DFMA at Dynisco...Sooner vs. Later

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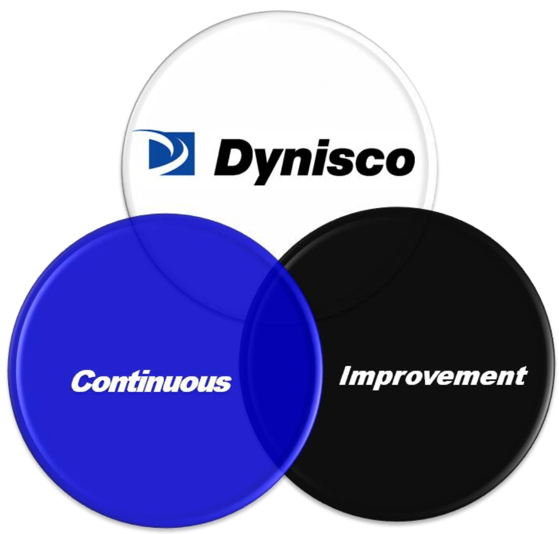

Abstract

Dynisco is relatively new in its use of the DFMA philosophy and supporting software but is realizing the positive effects of performing DFMA earlier in the new product development process. This paper will focus on the benefits of performing DFMA on designs sooner rather than later. It will cover the struggles organizations face with premature time to market decisions as well as the shortfalls in expected profits when a heavier focus is placed on cost reductions after a product is launched. This paper will also review a project with and without DFMA applied and describe the techniques being used to achieve the benefits associated with adding DFMA to the engineering tool box.

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Introduction

Design for Manufacture and Assembly (DFMA) is a philosophy and tool that when properly applied can generate grand results in the release of new products. The philosophy component helps to establish the thought process around simplifying a particular design or product. This simplification is achieved through the belief that less can be more. The tool component consists of structured activities that help reduce part count by applying standardized design related questions, discussing part geometries, and understanding the assembly sequence of a particular sub-assembly or assembly. Merged together, these activities can drive new design concepts while at the same time improving the overall profitability of the product.

Several challenges of applying DFMA are "when," and at what stage of the design. If used early enough and with other supporting tools, designs can be dissected in order to better understand component dependencies and function, potential downstream quality issues as well as cost drivers for materials and design components. If applied too late in the process, the effort results in a list of opportunities that will most likely not be acted upon.

Influence on Product Release

There are many forces both internal and external which influence the release a product into the market place. As launch pressure increases, the timing at which to release the product becomes more critical. Influences such as replacing legacy products or the need to complete an internal deadline generate a certain level of pressure from which designers must respond. As pressure increases due to bigger influences or forces the desire to release a product becomes greater and greater. Changes in product requirements, the opening of a new market or growth opportunity, or the surfacing of a new competitor or competitor product have even a bigger impact on the decision of when to launch.

In any of the instances listed above, the form, fit, and function must be fulfilled in order to ensure that the product meets the specifications defined by the customer or market. In addition, cost must be considered in order to achieve the profitability or gross margin desired. The main difference between form, fit, function, and cost is, cost targets can be deferred in an effort to release a product faster. The thought process is that cost reduction efforts will help drive costs down and profitability up at some future time after the product has been introduced. The fact that cost can be driven out of a product after it has been released is a true statement, however the amount of cost that can be driven out after the fact is significantly lower when compared to the results of performing DFMA sooner rather than later. The upcoming sections will examine the different opportunities and positive impacts when DFMA is applied earlier in the process as opposed to waiting to perform cost reduction efforts a later time.

Product Development Process

Businesses that are involved with developing products of various types possess some sort of product development process. Some are less formal requiring an occasional design review before product release, while others are more formal requiring specific deliverables and signatures before moving to the next stage of the design process. In either case, the common thread is that there is a timeline, some element of review and a release.

