DFMA® in 10 Slides

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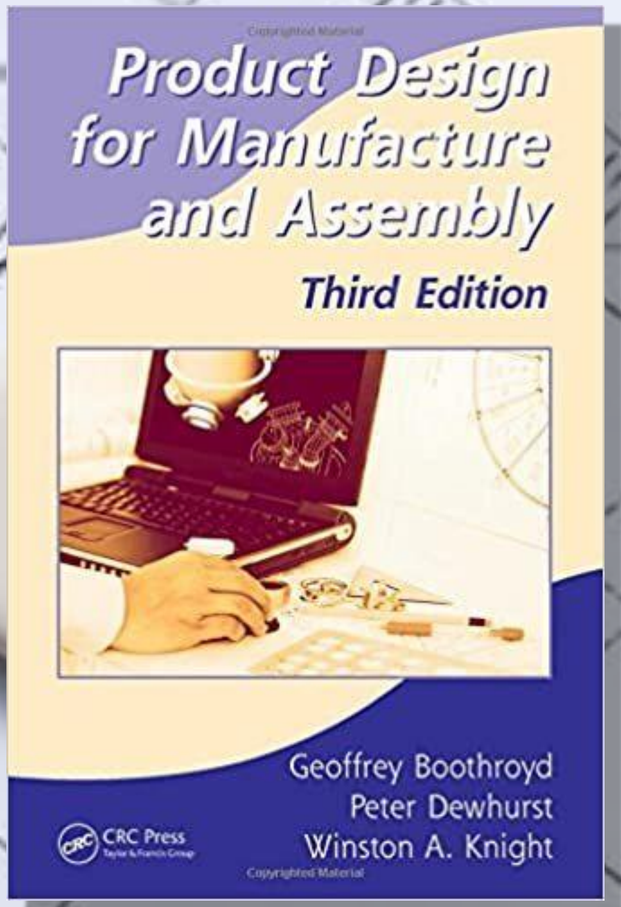
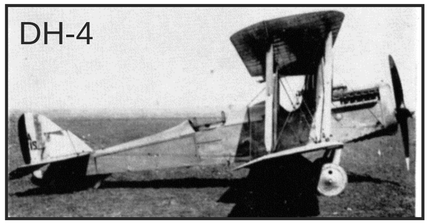
DFMA®
BOOTHROYD DEWHURST

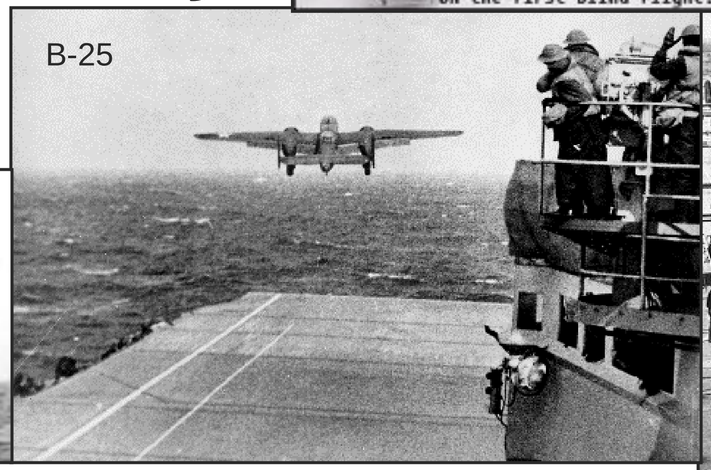


James Harold “Jimmy” Doolittle (1896-1993)

Early Aviation Pioneer

- 1922: One-Stop X-Country Flight
- 1925: Schneider Trophy
- 1927: First Outside Loop
- 1929: First Instrument Flight
- 1942: Doolittle Raid





James Harold “Jimmy” Doolittle (1896-1993)

