Eliminating **"Point of no return"** using DFMA software

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Abstract

"Point of no return" in general perspective means - a point beyond which one must continue on the current course of action because turning back is impossible, expensive and dangerous or the effort required in getting back would be greater than the remainder of the task to be undertaken. Similarly in any design to make cycle, the major activities involved are initial conceptual design, design reviews, prototype development and final production. This paper illustrates the importance of use of certain techniques, which incase not applied in the initial design to production cycle, will result in a **"Point of no return"** scenario. DFMA tool helps in eliminating this scenario.

Considering the current complexities of products being handled by Service companies and the depth of collaboration and partnerships of service companies with their OEM partners, and engagement throughout the product life cycle by the service companies, it becomes inevitable for service companies to not encounter "Point of no return". Encountering a "Point of no return" would mean very detrimental to the entire project (especially in the case were developmental activity is spread over few years), and this envisages to utilize matured innovative processes to avoid these scenarios. This challenge of not to encounter "Point of no return" in a multi-disciplinary concurrent engineering environment was combated with the help of innovative synthesis of various techniques like DFMA, Rapid Prototyping, Virtual Manufacturing etc, upfront in the design to make cycle. This innovation process employs a structured approach of iteration between the results of DFMA tool and usage of Rapid prototyping and Virtual manufacturing to eliminate "Point of no return" scenario.

DFMA tool supports in not to encounter "Point of no return" scenarios. In case of such encounters, reported by DFMA tool, a recourse using Rapid Prototyping techniques and Virtual Manufacturing, aided in implementing appropriate mistake-proof solutions, to resolve "Point of no return" scenarios. Once the remedy is attained, DFMA philosophy ensures no further hurdles during the course of project implementation.

Introduction

Engineering Services Industry is fast growing becoming an extended arm of the OEMs and they are well embedded in all activities covering the full cycle of design to make. A Service industry never parallel's with an OEM, but provides cost effective solutions to the OEMs. Hence the challenges encountered by them are diverse in nature, and to beat these challenges, service industries adopt several innovative strategies. Service industries are made up of companies that primarily earn revenue through providing intangible products and services. The OEMs are heavily dependent on the Service industries and hence a "Point of no return" scenario from service industry would sabotage the entire operation of OEM. Also in case of projects spread over few years, like in development of aircraft or an aero engine power plant, encountering "Point of no return" would render the entire program as non-functional and this would lead to huge losses in terms of effort, money, credibility etc. Engineering Services Company would be facing more challenges considering the nature of work, and companies working on cutting edge technologies would be more prone encountering "Point of no return" scenarios. Further aligning to the OEM requirements, understanding their working procedures/standard work/methodology, working in different time zones etc., makes service industries disposed to facing "Point of no return" scenarios.

The "Point of no return" scenario arises in a service industry when one delivers the project outputs which are not acceptable by the customer. The service provider company has to revisit and realign the process to meet the customer requirements/needs to avoid these scenarios. A better way out would be to implement innovative approach, so that these situations of "Point of no return" will never be encountered.

Background Information

Engineering Services companies working on component designs during the end of design life cycle would face more challenges with respect to "Point of no return" scenarios. Since the designs are near to completion there would be no flexibility from the design perspective for alterations. Hence an innovative method should be adopted to meet the design intent and at the same time support the paradigm of optimum cost. The traditional waterfall model of will have lot of limitations to weed out "Point of no return" scenarios.

The Main features of Waterfall model are:

- Each process flows forward from Customer requirements flowing downwards sequentially.
- This model does not look backwards or forwards from the step it is on to fix possible problems. For example: any design modification(s) if required, needs to be scrapped or heavily modified.

