FMC Technologies

We put you first.
And keep you ahead.

Rolling Out DFx at FMC

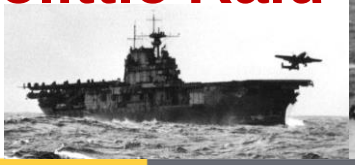
Bill Devenish – Global DFx Engineering Manager

James Harold “Jimmy” Doolittle (1896-1993)

Early Aviation Pioneer

His accomplishments include:

- **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)

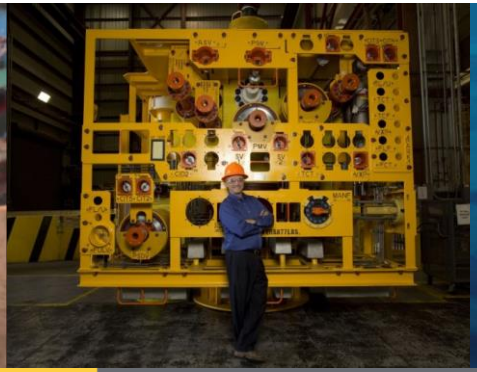
"In the early '20s, there was not complete support between the flyers and the engineers. The pilots thought the engineers were a group of people who zipped slide rules back and forth, came out with erroneous results and bad aircraft; and the engineers thought the pilots were crazy – otherwise they wouldn't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

… After schooling and working together for a year…

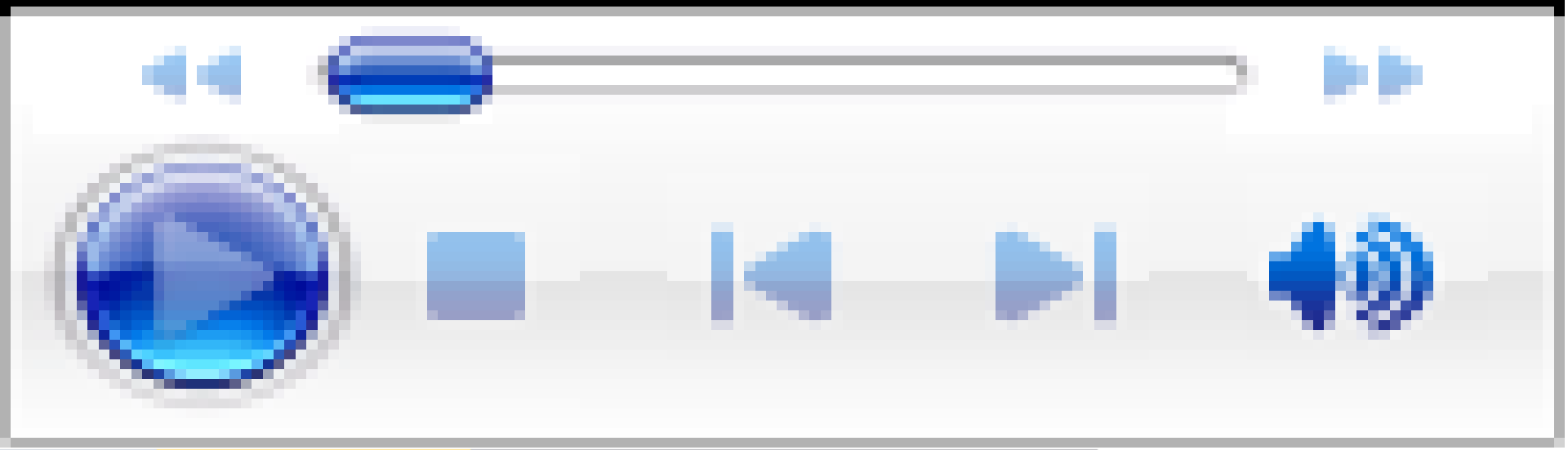
"I believe that there was thereafter a better understanding between pilots and engineers."

FMC Technologies, Inc.

