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# Rolling Out DFx at FMC

## How DFMA® fits within DFx?

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**6/2/2015**

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.

## Introduction

FMC Technologies, Inc. is an $8 billion company that develops and manufactures production equipment for the oil and gas industry. The company employs approximately 20,000 people across the globe in numerous design and manufacturing centers. The products at FMC are complex structures that require high reliability in extreme environments, from the frigid tundra to the crushing depths of the sea and hellish temperatures at the wellhead.


The recent drop in oil prices has dramatically affected FMC's business. Customers are now expecting the same equipment and services be provided at deeply discounted prices. This new business climate is encouraging FMC to become more efficient and cost conscious. The bright spot is that recently introduced DFx Engineering efforts, along with the use of DFMA®, are helping FMC overcome this challenge.

## Defining DFx

A few years ago FMC made the decision to incorporate DFx activities within the product development process to achieve the goals of enhanced safety, higher quality, improved delivery and reduced cost. The first step was to define DFx and communicate that definition throughout the company.

FMC defined DFx as Design for Excellence, with the emphasis placed on optimizing manufacturability through early engagement. DFMA® is one of the tools used within DFx to simplify product design and make timely data-driven design decisions during the initial product design stages.

DFx Engineers are the critical component of DFx, and so the next clarification step in the journey was to define the role of a DFx Engineer. Aligned with the definition of DFx Engineering, a DFx Engineer is an experienced Manufacturing Engineer who participates in early product development. They provide real-time manufacturing feedback to the development team as a design concept begins to take shape. Often this happens at the white board or napkin sketch stage, well before CAD models and drawings are generated.

It is important to keep in mind that DFx Engineers are NOT highly paid drawing checkers. Early observations found that the DFx Engineers would review drawings prior to product release, find numerous production risks and cost improvements, and then be told that the design wasn't changing due to schedule constraints. This was an ineffective use of valuable resources, as well as demoralizing to the DFx Engineers. Emphasis has now focused on moving DFx Engineering involvement earlier in the stage/gate process where their input can be acted upon and a positive difference made.

DFx Optimizes Manufacturability through Early Engagement

To assist with communicating these definitions, a three minute introductory video was created and distributed. It introduced the concept of DFx, DFMA® and Value Engineering, illustrating how they work together to achieve product simplification. The video was shown in various meetings, posted on internal websites and distributed through email links to targeted audiences.

## DFx Authority

Once the definitions for DFx had been developed it was time to establish the DFx authority. A Global DFx Engineering Policy was crafted to define the scope and boundaries for DFx Engineering. First, it should be mentioned that DFx Engineering is managed through the manufacturing organization. This ensures that the DFx resources don't lose their identity and become totally absorbed as design engineers into the development teams. Therefore, the DFx Policy was reviewed and approved by all members of the Global Manufacturing Engineering Council, also known as GMEC. The GMEC is comprised of Manufacturing Engineering Managers representing the numerous manufacturing sites around the globe. The ME Managers are also the functional line managers for the DFx Engineers at their site. Additionally, the DFx Policy was supported and approved by the Global Manufacturing Director and the Global Product Line Director who are the primary sponsors of GMEC. A variety of internal tools were utilized to communicate the Global DFx Engineering Policy companywide.

DFx Engineers are located in design and manufacturing centers around the globe. The global network consists of a mix of full-time and part-time DFx Engineers. The full-time DFx Engineers devote most of their time to numerous development activities, with a small portion of their time spent in hands-on manufacturing activities. The part-time DFx Engineers primarily support manufacturing and are only occasionally engaged with early development teams. FMC's long-term goal is to transition the part-time DFx Engineers to full-time roles as a way of providing DFx support to more project teams.

A Global DFx Engineering Manager leads the network of DFx Engineers. Emphasis is placed on coordinating global DFx activities, creating global DFx processes and developing tools to improve DFx effectiveness. Design for Manufacture and Assembly, also known as DFMA®, is one of the tools beginning to be used by the DFx Engineers at FMC to help improve their effectiveness and provide information for making data-driven design decisions.

