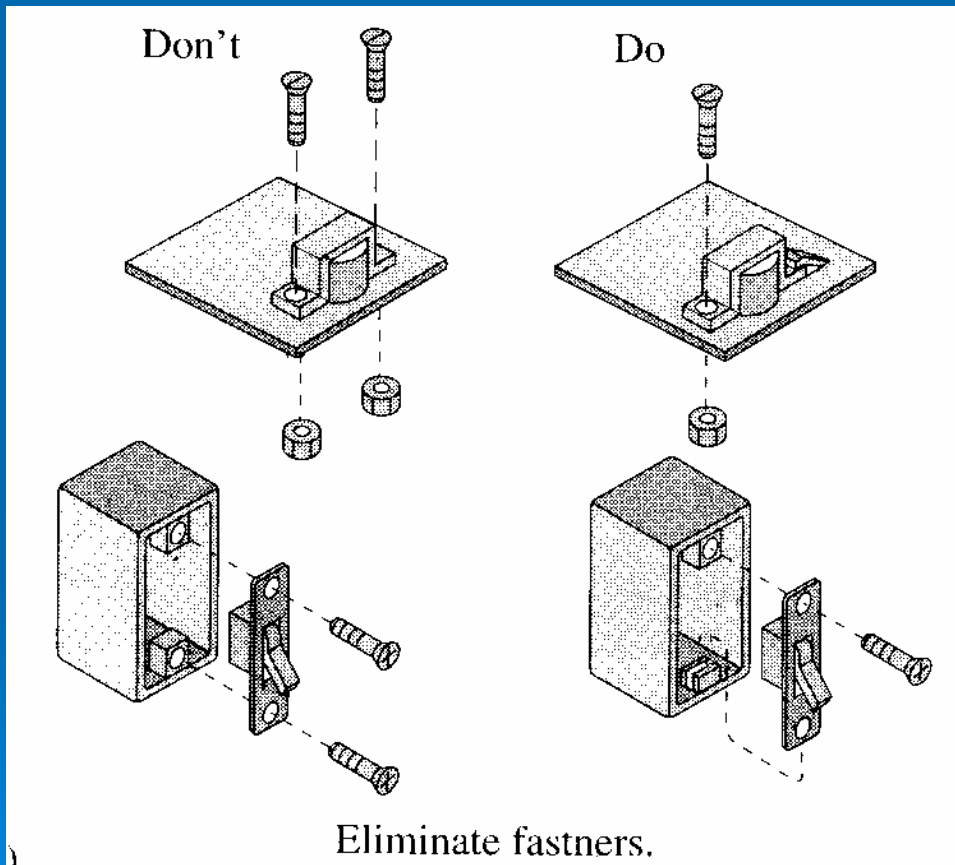
Case I



Case II

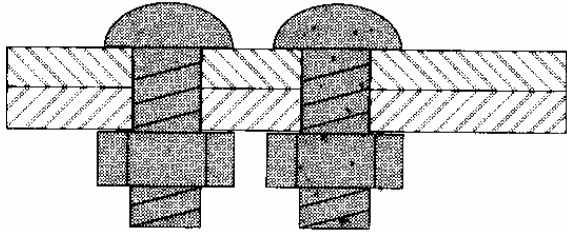
# DFM and DFA Design Guidelines

- Joining Options: parts can be joined using fasteners (screws, nuts and bolts, rivets), snap fits, welds or adhesives. Design to eliminate fasteners and to place them away from obstructions...

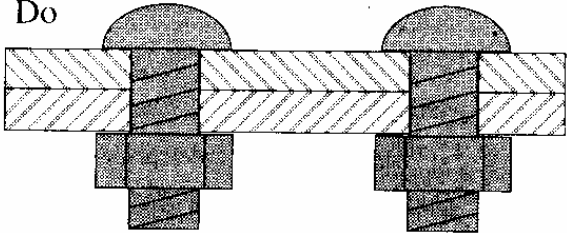


# DFM and DFA Design Examples...

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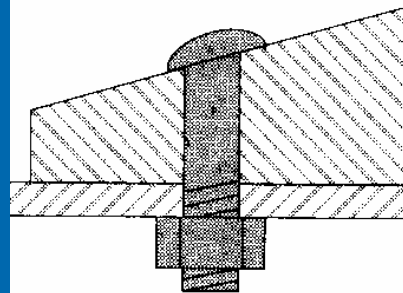


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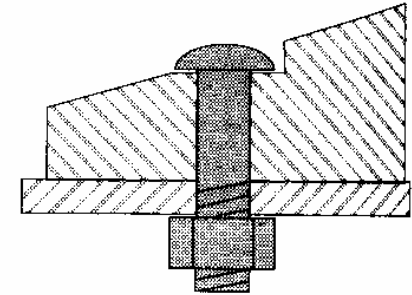


Proper spacing insures allowance for a fastening tool.

Don't

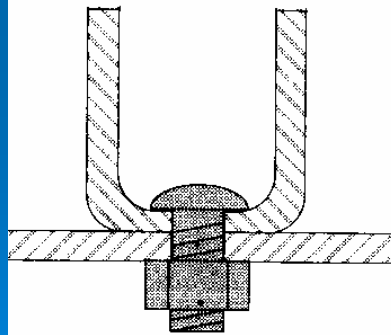


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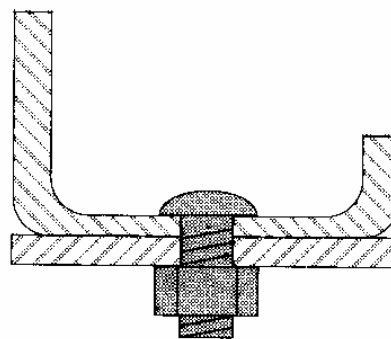


Providing flats for uniform fastening and fastening ease.

Don't



Do



Deep channels should be sufficiently wide to provide access to fastening tools. No channel is best.

# Combining to Minimize the Number of Parts

To determine whether it is possible to combine neighboring parts, ask yourself the following questions:

- Must the parts move relative to each other?
- Must the parts be electrically or thermally insulated?
- Must the parts be made of different material?
- Does combining the parts interfere with assembly of other parts?
- Will servicing be adversely affected?

If the answer to all questions is “NO”, you should find a way to combine the parts.

# Minimizing the Number of Parts

## Another Approach

The concept of the *theoretical minimum number of parts* was originally proposed by Boothroyd (1982). Generally, during the assembly of the product, a part is required only when;

1. A kinematic motion of the part is required.
2. A different material is required.
3. Assembly of other parts would otherwise be prevented.

If none of these statements are true, then the parts do not need to be separate entities and may be combined.

Follow the KISS principal:

“KISS” – Keep It Simple Stupid

End . . .

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and Assembly