When I initially started in my role as Director of Product and Process Improvement, I was interested in examining the ES&C Product Development Process at Dynisco. I was even more interested in identifying if Dynisco had integrated any Design for Manufacture and Assembly efforts within the process. After some research, I was pleasantly surprised to find a requirement for a DFM report within the established stage gate process. I was somewhat disappointed however to find out that the requirement was associated with the Gate 4 release (Figure 1). This prompted the question… What design engineer would modify his or her design so late in the game, and if so how beneficial would those changes actually be?

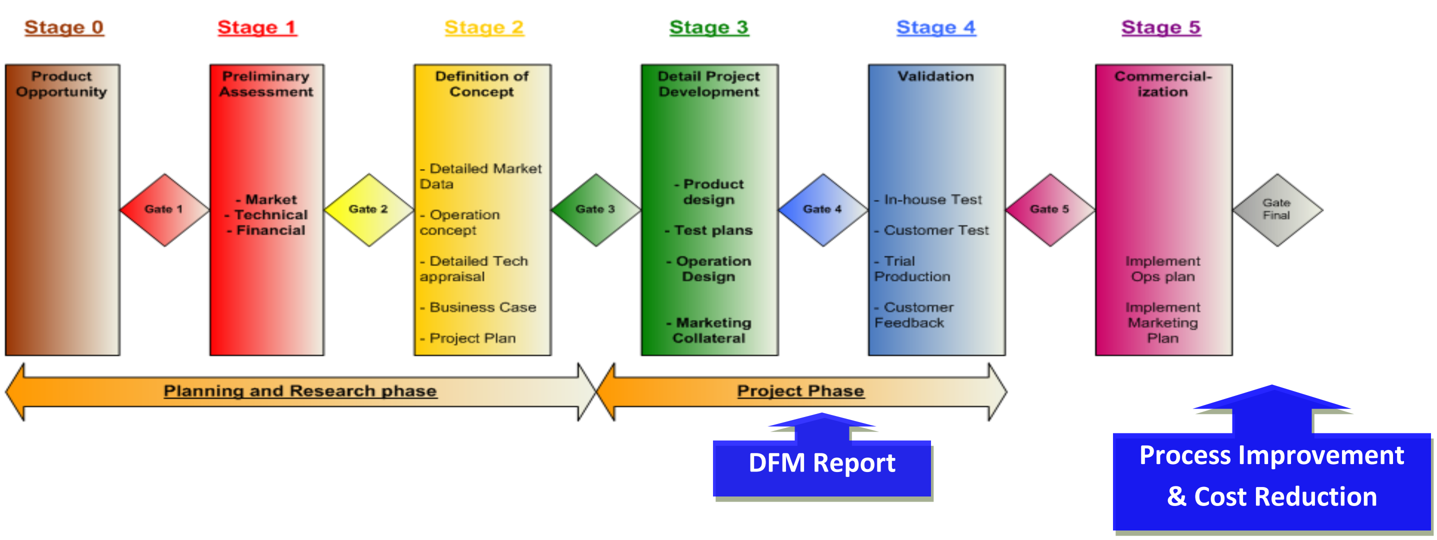


Figure 1- Dynisco Product Development Process (Original)

For those familiar with the Design for Manufacture and Assembly philosophy, it should be safe to assume that there is also an understanding that, "Design Drives Cost". As the effort progresses from concept to prototype to design, to product, costs generally increase due to the influence of the designers involved. Materials are selected, processes are established, labor is assigned and overhead is allocated, all in an effort to release a product to customers. As the timing of the DFM report requirement was challenged, we realized that we were missing the opportunity to positively influence not only the design, but the downstream costs associated with the design. We also discovered that part count and design function become more dependent on each other as the design progresses further downstream in the design process (Figure 2). In other words, costs became harder and harder to influence and or reduce within the design because the components, more specifically, the number of components become locked into the function as the design progresses. Once this occurs, designers are much more reluctant to try to eliminate parts once the parts are associated with the function of the design / product. The opportunity to impact the product cost and associated overheads significantly diminishes.