## DFx / DFMA® Implementation

DFMA® was a new tool for the DFx Engineers. To utilize it effectively, careful preparation was required for its use and adoption. As the planning commenced, it was discovered that a location in Scotland had previously acquired three floating site licenses of the DFMA® software from Boothroyd Dewhurst, Inc. All three licenses remained unused due to lack of experience with the tool and the other locations had no awareness of its existence.

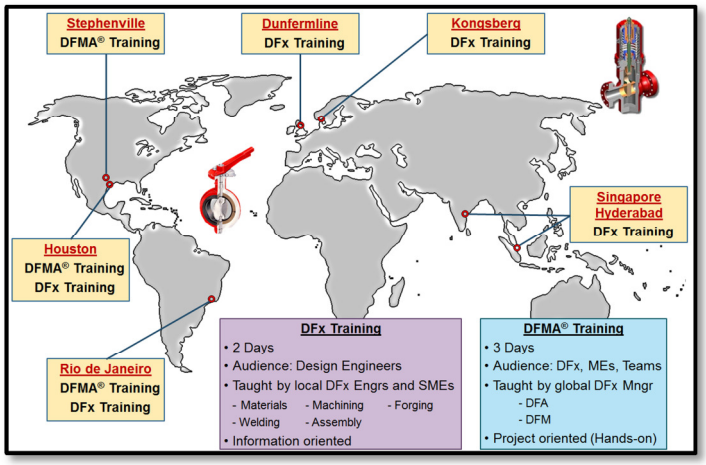
Evaluations were made of the various global sites to determine which three would be appropriate for sponsoring and using the existing software. The initial focus was on the DFA portion of the tool. Therefore, the criteria included locations with higher volume assemblies, combined with enthusiasm from the local DFx Engineers to learn and utilize the tool. The decision was made to locate the licenses in Rio de Janeiro, Brazil, as well as Houston and Stephenville, in Texas.

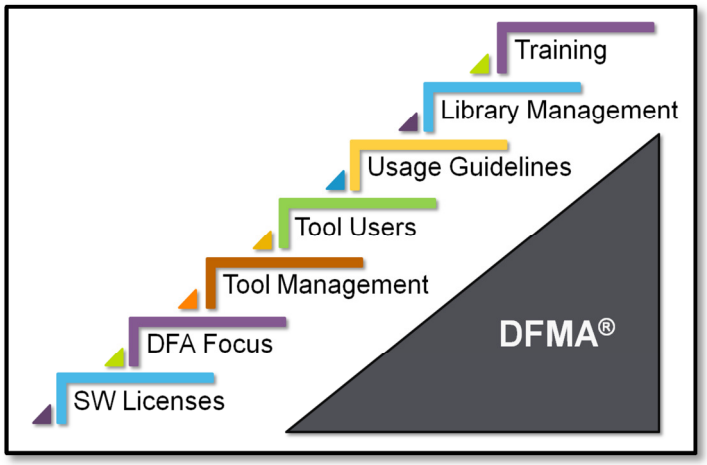
A DFx Engineer is an experienced Manufacturing Engineer who participates in early product development

It was also decided that the primary user of the DFMA® tool would be the DFx Engineer. This would allow the DFx Engineer to become the tool expert, using the tool to guide collaborative discussions within the development team. This also eliminated the initial need for additional licenses and reduced the amount of training required to make use of the tool. The Design Engineers, unencumbered with learning another analysis tool, were then allowed to focus their attention on designing and achieving the technical requirements.

Rolling out DFx at FMC has revolved around two training courses. The first is a two-day DFx Training course. It covers the manufacturability topics of machining, materials, welding, forging and assembly. The primary target audience is the design engineering community, with over 1,000 engineers attending the class so far. The course is taught by the DFx Engineers and Subject Matter Experts. It is information oriented with the material being presented through slides, videos and factory tours. Tests are administered before and after the class. The scores for the pre-course assessment average 46%, while the post-course test scores average 76%. This indicates a 65% knowledge increase in basic manufacturing processes. More importantly, the course helps the engineers identify where to obtain detailed manufacturing information.