Safety
Quality
Delivery
Cost

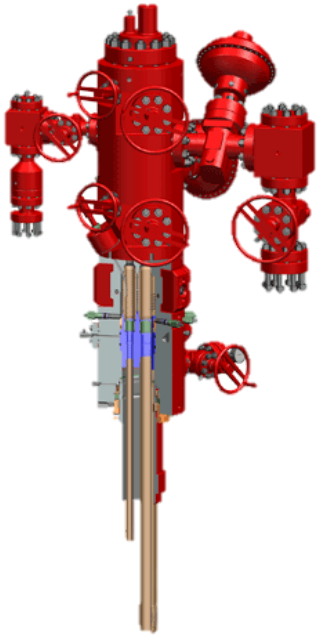


DFx at FMC



What is DFx at FMC?

DFx Optimizes Manufacturability Through Early Engagement



DFx = Design for Excellence

DFx = Design for “x”, where “x” is all desirable attributes

DFMA® is one of the tools used by DFx

What is a DFx Engineer at FMC?

A DFx Engineer is an experienced Manufacturing Engineer who participates in early product development

DFx Engineers are NOT highly paid drawing checkers

Global DFx Engineering Policy

GMEC Members:

- Site Mfg Engineering Managers
- Global DFx Engineering Manager

GMEC Sponsors:

- Global Manufacturing Director
- Global Product Line Director

GMEC = Global Manufacturing Engineering Council

Global DFx Policy — FMC Technologies

The formal DFx Vision states: *DFx provides expertise to optimize manufacturability through continuous collaboration during the development lifecycle.* This statement can be simplified to say: *DFx optimizes manufacturability through early engagement.* To fulfill this vision, a DFx Engineer is defined as an experienced Manufacturing Engineer who participates in early product development.

APPROVED

DFx Engineering Scope:

1) DFx Engineering resides within the Manufacturing Engineerin[illegible].
2) A DFx Engineer shall be assigned to all projects [illegible] manufactured and/o[illegible]ed pa[illegible]. Development is for new design and/[illegible]sign efforts, utilizing a[illegible] proce[illegible]s (i.e. machining, weldin[illegible]g, etc.) for creating parts.
3) DFx Eng[illegible]rge their time to the [illegible] n.
4) DFx [illegible]ngineering involveme[illegible] d at [illegible]esign [illegible] or Su[illegible]a, DFx activity begi[illegible] he [illegible] DFx [illegible] lso [illegible] as a fu[illegible] fu[illegible]tional te[illegible]

What DFx E[illegible]neers d[illegible]:

1) DFx [illegible]ngineers [illegible]luate a[illegible] monitor part and assembly design [illegible]anufacturability. During this activ[illegible] they id[illegible]uring risks. They also colla[illegible] Design Engineering, Cost Engineering and Value [illegible]ngineeri[illegible]
2) DFx Eng[illegible]ers participate in [illegible] Engineering authorization for release of parts and assemblies.
3) DFx Engine[illegible] and mentoring for Manufacturing Engineers and Design Engineers.
4) DFx Engineers support global DFx initiatives and local Manufacturing Engineering activities.

What DFx Engineers don't do:

1) DFx Engineers don't release designs.
2) DFx Engineers don't conduct hands-on manufacturing and production, including inspection.

SIGNATURES (GMEC Sponsors and Members)

Serena Jones: Global Manufacturing Director, Subsea-Dunfermline	Bob Sullivan: Global Product Line Director, Surface-Houston
Scott Squires: Manufacturing Technology Manager, Surface-Stephenville	Stuart Stout: Global Mfg Processes Manager, Subsea-Houston
Carlos Rawls: Manufacturing Engineering Manager, Subsea-Houston	Jeff Hallett: Manufacturing Engineering Manager, Surface-Houston
Bernardo Solé: Manufacturing Engineering Manager, Subsea-Rio de Janeiro	Wayne Thomson: Manufacturing Engineering Manager, Subsea-Dunfermline
Roy Andrè Weum: IVE Manager, Subsea-Kongsberg	Chia Sheng Fong: Manufacturing Engineering Manager, Subsea-Nusajaya
Yong Peng Koh: Product Manufacturing Manager, Subsea-Singapore	Bill Devenish: DFx Engineering Manager, Subsea-Houston — 17. Sep. 2014