"In the early '20s, there was not complete support between the flyers and the engineers. The pilots thought the engineers were a group of people who zipped slide rules back and forth, came out with erroneous results and bad aircraft; and the engineers thought the pilots were crazy – otherwise they wouldn't be pilots.“

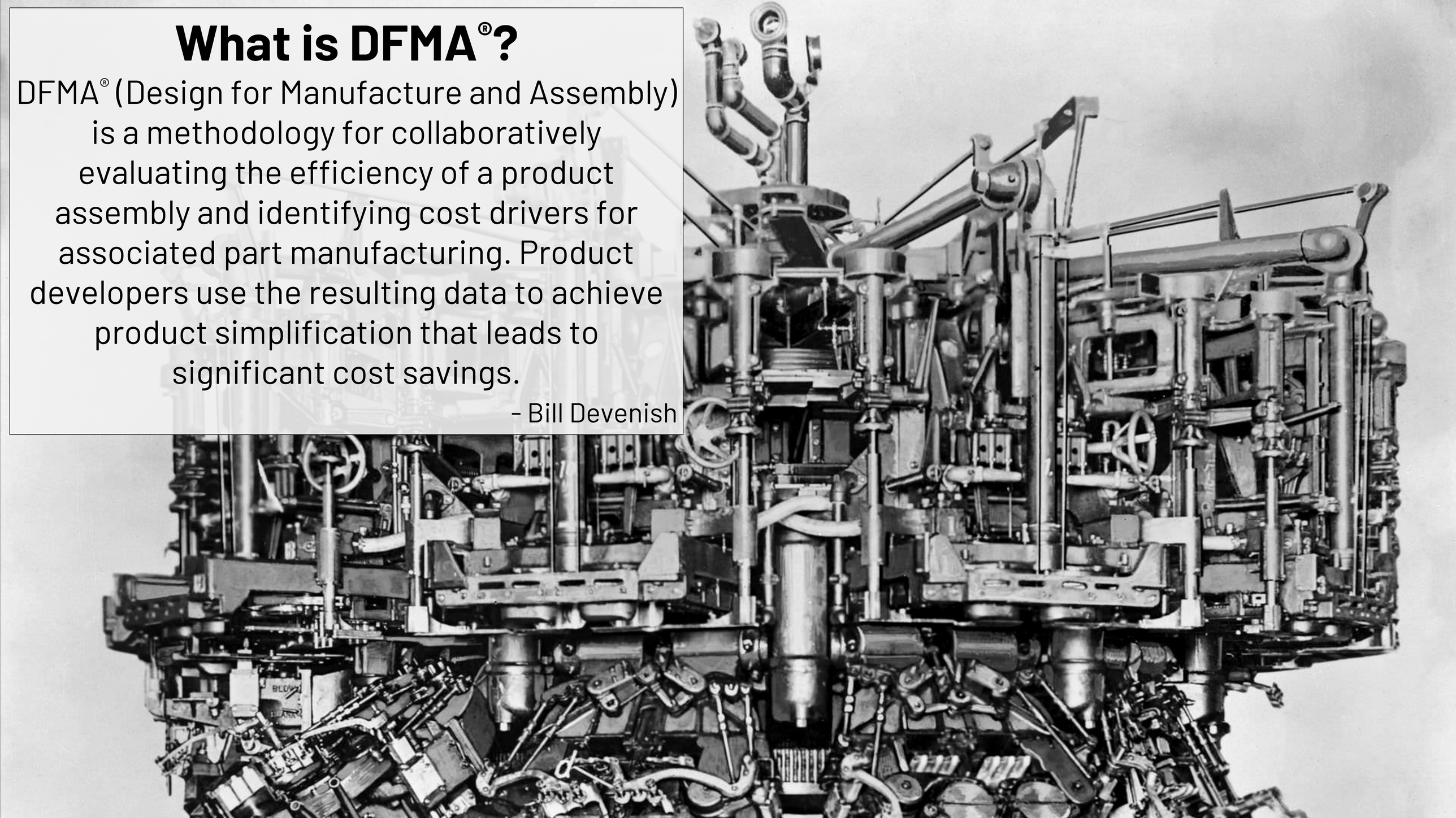
… After schooling and working together for a year…

"I believe that there was thereafter a better understanding between pilots and engineers."