The other training course is a three-day DFMA® workshop that has the dual objective of providing DFMA® tool training coupled with actual product design improvement. The class, therefore, is project oriented and primarily hands-on. Currently it is taught by the Global DFx Engineering Manager and teaches how to use the DFMA® software for conducting DFM and DFA analysis. The primary target audience includes DFx Engineers, other Manufacturing Engineers and project teams.




Additionally, the DFx community is making use of newly introduced knowledge management tools within FMC. One of these tools is an internal blog site known as The EDGE. DFx Engineering established an area on The EDGE that offers a forum for bi-directional communication. It provides the opportunity to capture discussions in a question-answer format. The discussions are followed by all members of the DFx EDGE network.

Another communication tool recently implemented by FMC is an internal Wiki site called The WELL. This broadcasts information unidirectionally. DFx has made extensive use of this tool to provide definitions for DFx acronyms, along with explanations for commonly used DFx terms. Basic DFMA® information has been posted that explains Minimum Part Criteria and the DFA Index. Videos are also available on The WELL to illustrate some of the basic DFx concepts.

## DFx Challenges

The roll out of DFx at FMC has faced a few challenges. First, there is no global reporting structure for the DFx Engineers. Since they report to their local Manufacturing Engineering Managers their priority is focused on meeting local production needs. This provides little time set aside for supporting global coordination and improvement activities. Another aspect of this challenge is that many of the part-time DFx Engineers are tasked with too much hands-on ME work which hampers their ability to get involved in early product development. They are usually too busy fighting production fires. Work is now underway to create long-term career and succession planning in an effort to transition the part-time DFx Engineers to full-time. Acquiring senior management support is also beginning to help with setting priorities for both sets of DFx Engineers.

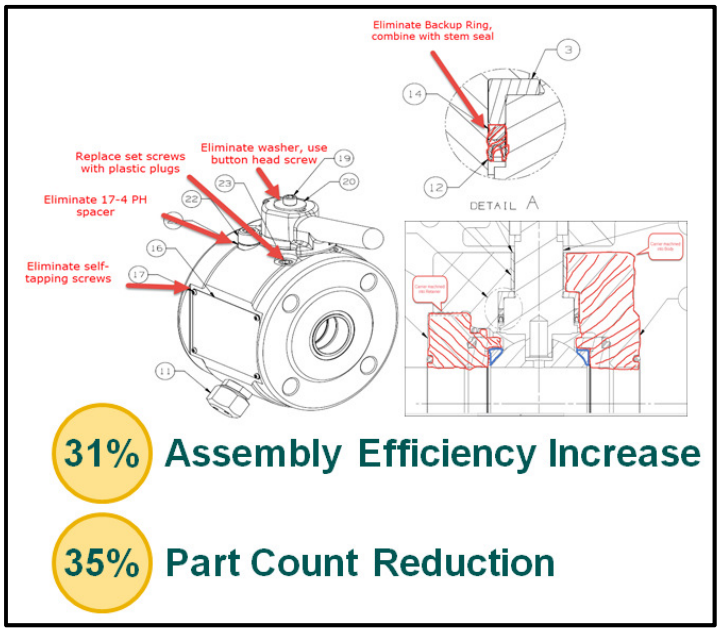
The second challenge is insufficient time, and resources, to develop and validate the DFMA® libraries for FMC specific operations and equipment. Plans are being made to address this before a large number of files are created and a variety of processes and conventions have been adopted at different locations.