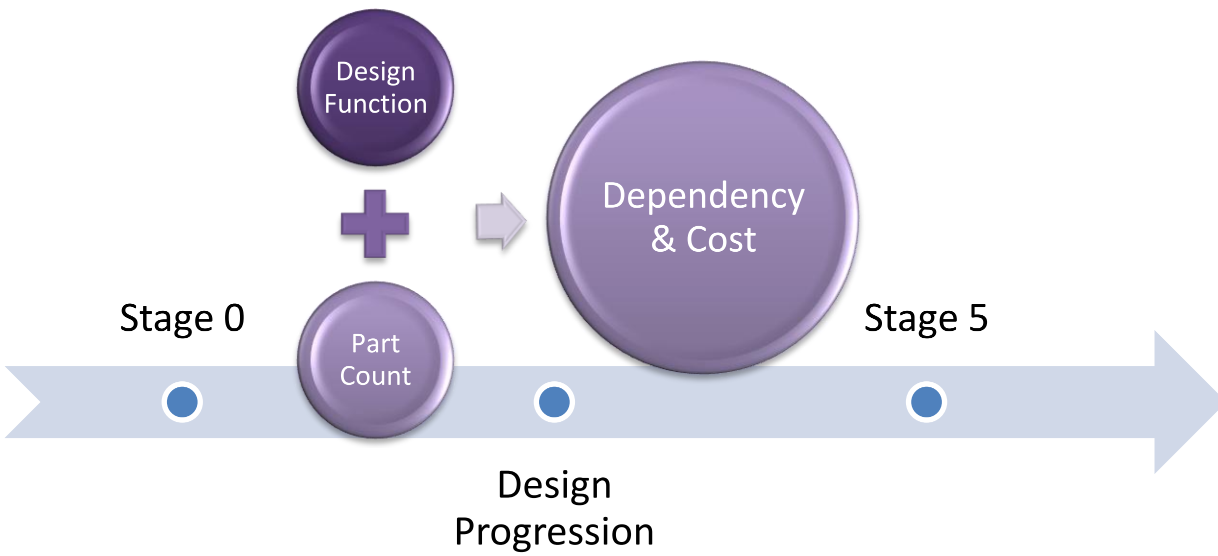


Figure 2- Part Count and Design Function Dependency

As our design community became more educated and comfortable with Design for Manufacture and Assembly principals, we began to move the DFMA reviews further upstream in the process. Design reviews were transformed from an engineering specific gathering to a multi functional team approach activity. Engineering, Manufacturing, Quality, Product Management, Sales and in some instances external suppliers were all invited to participate in the review. As the basic principles of DFMA were applied, part count was challenged using the "Candidates for Elimination" process. This process is based on the DFMA principals of part count reduction, where the designers must answer the following questions:

- Does the part have to be separate due to material compatibility issues?
- Does the part have to be separate because it moves relative to other parts?
- Does the part have to be separate for assembly or disassembly purposes?

If the answer to any of these questions is, “yes” then the part is considered a, “required” part. Alternatively, if the answer is “no” then the part should be challenged by the design review team and identified as a candidate for elimination.

The design review team found that the Design for Manufacture and Assembly software developed by Boothrooyd and Dewhurst provided a structured approach to review part count, possible assembly issues, initial cost data and estimates on assembly time. More importantly, the structured approach of the software helped facilitate ideas for design alternatives which were captured in real time within the software package.
As the organization matured in its understanding of what DFMA was, and how to incorporate it into the design reviews, we redirected our focus toward the implementation of DFMA from an organizational perspective. The design review teams became more and more comfortable with the DFMA tool, but lacked the understanding of the preparation needed prior to the DFMA review, as well as the post work, which included metrics capturing part cost, part count, assembly cost, assembly time and function enhancement. This gap was addressed by educating the design review teams on Systematic DFMA Deployment (1). Dr. Shipulski worked with our Continuous Improvement Team and developed a tailored presentation which was based on a workshop that he hosted at the DFMA forum back in 2010. The training focused on setting up and tracking metrics that would allow the team to observe progress throughout the design. He utilized Dynisco specific examples to optimize the concepts presented in his training.

As a result of the early wins with DFMA and a better understanding of how to integrate the various facets within the design reviews, the Product Development Process was modified to include benchmarking, Pareto baselines, multiple DFMA reviews and process improvement plans (Figure 3).