What is DFMA®?

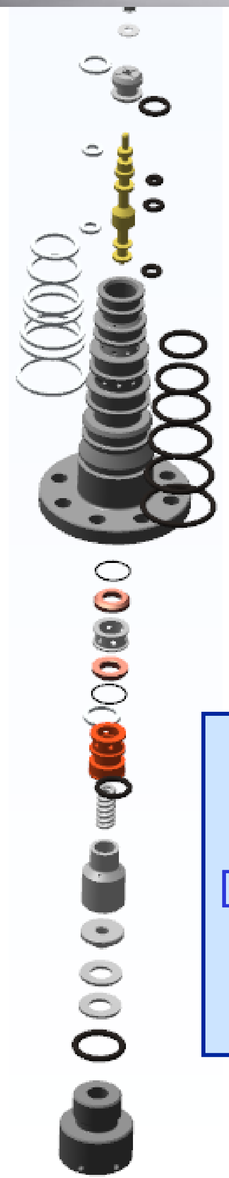
DFMA® (Design for Manufacture and Assembly) is a methodology for collaboratively evaluating the efficiency of a product assembly and identifying cost drivers for associated part manufacturing. Product developers use the resulting data to achieve product simplification that leads to significant cost savings.

- Bill Devenish



DFMA®
BOOTHROYD DEWHURST

DFMA® (Design for Manufacture and Assembly) is a product simplification and early should cost methodology developed by Boothroyd Dewhurst, Inc.



DFA
Design for Assembly

Product Simplification Process

- Estimate Early Assembly Time & Cost
- Determine Assembly Efficiency
- Compare Alternate Design Approaches
- Improve Assembly & Reduce Product Cost

DFM
Design for Manufacture

Early Should Cost Estimating Process

- Evaluate Alternative Fab Processes
- Align Process & Operation Variables

CAUTION

Not to be confused with Design for Manufacturability, or DFMEA (Design Failure Mode Effects Analysis)

DFA & DFM

- Identify Key Cost Drivers
- Make Data Driven Design Decisions

What are the Minimum Part Criteria?

The **Minimum Part Criteria** uses a part categorization technique within DFMA® that facilitates part combination and/or elimination. It increases understanding of product functionality and then assists in the effort to achieve product simplification.

- Bill Devenish

Material

The part must be made from a fundamentally different **Material** than parts already assembled.

Assembly

Separate to allow **Assembly** is when the part must allow for the assembly of previous parts.

Base

A **Base Part** is usually the first part in an assembly. There can only be one base part in an assembly.

Movement

Movement is when the entire part must move relative to the parts already assembled.

The remaining parts that don't meet the criteria are candidates for combination or elimination. Including fasteners and connectors.

Doesn't Meet Criteria

Fasteners

Fasteners are defined as parts that secure other items together.

Fasteners add cost and are significant contributors to quality problems. Using different types and sizes of fasteners in a product introduces opportunities for errors through misplacement, inadequate torque and in some instances, forgetfulness.

Theoretically, fasteners are candidates for elimination, and never meet the DFMA® Minimum Part Criteria.

DFMA® efforts seek to eliminate or reduce the number of fasteners. Designing parts to utilize slot and tab features, or other alternative capture methods, can reduce fasteners. Designing parts with snap features, and combining parts, can lead to the elimination of fasteners.

- Bill Devenish

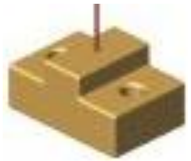
Part Symmetry

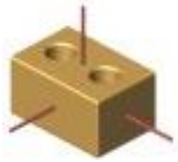
Symmetry of small parts (<10 in.) affects assembly process time.

