CHAPTER 4

AGILITY IN PUMPS AND DESIGN OF DAFEA MODEL

4.1 INTRODUCTION

As mentioned earlier, the global competition has been driving the manufacturers to acquire agility characteristics. This compelling trend of acquiring the agility characteristics has started in the pump industry as well. For instance, during the recent years, the pump manufacturing companies have been producing pumps with varied colours in order to attract the customers. However, the pace of development towards acquiring the agility characteristics in pump manufacturing arena has been very slow. In this background, the findings of the module of the doctoral work reported in the previous chapter were referred for infusing agility in the pumps. As mentioned in the conclusion section of the previous chapter, the traditional manufacturing companies are required to first prioritize to infuse functional characteristics and then ergonomic and aesthetic characteristics. In the context of these observations, during the pursuance of the doctoral work being reported here, the theoretical aspects of infusing functional, ergonomic and aesthetic features in pumps for achieving agility were explored. Further, it is observed that in modern industries like mobile phone industry, CAD is exploited to digitize and infuse virtually agility in the products. Hence, it is imperative that CAD needs to be exploited for infusing functional, ergonomic and aesthetic features in pumps. In order to carry out this task, a model is required to be developed.
Accordingly, at this stage of doctoral work, DAFEA model was designed. The details of these efforts made while pursuing the doctoral work being reported here are presented in this chapter. First, the theoretical aspects of infusing functional, ergonomic and aesthetic features in pumps to achieve agility are described. Then, the power of applying CAD in achieving agility in pumps is described. Third, the design features of DAFEA model are presented.

4.2 AGILITY IN PUMP DEVELOPMENT THROUGH IMPROVING FUNCTIONAL FEATURES

The pump manufacturing companies can imbibe agility characteristics by adopting several functional features. For instance, a pump can be designed to discharge high volume of liquid at a faster rate in a given period of time. Likewise, the functions of a pump can be automated with embedded system technology and monitored using mobile phone. A pump may also be designed to operate using alternate energy sources (battery, wind power and solar power in the absence of electrical power. Highly corrosion resistant and smart materials may be used to manufacture pump parts in order to avoid clogging throughout its service life. This kind of functional features would enable the infusing of agility characteristics by tremendously improving the performance of pumps.

4.3 AGILITY IN PUMP DEVELOPMENT THROUGH ERGONOMIC FEATURES

In the second direction, ergonomic features may be adopted to impart agility characteristics in the pump design. For example, pump components can be designed by using advanced composite materials, which will have great strength but weigh less. The use of light weight components in
the manufacturing of pump will ease its handling ability. Likewise the pump may also be provided with easy to install features, so that it can be made portable. The noise level of the pump during its operation may also be minimized using rubber dampers. Adopting these innovative ergonomic features in the pump design may impart agility characteristics in the pump design.

4.4 AGILITY IN PUMP DEVELOPMENT THROUGH AESTHETIC FEATURES

The agile characteristics may be imbibed in the pump development by applying aesthetic aspects. For example, the external body of the pumps can be painted by using different colour paints based on the requirements of the customers. Interestingly, in the recent years, few pump manufacturers have started to manufacture pumps which are painted in different colours. A glimpse of pumps painted by using different colours can be had by visiting ‘http://www.kirloskarpumps.com/product-pump-monorloc-pumps.aspx’ (Kirloskarpumps, 2015). Likewise, in the pump manufacturing arena, for a quite long period, the external bodies of the pumps were incorporated with standard shapes. The shapes of external bodies of pumps can be varied to make the external appearance of the pumps attractive. Besides images may also be painted on the pump which will be attractive to the customers. In this direction, further studies in aesthetics may be made and the ideas may be incorporated in the development of pumps.

4.5 AGILITY, PUMP AND CAD

In order to impart agility characteristics by infusing functional, ergonomic and aesthetical features in the design of pumps, enormous number
of experiments are required to be conducted. In order to test the manufacturability of the new designs of pumps that would facilitate the adoption of agility, several trial runs by involving huge expenditure need to be conducted. Both these major hurdles may be avoided if the design of pumps is digitized. In the engineering field, CAD plays crucial and facilitating roles in infusing agility characteristics in products. In this background, the state of the art researches on applying CAD in the manufacturing of pumps were studied. (Vinodh et al. 2011a).