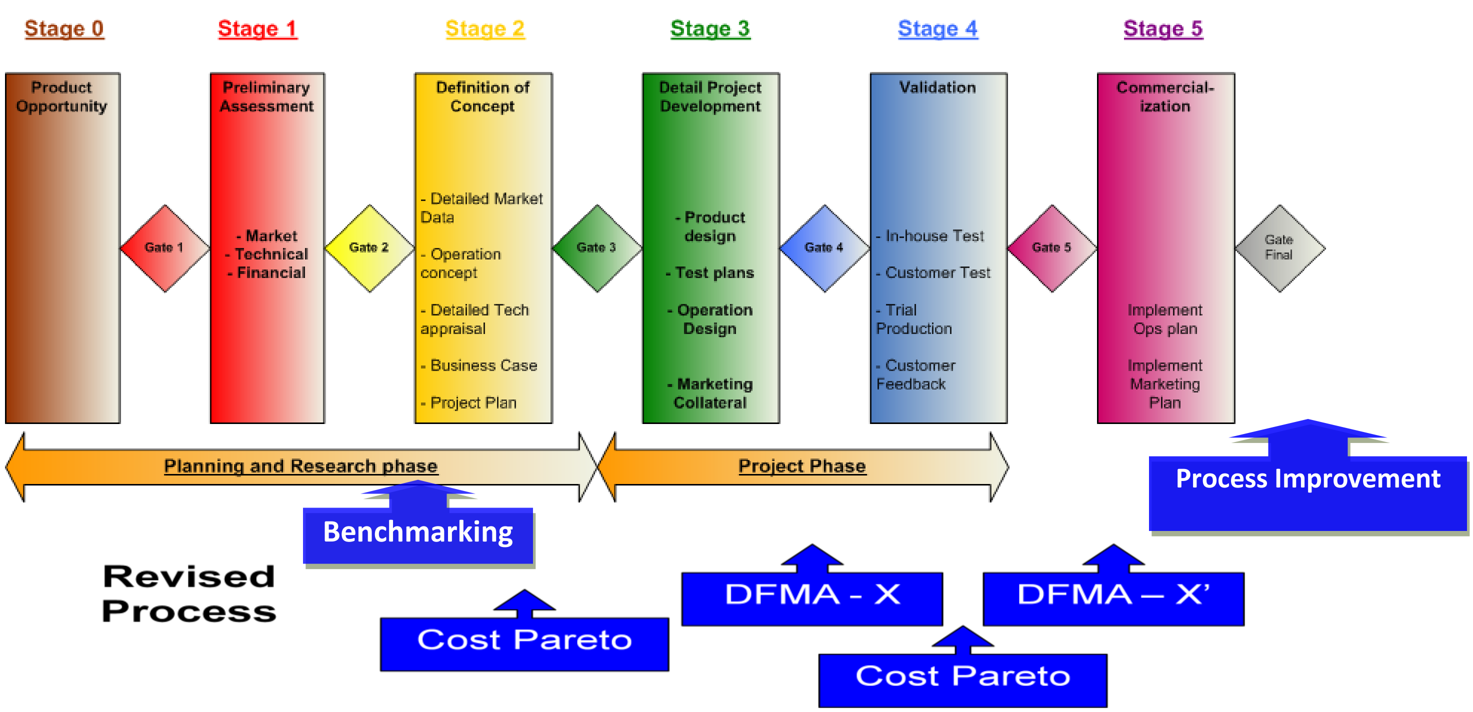


Figure 3- Modified Product Development Process

DFMA vs. Cost Reduction

The Design for Manufacture and Assembly process has a direct correlation to the costs associated with a new product and its release into the market place. The main difference between DFMA activities and Cost Reduction efforts is in the timing of when they occur. DFMA is a pro-active approach of developing an understanding of what drives cost within a design i.e. components, materials, processes, while traditional cost reduction is more of a reactionary approach initiated after the design has been released into the market place. The focus of the cost reduction activities is namely in the space of part price variance (PPV), volume discounts, and establishing "bidding wars" between suppliers in the hopes of achieving a lowest component price scenario. Another differentiating factor is in the level of involvement of various functions impacted by the design decisions leading up to the final release of the product. In the DFMA approach, many more groups are included within the discussion regarding the design (Table 1). The downstream stakeholders have an opportunity to preview the decisions being made about the product. Information regarding material selection, vendor selection and preliminary manufacturing processes can be shared across functional boundaries and experts within the various groups can be consulted appropriately. Many of the decisions influencing product cost can be discussed in the early stages, avoiding potential cost pitfalls downstream.