Global DFx Engineers

DFx Vision

DFx provides expertise to optimize manufacturability through continuous collaboration during the development lifecycle

A DFx Engineer is an experienced Manufacturing Engineer who participates in early product development

Stephenville
Manufacturing Engineering Mngr:
Jim Logan
DFx Engineers:
Jaimes, Rafael (P/T)
Tanner, Wade (P/T)

Scotland
Manufacturing Engr Mngr:
Wayne Thomson
DFx Engineers:
Andy Anderson (P/T)
Colin Knight (P/T)
Brian Taylor (P/T)
Brian Young (P/T)

Kongsberg
Global IVE Mngr:
Roy Andrè Weum
DFx Engineers:
Jørgen W Hansen
Nils Olav Huseby

Houston (Surface)
Manufacturing Engr Mngr:
Jeff Hallett
DFx Engineers:
Jeff Hallett (P/T)

Houston (Subsea)
Manufacturing Engr Mngr:
Carlos Rawls
DFx Engineers:
Sridhar Bugudanahalli (Cont.)
Mai Nguyen
Juan Salinas

Rio de Janeiro
Manufacturing Engr Mngr:
Bernardo Solé
DFx Engineers:
Mônica Araújo (P/T)
Leandro Duarte (P/T)
Fábio Libardi
Kleber Stoffel
Marco Vinicius (P/T)

Nusajaya (Global Supply)
Manufacturing Engr Mngr:
Chia Sheng Fong
DFx Engineers:
Wai Hou Fum

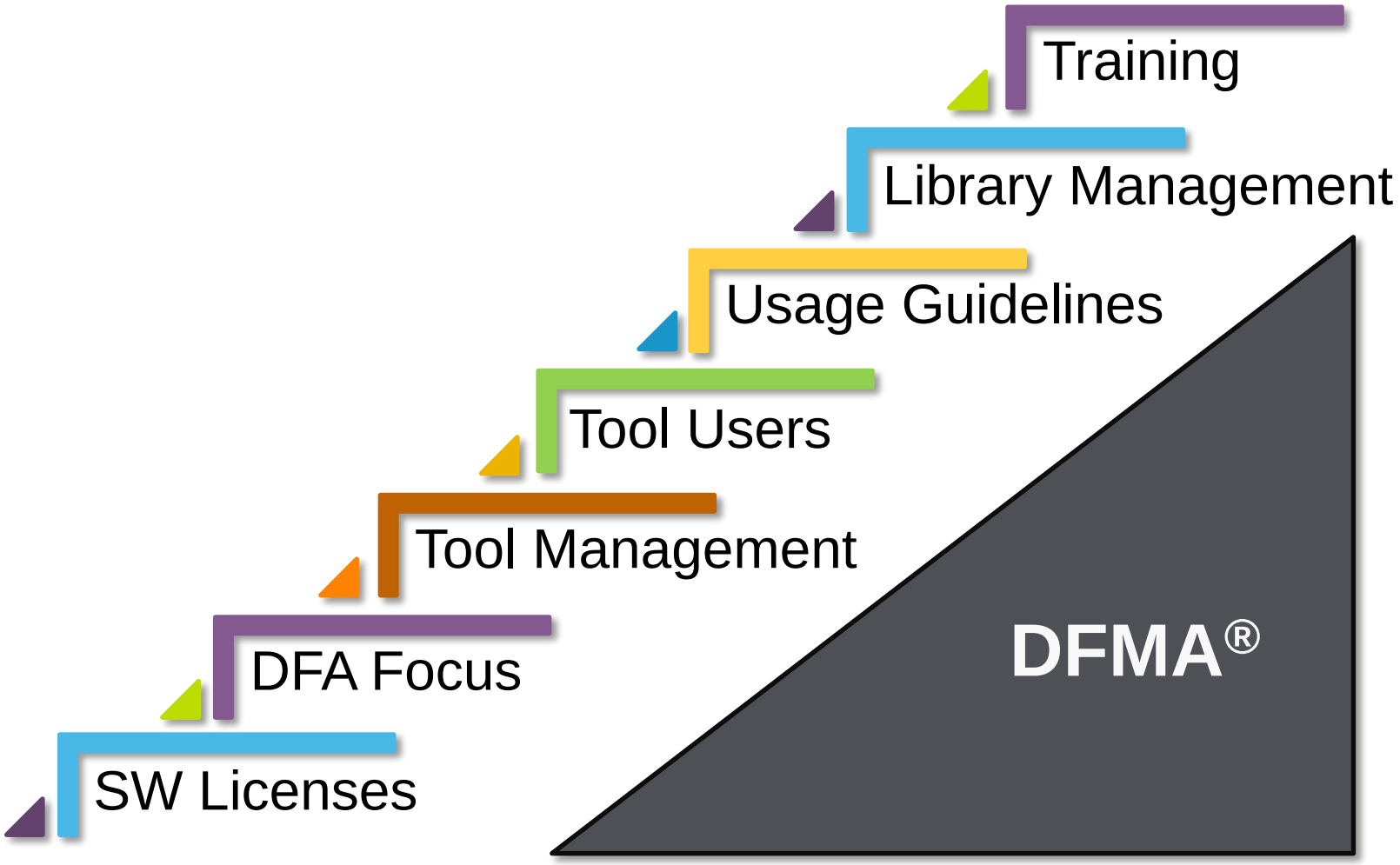
Singapore (Subsea)
Manufacturing Engr Mngr:
Chua Wee Meng
DFx Engineers:
Kum Weng Phoon
Alvin Yip
V. Sathiyan (P/T)