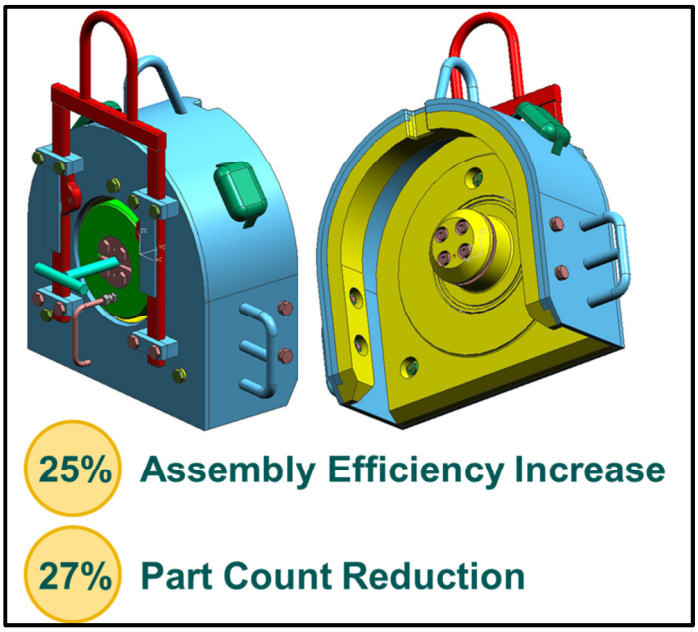
A third challenge is the traditional lack of early manufacturing engagement. Both sides, engineering and manufacturing, know that early involvement needs to happen, and they desire to do it. The difficulty lies with both sides not knowing how to do it. DFx checklists and guidelines are helping to bridge the gulf between the two functions, but the critical tool for encouraging early collaboration has so far been the use of DFMA®. The tool provides an avenue for both sides to evaluate early design concepts together as they use their combined experience and skills to answer the questions posed during the analysis.

## DFx Successes

Far more significant than the challenges are the successful results that DFMA® is having within the DFx organization. Last year a DFMA® training workshop was conducted in Stephenville, TX. The primary goal was to provide DFMA® training for two of the part-time DFx Engineers. Since the three-day workshop was a hands-on activity, the training centered on a project to redesign an existing Compact Valve assembly. This was a product that had been around for many years, and was expected to continue shipping for many more. The product engineer and knowledgeable assembly technician also participated in the event. Their input proved to be invaluable as details of the assembly were revealed.

At the end of the workshop, the part count had been reduced 35%, and the DFA Index increased 31%. The primary design improvement focused on the ability to assemble and ship 33% more products with the same floor space and personnel.




In the fall of 2013, an on-site DFMA® and Value Engineering training workshop was conducted in Rio de Janeiro, Brazil. While many ingenious improvement ideas were developed in the workshop, it was held too late. Material had already been ordered and the project schedule didn't allow for radical changes to be made. However, in attendance was a DFx Engineer whose primary job role focused on assembly. After the workshop he became an advocate for engaging DFA analysis early in the concept stages of design.

A few months after the initial workshop in Brazil, the DFx Engineer began working on a project team tasked with designing a new Isolation Cap for an upcoming Manifold product. The design concept was still in the early stages and only consisted of preliminary CAD models. No part numbers or drawings yet existed.

This set the stage for additional DFMA® training through a series of hourly web-based meetings during a three week period. Once the baseline DFA analysis was completed, and alternative ideas compared, the team identified opportunities to reduce part count by 27% and improve assembly efficiency by 25%. The redesign ideas were generated early enough to be adopted by the development team without impact to the project schedule.

The success of these efforts demonstrated the benefits of early DFMA® involvement. As a result, DFA analysis is now part of the process for the DFx Engineers in Brazil to perform on early design concepts. Also, they are becoming proficient at using the tool. Other locations within FMC are now starting to take an interest in utilizing DFx resources in the early phases of their design projects.

## Conclusion

DFx Engineering is becoming an influential role during product development at FMC, and the use of DFMA® is proving to be a critical tool for the DFx Engineers. Awareness and understanding is increasing as FMC works toward full DFMA® implementation within the DFx role. It is also fostering a collaborative environment for optimizing product design. FMC expects to continue experiencing positive results as it institutionalizes DFx to overcome the current industry challenges and reach their goals of enhanced safety, higher quality, improved delivery and reduced cost.