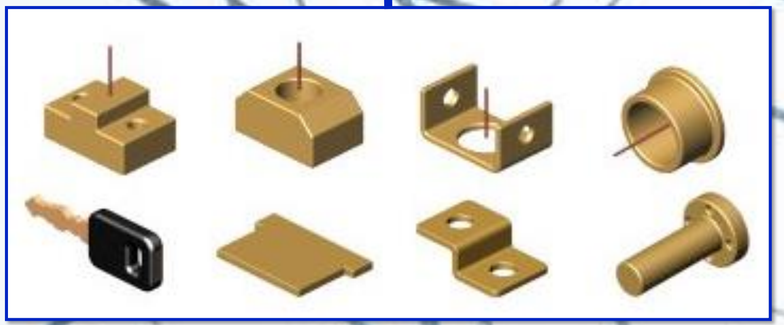
Symmetry exists about an axis when the part repeats its orientation after it is rotated about that axis through an angle of 180 degrees or less.

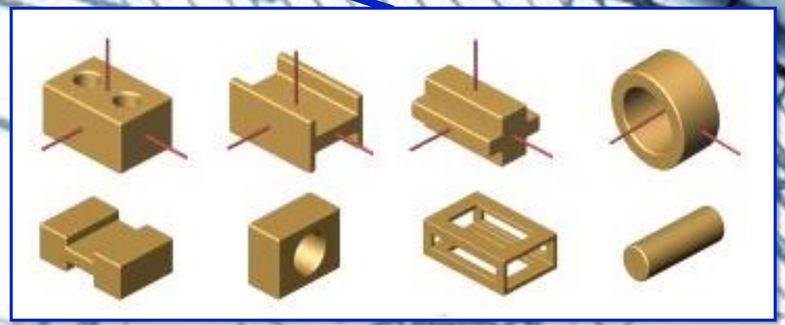
Symmetry
180 degrees or less about:


No axes


One axis


Two axes

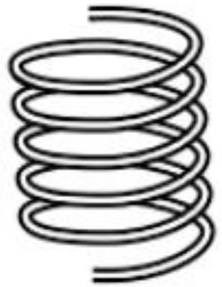




Part Handling Difficulties

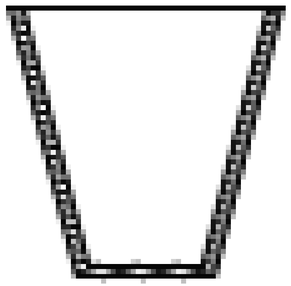
Time penalties are associated with additional fetching, grasping and orienting of loose parts

Tangle



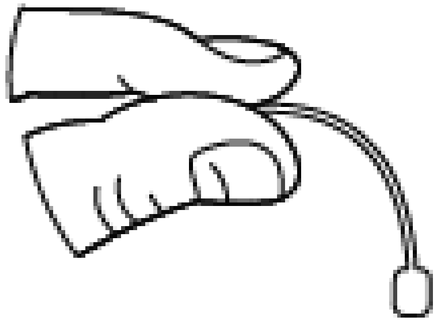
Parts that interlock and require two hands for separation

Nest



Parts that interlock with other like parts and require separation

Flexible

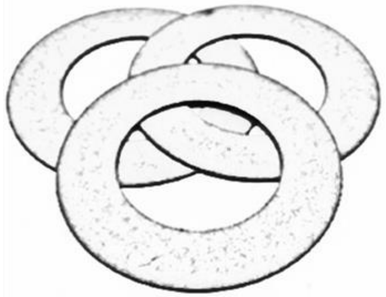


A part that substantially deforms under its own weight during handling

Slippery

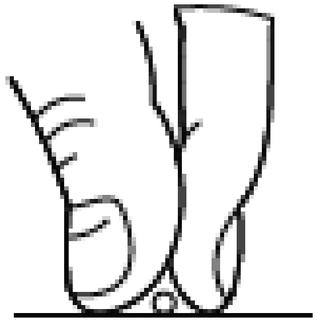
A part that slips from fingers because of its shape or slippery coating