Stakeholder Involvement and Influence on Design Cost

Function	DFMA	Cost Reduction
Engineering	X	
Marketing	X	
Supply Chain / Purchasing	X	X
Operations	X	X
Quality	X	
Suppliers	X	

Table 1

One of the turning points that prompted Dynisco to examine the DFMA approach to driving cost out of our products was during the early stages of a new sensor design. Between stages 2 and 3 of the Product Development Process, there had been multiple concepts reviewed. The design team initiated multiple DFMA sessions in an effort to spark some creative alternatives as well as to develop a cost base line from which to improve upon. The team conducted 3 design reviews on one of the major sub assemblies. Unique parts, materials and manufacturing methods were reviewed for all three design options. From a functional standpoint, all three options appeared to be viable based on the research performed by engineering.

Initial target costs for the product were established and cost Paretos were created for each sub assembly option. As parts were eliminated and or combined and manufacturing methods were established and revised, the costs associated with the sub assembly redesign dropped significantly. The following graph shows the relationship of part count reduction to cost in the various DFMA efforts (Figure 4).

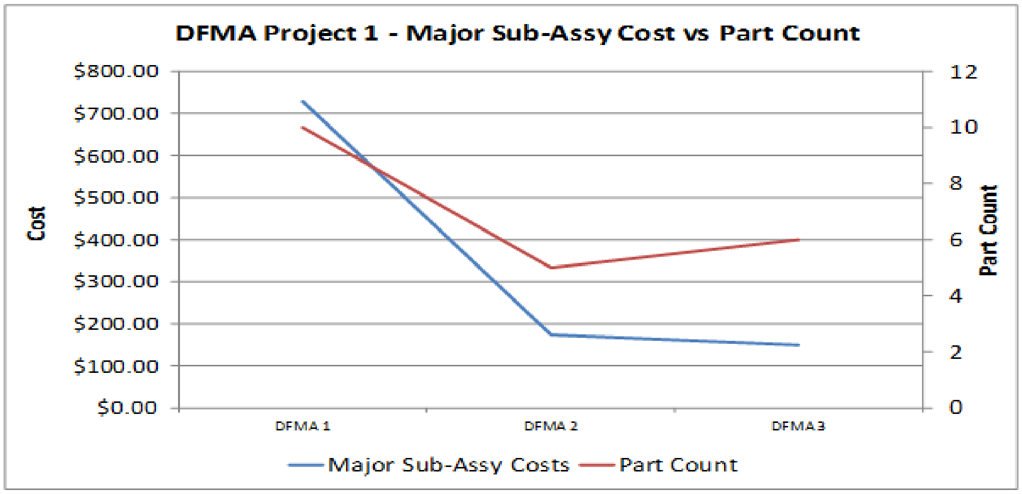


Figure 4- Part Count Reduction and Influence on Sub Assembly Cost

In an effort to build more of a case to support DFMA efforts in the early stages of the design, a comparison was established and reviewed with the executive staff in August of 2011, on the value of performing DFMA earlier vs. cost reductions later. Two scenarios were presented in order to reinforce the value of driving out design cost rather than relying on cost reductions to help improve profits and gross margins of products. It was demonstrated that if the sensor had been released to the market without taking the time to perform DFMA multiple times, the potential savings "might" have been approximately $140. This assumes that the purchasing agents could work with the vendors to take cost out over time. Performing the DFMA up front allowed the team to reduce the number of parts and modify the manufacturing processes which resulted in an actual savings of $530 which is realized right at the product launch. Table 2 summarizes the impact of eliminating parts and driving out cost in the early stages of design. In addition it should be noted that that the profit per unit using the DFMA approach is immediate upon release of the design. The refinements made to the design using DFMA enable the profit delta to be achieved on the very first unit sold. The profits associated with cost reductions are not realized until a later time after the design has been released. This could mean the difference in thousands or millions in company profits depending on volumes.