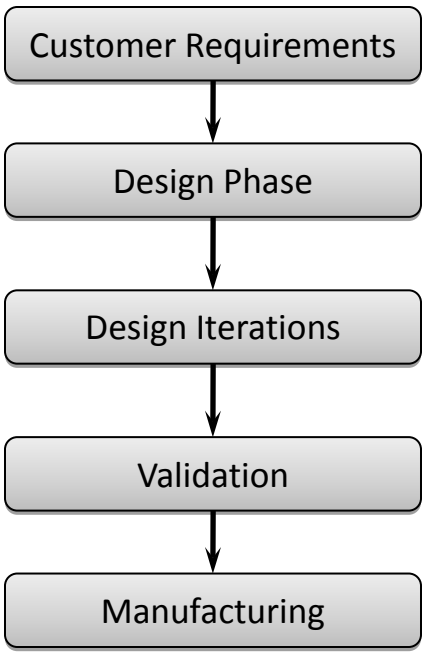

Fig.1 : Traditional Waterfall model

The best way to eliminate these scenarios of "Point of no return", the Manufacturing Engineering team should be integrated with the design team using the concurrent engineering approach. Concurrent engineering methodology is based on performing tasks concurrently (i.e. parallelization of tasks). This approach is used in product development cycle in which functions of design engineering, manufacturing engineering and other functions are integrated. By integrating the above mentioned groups, the total design cycle gets reduced to bring a new product to market.

It's based on two phases:

- All phases like functionality, producibility, assembly, testability, maintenance issues, environmental impact, disposal and recycling etc. are taken care during the initial process.

- Preceding design activities should all be occurring at the same time, or concurrently.

These Phases not only help in increasing the Productivity and quality but also helps in improving the design, redesign and fixing the errors earlier, which enhances significant impact on the later stages of the Design and Production cycle.

Some of the features of concurrent approach are:

- Complete aspects of product life cycle are taken into account, allowing for a more evolutionary approach to design.
- This model **does** look backwards and forwards at every step to fix possible problems.

- Gives more freedom and Ownership of the design for the Designer.

Considering these positive traits of concurrent approach, it appears that a good antidote for "Point of no return" would be concurrent engineering. But still one would find some gaps, and a closure action would be an innovative approach of augmenting DFMA with some physical / virtual prototyping tools and technologies so that the "Point of no return" scenarios are totally nullified.

The Challenge

Development of product from a concept to design takes many years of efforts and time. Lot of Engineers, from various discipline put their valuable efforts. Front end technologies, used in aerospace application, would require more effort and time to implement the same. A typical development life cycle for an aero power plant would take 5+ years. The prerequisite during the development life cycle is to avoid "Point of no return" scenarios. Several techniques are used to cut down the development life cycle time, but a good process is required to make sure that the development always progresses forward.

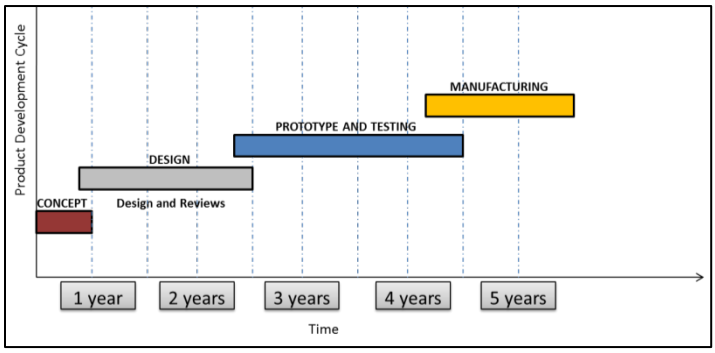

Fig.2 : Typical time frames in a development cycle

During the design phase, engineering assumptions are made. The design phase progresses based on these assumptions. Once a prototype is designed and to be manufactured, manufacturing difficulties may arise due to various reasons as mentioned below:

- Region.
- Material availability, cost and condition.
- Machines.
- Lead/Cycle Time.
- Manufacturing Cost.
- Manufacturing Technology.