Singapore (Surface)
Manufacturing Engr Mngr:
Jaya Nettor
DFx Engineers:
DFx Engineer (TBD)

9 DFx Engineers (Full-Time)
11 DFx Engineers (Part-Time)
1 DFx Engineers (Contract)
1 DFx Engineers (TBD)
Global DFx Engineering Manager:
Bill Devenish

EDGE Coordinators
Nils Olav Huseby
Kum Weng Phoon
Kleber Stoffel

Implementing DFMA® within DFx

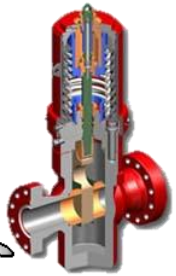


Training – DFx and DFMA®

Stephenville
DFMA® Training

Dunfermline
DFx Training

Kongsberg
DFx Training



Pre-Course = 46%

Post-Course = 76%

Houston
DFMA® Training

Houston
DFx Training

Singapore
Hyderabad
DFx Training

Rio de Janeiro
DFMA® Training

Rio de Janeiro
DFx Training

DFx Training

- 2 Days
- Audience: Design Engineers
- Taught by local DFx Engrs and SMEs
  - Materials
  - Machining
  - Forging
  - Welding
  - Assembly
- Information oriented

DFMA® Training

- 3 Days
- Audience: DFx, MEs, Teams
- Taught by global DFx Mngr
  - DFA
  - DFM
- Project oriented (Hands-on)

Knowledge Management

The EDGE

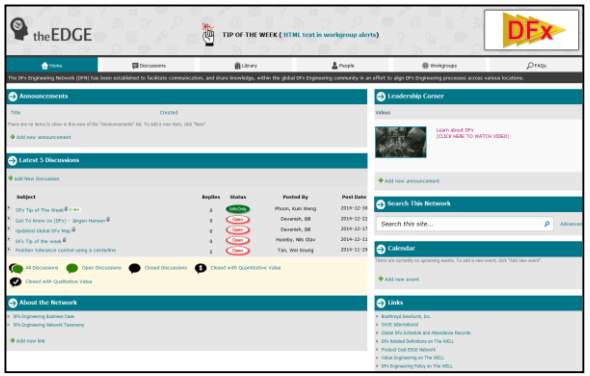
- Internal Blog Site
- Capture Discussions
- Question and Answer Forum
- Bidirectional Communication