Scenario	Cost at Release		Final Results
1) Sub assembly released without DFMA effort	Approximate Sub assembly cost at release - $700	Cost Reduction effort undertaken – 20% savings achieved **within 6 months of product release**	Final Cost Achieved - $560 ***$140 – to bottom line profits of product***
2) Sub assembly released utilizing DFMA	Approximate Sub Assembly cost at release - $170		Final cost achieved - $170 ***$530 – to bottom line profits of product***
		Profit Delta	**$390 per unit**

Assumption:

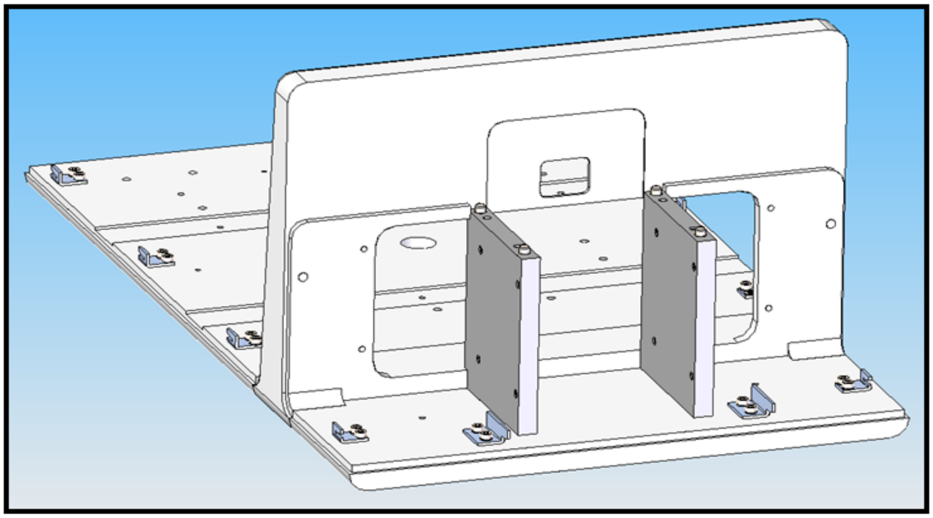
1) Supply chain could achieve a 20% cost reduction thru traditional means of negotiation with suppliers

Table 2

Real World Examples

As we branched out our DFMA efforts to other businesses within Dynisco, additional examples of the benefits of applying DFMA earlier surfaced. In the case of Alpha Technologies (Dynisco's business that focuses on rubber and composite measurement instrumentation) one particular product was being "refreshed" in order to gain better market acceptance. In an effort to speed up the redesign process, a portion of the work was given to an outside design firm. The design firm was tasked with developing a base that was aesthetically different from the older design. The outside firm provided a proposal that did not utilize DFMA concepts. Although it met the requirements for a different look and feel, material selection, component parts, assembly times and tolerance requirements drove costs higher than expected or desired. The base consisted of 62 parts, an expensive and difficult to source aluminum material and incorporated assembly time and assembly cost into the part. The initial base assembly design proposal is summarized in Figure 5.