Sticky



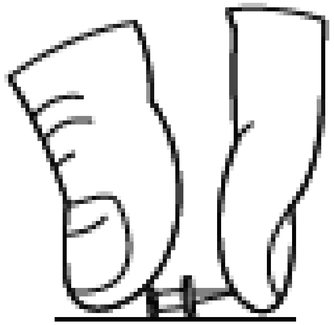
Parts that stick together and require two hands for separation

Small



A part that is too small for handling without a tool

Sharp

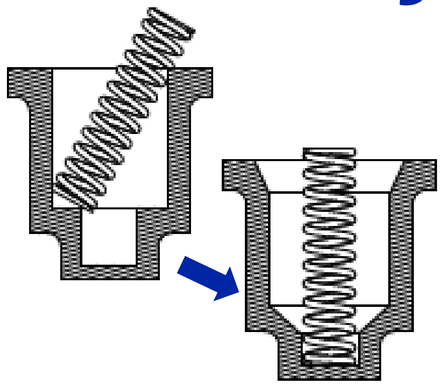


Additional time needed to carefully handle a part that is fragile or sharp

Part Insertion Difficulties

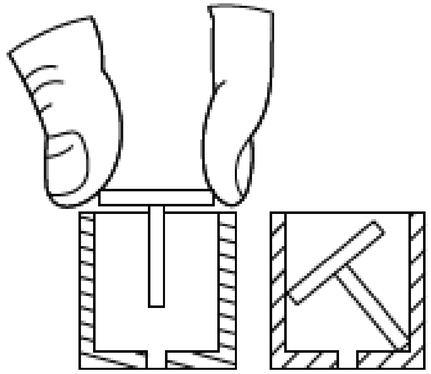
Time penalties are associated with difficulties experienced when placing parts into the assembly

Self-locating



Part insertion is not facilitated by chamfers or similar features

Access



Mating location is obstructed or has poor hand clearance

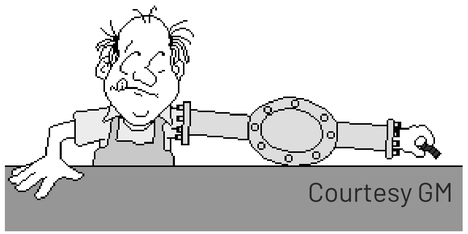
Vision

The sight of mating location is restricted or hidden

Multi-point

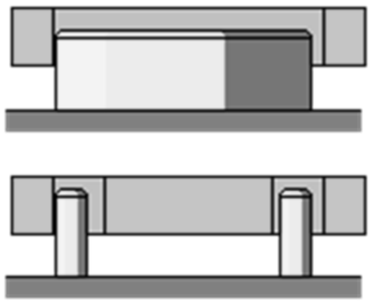
Part requires multiple placement points or multiple adjustments

Depth



Depth of part insertion exceeds 1 inch

Resistance



Part insertion against a force greater than 10 lb. due to small clearances

Excess Force

Part insertion requires the use of mechanical assistance

The DFA Index

The **DFA Index** measures assembly efficiency and compares alternate design concepts that meet the same functional requirements. It encourages Product Simplification by facilitating creativity.

- Bill Devenish

The **DFA Index** can be used as a quantitative metric to track product development progress. It helps make data driven decisions, instead of relying on instinct, gut-feel, or intuition.

- Bill Devenish

Calculating the DFA Index

$$E_{ma} = \frac{N_{min} \times t_a}{t_{ma}} \times 100$$

E_{ma} : Denotes the value for the DFA Index

N_{min} : Sum of parts that meet the DFMA® Minimum Part Criteria

t_a : Ideal assembly time (2.93 seconds) for a given part

t_{ma} : Estimated actual assembly time for all parts and operations (includes time penalty for difficulties)

The DFA Index (E_{ma}) is a ratio, from 0 to 100, with a higher number representing a more efficient design.