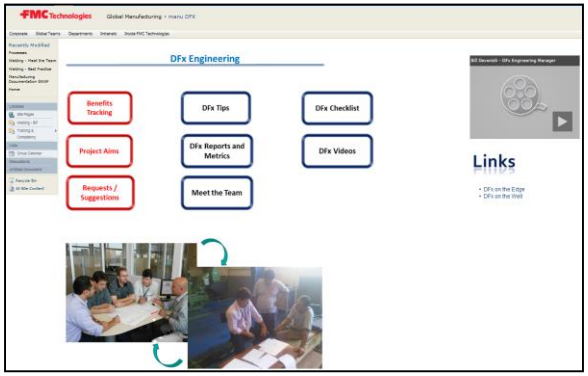
SharePoint

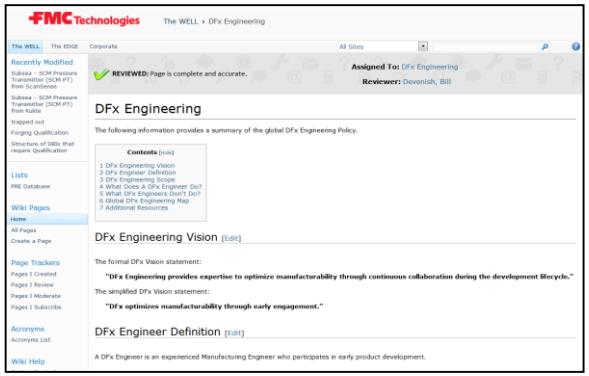
- Internal File Storage
- Control Files
- Archive files
- Bidirectional Communication

The WELL

- Internal Wiki Site
- Acronyms
- Definitions
- Explanations
- Unidirectional Communication





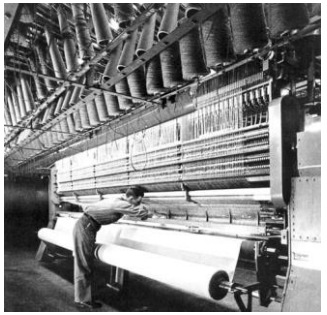


DFA Index Video

DFx Challenges

- No global reporting structure

- Insufficient time and resources for controlling DFMA® libraries



- Lack of early engagement
  - Engineering vs. Manufacturing
  - Part-time DFx Engineers have too much hands-on ME work

Success Examples

DFx Analysis of Compact Valve (Stephenville)

Baseline Analysis

- Total Assembly Part Count **100**
- Total Operations **100**
- Theoretical Min. Parts **26**
- Total Assembly Time **100.0 min**
- Total Process Cost **$100.00**
- Total Parts Cost **$100.00**
- DFA Index **4.2**

NOTE: The baseline numbers have been normalized to 100, with redesign numbers reflecting relative improvement.