During the design phase the designer, designs the parts by considering the form, fit and functional criteria. The detail manufacturing operation sequence(s) are not determined during the design phase. Once the design is frozen and it goes for production, there may be factors affecting

the manufacturing process. The “Point of no return” scenarios may arise when working on the design or manufacturing attributes like

- Manufacturing feasibility assessment
- Part count reduction
- Difficulty in Assembly operations
- Process Simplification

To eliminate “ Point of no return scenarios” an innovative approach is required, for nullifying the roadblocks.

Innovative Solution

To nullify the “Point of no return” scenarios, an innovative and mistake proof was devised and adopted. DFMA was strengthened and augmented with new tools and technologies like Virtual Manufacturing and Rapid Prototyping. All parts, which would have “Point of no return” scenarios, were prototyped and passed through virtual manufacturing process to weed out the road blocks.

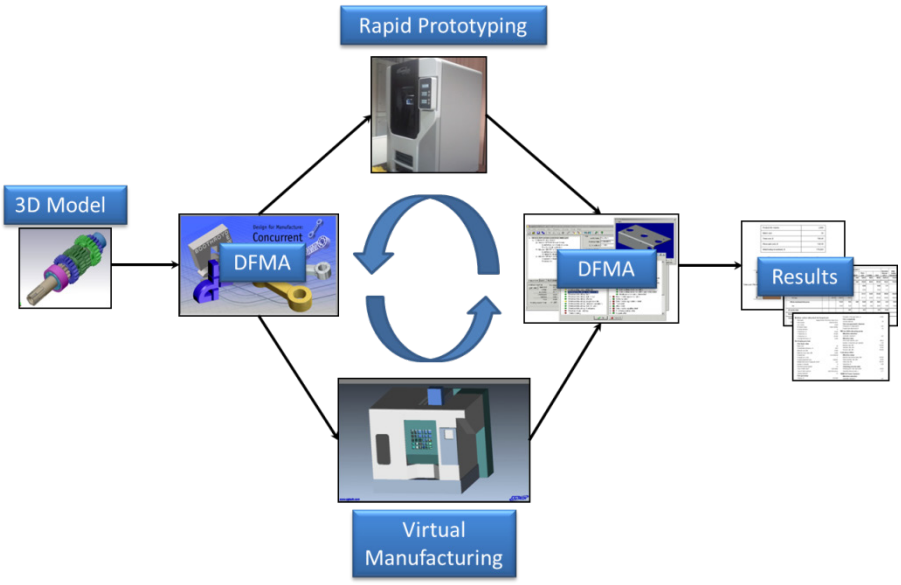

Fig.3 : Integrated DFMA Approach

The Integrated DFMA model had Rapid Prototyping and Virtual Manufacturing techniques deeply embedded into the process flow. DFMA triggers the possibility of encountering "Point of no return" scenarios. The integrated approach makes us of Virtual Manufacturing techniques (Process Planning, NC Programming and Virtual Simulation) for overcoming these scenarios and the next recourse would be also to make physical models using Rapid prototyping techniques. This integrated approach avoids "Point of no return" and manufacture / assembly of actual parts is guaranteed. The output from the Rapid Prototyping / Virtual Manufacturing is again ported to DFMA tool to ascertain costs and the typical cost bench marking process continues further.