Base Assembly (Initial Design)

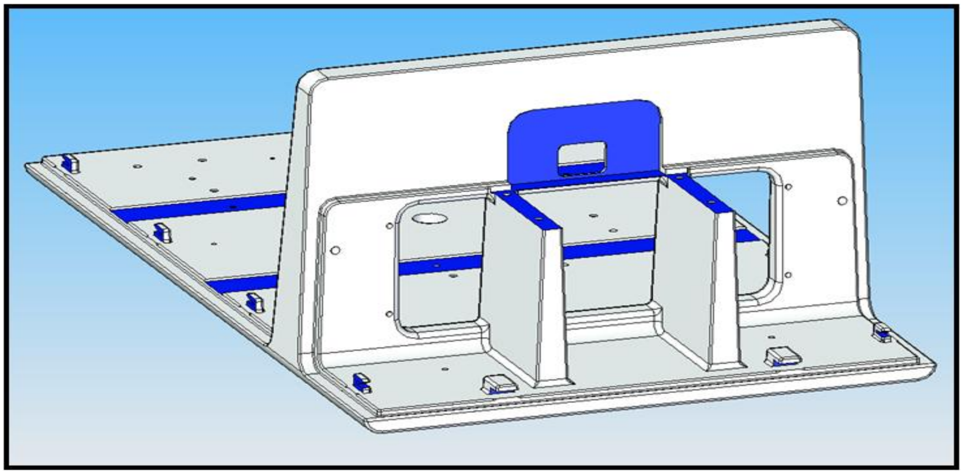


Part Count, 7 PN's:	62
Material:	MIC-6 Alum. Plate
Material Cost:	$5.00/lb
Tolerances (63 Fin):	+/-.005
Assembly Time:	14 minutes
Assembly Cost:	$26.74
Total Cost:	$567.68
Production Life Cost: $283,840 (10 years, 50 units/year)	

Figure 5- Base Assembly – No DFMA

Although there was pressure to release the design in order to get it into the marketplace, the internal design team was given time to review the base assembly in an effort to improve what was proposed by the outside firm. By utilizing and applying the DFMA principals, the team was able to significantly reduce the cost of the base assembly, while maintaining the form, fit, function and aesthetic requirements, (Figure 6). The most significant change between the two proposals was the manufacturing process chosen for the 2^{nd} design alternative. The original design consisted of a fabricated plate which was machined, uprights, which also required machining, and retaining clips that were secured with washers and screws. The new proposal was cast with only the critical features machined. The retaining clips were cast into the part thus eliminating the need for separate clips, screws and washers. As a result of this change, the assembly time which was originally 14 minutes, was reduced to zero. Most importantly, the cost of the part was reduced from $567.00 to $186.00. This represents a 67% reduction in part cost. Had the team not been given the time to review the design, the base would have been released at the higher cost, leveraging only PPV and volume discount efforts as a means to improve the profitability of the product.

Base Assembly (DFMA Design)



Part Count – 1
Material: A356-T6 Alum.
Material Cost: $2.50/lb
Tolerances: As required
Assembly Time : 0 minutes
Assembly Cost : $0
Total Cost: $186.10
Production Life Cost: $93,050
(10 years, 50 units / year)

Figure 6- Base Assembly after DFMA

Conclusion

There are many internal and external forces that influence the decision to release a product into the marketplace. Some of these are true drivers, such as competitor pressure while others are more mandate driven. In either case it is important to evaluate the design from a form, fit, function and cost perspective. In order to do this effectively, DFMA must be integrated into the product development process. It is not only imperative that it is integrated into the process but integrated at the proper time(s) within the process. Performing DFMA sooner rather than later enables more key stakeholders to provide insight from their perspectives, and expertise, and enables changes to occur while product function and component parts are still somewhat decoupled. Designers are often more open to change earlier in the process. As the parts and function become more dependent on each other, the chance for change diminishes.

It was also shown that traditional cost reduction efforts after a product launch, although effective, do not influence the overall profitability as effectively as applying the DFMA techniques early in the process. There is a enhansed up front lever on cost, profitability, and gross margin when DFMA is applied. Once part count, function and cost are locked in, the levers to influence product cost shift to the abilities of the buyers and supply chain specialist rather than the designers who have the most influence.

Dynisco has witnessed firsthand, the benefits of the DFMA philosophy by modifying their Product Development Process and providing the upfront time to apply a team based approach to the design review process. The “Sooner vs. Later” approach is enabling new product launches to exceed target launch costs and drive significant improvements in gross margins while developing more collaborative and robust products.

References

[1] Dr. Mike Shipulski, "Systematic DFMA Deployment," *Presentation*, June. 2010.