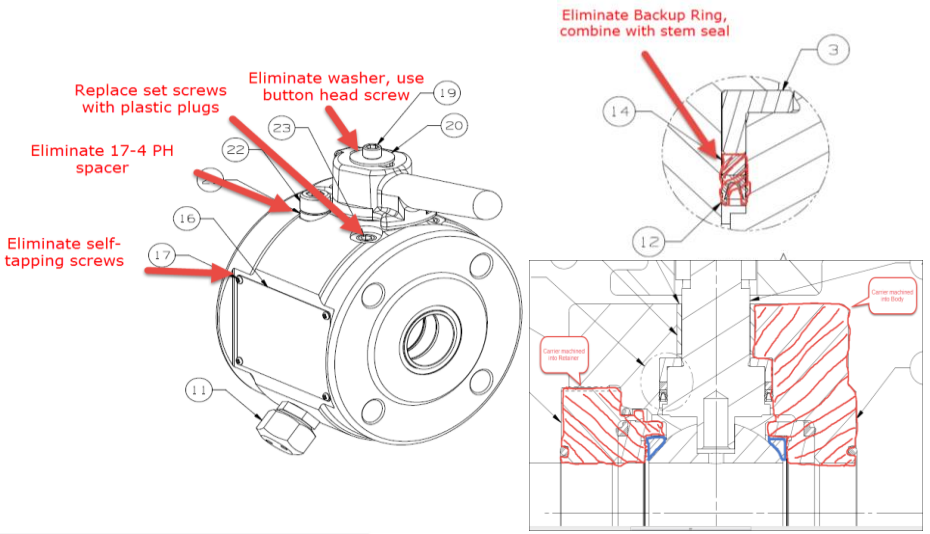
Redesign Analysis

- Total Assembly Part Count **65**
- Total Operations **94**
- Theoretical Min. Parts **26**
- Total Assembly Time **77.0 min**
- Total Process Cost **$77.00**
- Total Parts Cost **$97.00**
- DFA Index **5.5**

- 35% Part Count Reduction
- 31% Assembly Efficiency Increase
- 33% Capacity Increase

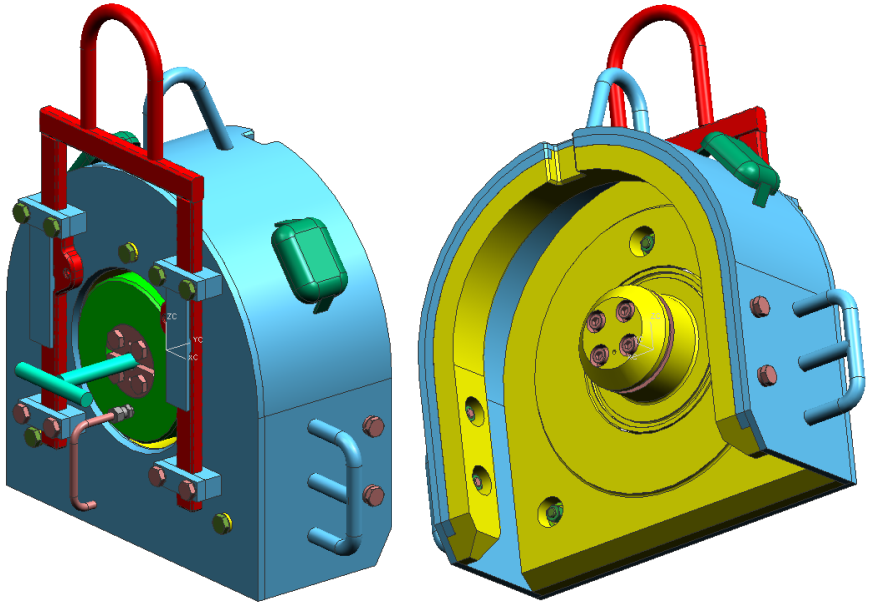
Improvement Suggestions

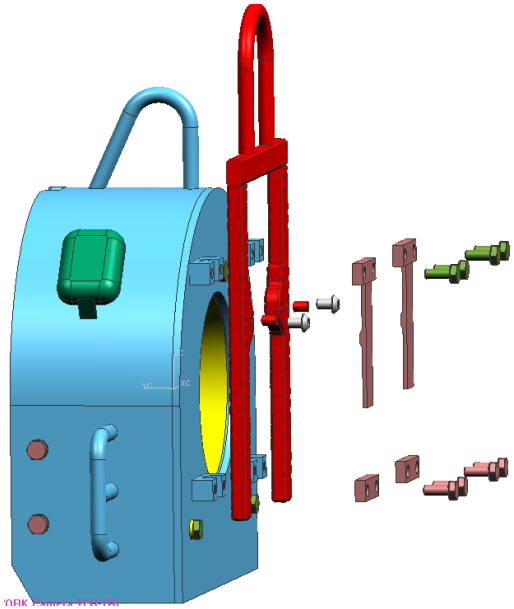
- Eliminate 3/16 spacer by using a slightly longer bolt (may be possible to remove)
- Replace 3 set screws with plastic plugs
- Replace the flange cover and 8 screws with a plastic snap on cover
- Eliminate Back-up Ring and combine into stem seal
- Add adhesive to name plate and eliminate 4 self tapping screws and hole in body
- Change the handle material to aluminum
- Eliminate washer by reducing handle inner Ø, replace cap screw with button head
- Investigate cost of lubricants used during assembly