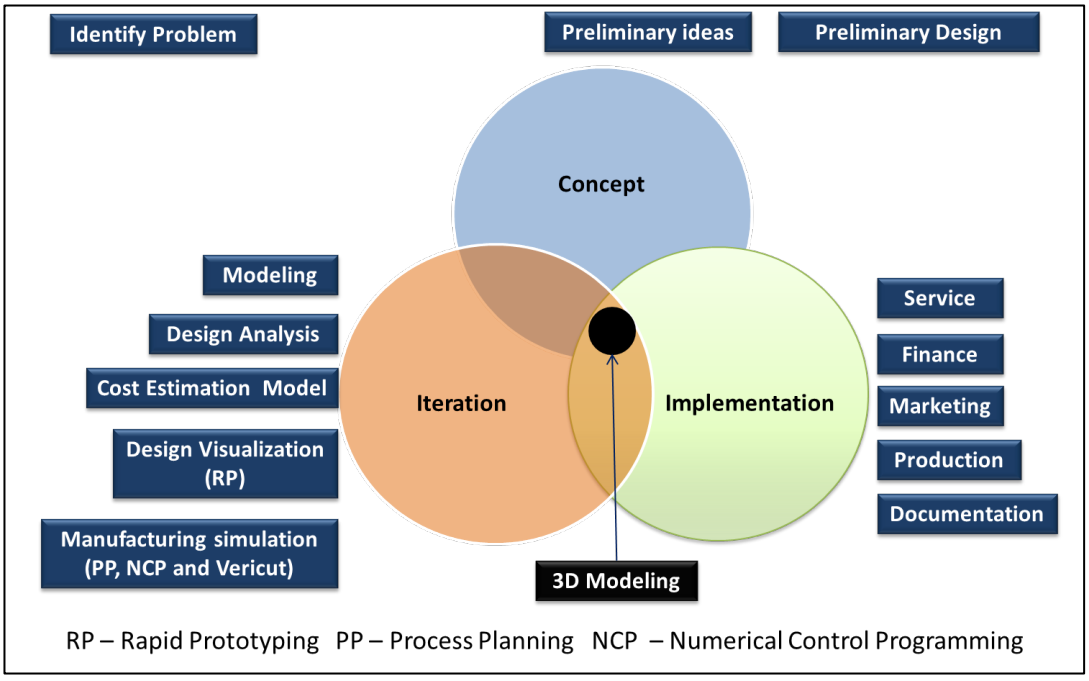

Fig.4 : Integrated DFMA Approach with modifiers

The Integrated approach with modifiers (Service, Finance, Marketing etc) further brings in robustness and "Point of no return" scenarios never pop up. For a service industry this innovative approach is absolutely essential to meet the obligations stipulated by the customer. This requires a strong basis of commitment and teamwork since the overall success of the Integrated approach method relies on the ability of different groups to effectively work together. Often this can be a difficult obstacle, but is something that must be tackled early to avoid later problems.

Lessons Learned and Best Practices

Application of the integrated approach paved path for several success stories and statistics revealed a realization of savings close to 10 – 20 %. The approach has been deployed at different phases product development life cycle – design, manufacture, supply chain etc. Also the technique is popularly being used for assessment of manufacturing feasibility, studying of

different design iterations, part count reductions, Design for assembly etc. Extensive study of the baseline design components and suggested "Process Simplifications" to eliminate the "Point if no return" scenarios was also carried out.

A typical case study adopting this integrated approach is presented here. The part under study had very complex manufacturing attributes. To explore different options, one route strongly pursued was comparison between one piece construction versus two piece construction. Using the integrated approach, both rapid prototyping and virtual manufacturing techniques were deployed. From this various parameters were collected and the data was used to build cost estimation models using DFMA. The results obtained from DFMA are presented below.