DFM

Design for Manufacture – Concurrent Costing

Processes

- Assembly Fabrication
- Blow Molding
- Die Casting
- Forging
- Injection Molding
- Investment Casting
- Machining
- Metal Extrusion
- Metal Inject Molding
- Plastic Extrusion
- Powder Metallurgy
- Sand Casting
- Sheet Metal Cutting
- Sheet Metal Drawing
- Sheet Metal Stamping
- Thermoforming
- Structural Foam Molding

Materials

- Aluminum Alloy
- Ceramics & Carbides
- Copper Alloy
- High Temp Alloy
- Infiltrated Metals
- Cast Iron
- Iron Copper/Copper Steel
- Magnesium Alloy
- Nickel Alloy
- Filled Thermoplastic
- Plain Thermoplastic
- Refractory Metal
- Self-Lube Bearing Metal
- Steel, Alloy
- Steel, Carbon
- Steel, Free Machining
- Steel, Stainless
- Steel, Tool
- Titanium Alloy
- Zinc Alloy

Operations

- Anodizing
- Assembly
- Bar Feed
- Bending
- Blasting
- Cleaning
- Core Removal
- Deburring
- Grinding
- Hardening
- Heat Treating
- Honing
- Inspection
- Machining
- Marking
- Masking
- Measuring
- Packaging
- Painting
- Plating
- Polishing
- Pressing
- Repair
- Steam Treatment
- Welded Fab
- Welding
- Washing
- Wire Brushing
- Wire EDM

Should Cost Estimate

- Material
- Setup
- Process
- Rejects
- **Piece Part Cost**
- Amortized Tooling
- **Amortized Total**
- Tooling Investment

DFM analysis provides the information to make data driven design decisions.

Successful DFMA® Workshops

Purpose

Use DFMA® to collaboratively optimize design

Timetable

Conduct during early concept phase

Duration

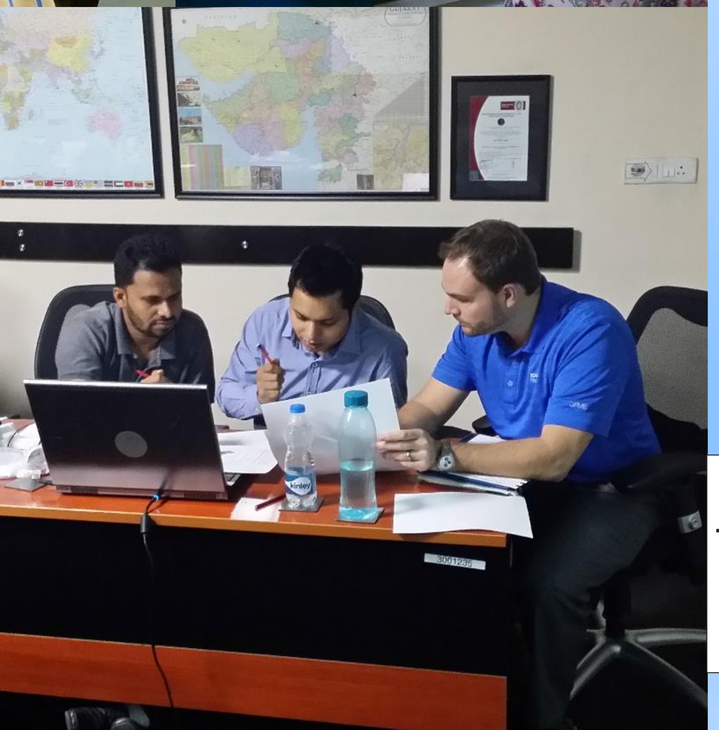
2-4 consecutive days

Attendees

4-6 cross-functional team members

Results

Cost reduction through product simplification
Comprehend the DFMA® language




Thanks For Your Time
Questions?
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