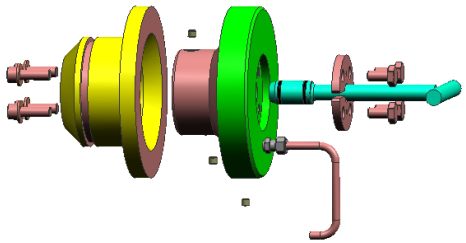


Design for Value Workshop (Rio de Janeiro)

DFA Analysis of Isolation Cap (Rio de Janeiro)







Suggested Changes

1) Combine the two Locking Strips into one part
   - Reduces associated Lock Washer, Hex Bolt and Torque operation

2) Incorporate Handle Guide into the Main Frame Housing
   - Eliminates associated Lock Washer, Hex Bolt and Torque operation

3) Combine the two Stab Plates into one part
   - Reduces associated Lock Washer, Hex Bolt and Torque operation

Results

- **Assembly Efficiency Increase**
  25%
- **Assembly Time Reduction**
  20%
- **Part Count Reduction**
  27%
- **Operation Count Reduction**
  27%

Rolling Out DFx at FMC

Abstract – 2015 DFMA® Forum

FMC Technologies, a global manufacturing company for the energy industry, recently introduced DFx functions to improve product design through early development engagement. Bill Devenish, the Global DFx Engineering Manager, is responsible for defining the DFx role and establishing processes to facilitate Design/Manufacturing collaboration, often across multiple sites around the world. Various Knowledge Management tools, including videos, are utilized to improve communication and capture information. Additionally, the roll-out of targeted DFMA training and tool usage definitions is beginning to increase the assembly efficiency of complex designs.

Bio – Bill Devenish

Bill Devenish, a long-time DFMA advocate, has over 25 years' experience in product development.

While R&D Manager at Nokia, he led the team that developed the first smart phone released in North America in 1998.

Bill has held engineering and management positions within small, large and mid-sized companies where he his focused on institutionalizing DFMA.

As the MAD Manager at Harris RF Communications, he championed the use of DFMA by a team of design, manufacturing and sourcing engineers who identified over $3 million in savings during their first training session.

Bill earned his B.S. degree in Engineering from Brigham Young University and an M.S. degree in Management from the Oregon Graduate Institute.

He has been awarded ten patents and has authored several papers on DFMA.

Currently, Bill is the Global DFx Engineering Manager at FMC Technologies.

Bill Devenish: Global DFx Engineering Manager

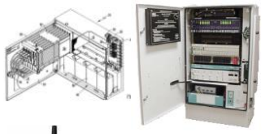
Brigham Young University
- B.S.
- Design Engineering

Oregon Graduate Institute
- M.S.
- Engineering Management

Florida Institute of Technology
- Graduate Certificate
- Systems Engineering

Motorola, Inc.
- Mechanical Engineer

NEC America, Inc.
- Sr. Mechanical Engineer



Nokia Mobile Phones
- R&D Manager

AirNet Communications
- Sr. Engineering Manager

Harris Corporation
- MAD Manager

QSI Corporation
- Director of Engineering

PCB – Larson Davis
- Engineering Manager

FMC Technologies, Inc.
- DFx Engineering Manager