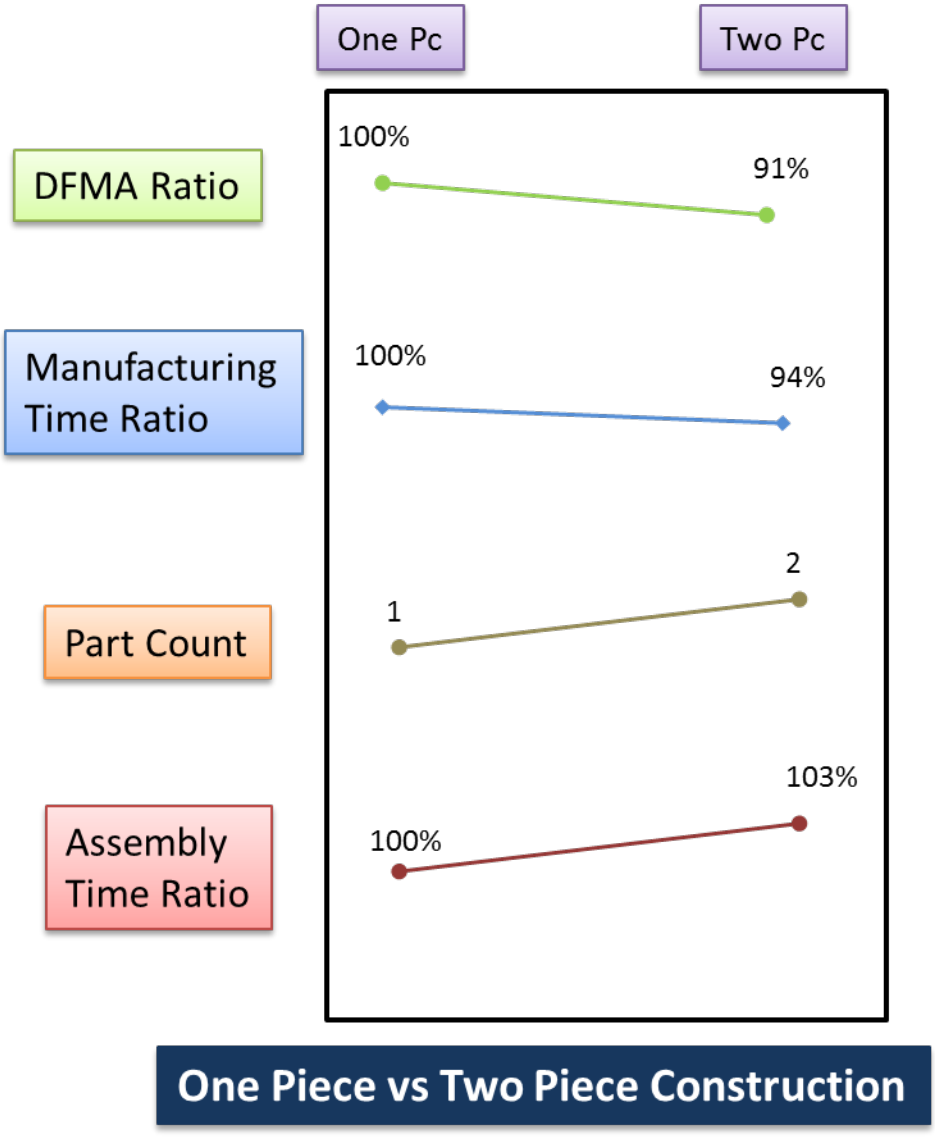

Fig.5 : DFMA results using Integrated Approach

Conclusions and Future Plans

Engineering service companies face stiff challenges during product development life cycle and are forced some time to collide with “Point of no return” scenario. Encountering these scenarios would be very sabotaging for the service companies and their very purpose of service existence could be at jeopardy. This warrants the requirement of an Innovative approach to bail out service companies for not bumping into these situations, especially during the mature state of co-development and collaboration project ownership.

An Integrated DFMA approach was devised to combat these critical scenarios. At the instance of “Point of no return” sensed by DFMA tool, techniques / tools like Rapid prototyping and virtual manufacturing are employed to ascertain part manufacturability and the outcome is routed back to DFMA tool for ascertaining the costs associated. This approach has shown a novel route for avoiding “Point of no return” scenarios. Further it boosted the confidence of all the stakeholders and also rendered savings close to 10 – 20%. The Integrated approach with modifiers even strengthened the entire process and made the concept deliver mistake proof solutions.

The plan is to extend this approach to the next level to make it more comprehensive. The target is to develop regional based DFMA libraries, part family based libraries, intelligent backup processes, etc and equip DFMA tool to encompass more intellectual database, so that “Point of no return” scenarios are never encounter in the life cycle. These concepts are being extend to aftermarket phases also, which is very important in aerospace industry. Nullified “Point of no return” means robust and matured processes and a guaranteed product success.

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