Few researchers have carried out research in developing certain pump components through CAD and RPT in an agile manner. Vinodh et al. (2010) have reported a research on agile product development through CAD and RPT in a traditional pump manufacturing company. Initially, these authors modelled the casing and impeller of the existing pump using Pro/Engineer Wildfire software package. Then, these authors altered the existing design to create new models by varying the head and discharge. The new designs were subjected to flow analysis using GAMBIT and FLUENT software packages. After conducting the flow analysis, the prototype of the selected CAD model of the impeller was created using Fusion Deposition Modelling (FDM) process of RPT. Then these authors identified the actual cost of producing the products using Activity Based Costing (ABC) technique. Thus these authors examined the way of imparting agility characteristics in designing pump components by using CAD. However, no paper reporting any researches on the application of CAD on the whole pump has so far appeared in the literature arena. In the context of making this observation, the importance of CAD and its role as an agile enabler in pump manufacturing companies is described in this section.

CAD enables the digitization of the components and fuels agility in the design and development of products. The digitisation of the product aids
to minimize the product development time and to introduce innovative features to delight the customers. The CAD enables virtual designing which gives rise to several alternatives. The digitization through CAD would enable the infusing of functional, ergonomic and aesthetic agility in the case of developing pumps. The research reported by Vinodh et al. (2011) indicates that, CAD can be applied to modify the actual design of components in response to the customers’ dynamic demands. The CAD also enables the analysing of the performance of pumps virtually in the electronic screen. For instance, the casing model of the pump can be replaced with plastic material in place of grey cast iron. Then, the model can be subjected to computer aided analysis by using software packages like GAMBIT and FLUENT. Thus, new models of pumps can be innovatively designed within a short period of time to accelerate the journey of agility of pump manufacturing company. Furthermore, the CAM facility can be utilised to manufacture the components of pump by employing automated machines.

4.6 DESIGNING OF DAFEA MODEL

A described study of the information presented in the above section would indicate that several issues that would facilitate to gain the support of the top management and employees are considered. In the context of drawing this inference, in order to implement AM paradigm in the pump manufacturing industries, a model named “Digitization aided Aesthetic Functional and Ergonomic Agility model (DAFEA model) is being proposed in this paper. The conceptual features of DAFEA model are depicted in Figure 4.1. As shown, the endeavour to infuse agility characteristics in the manufacturing of products has to begin by appointing a DAFEA coordinator (who should possess knowledge about agile manufacturing, digitization technologies and DAFEA model) and enlightening the concepts of agile
manufacturing in the company. In this regard, the DAFEA coordinator has to deliver lectures by citing several examples of infusing agility in the manufacturing of products and thereby, acquiring competitive strength. After thus enabling both managerial and non-managerial employees to recognize the essence and need of implementing agile manufacturing principles in the manufacturing of products, a study on manufacturing aspects of the different products manufactured in the company is required to be carried out. This study must be accompanied by the identification of the steps of manufacturing the different products. Further, the design aspects of these products as well as the components are required to be studied. After gathering knowledge about the manufacturing aspects, the same are to be critically studied for the purpose of infusing agility in a product. This product is regarded as the candidate product. This candidate product is chosen based on the easiness with which agile characteristics can be infused by using digitization technologies. DAFEA model has been designed to adopt CAD technology for digitization of the candidate product as CAD is the easily adaptable technology which has been found to be powerful in infusing agility characteristics in products by reducing the product development time and cost (Vinodh & Kuttalingam, 2011). Hence, after choosing the candidate product, the components of these products are digitized by creating the three dimensional (3D) models of them using CAD software packages like Pro Engineer, CATIA and Solid works. Then, the 3D models of the components are required to be assembled to digitize the final product by using the chosen CAD software package. As mentioned earlier, the agility is highly exhibited in mobile phone manufacturing industry. In this industry, mobile phones with amazing features are designed and manufactured within a short period of time. Emergence of this kind of mobile phones has been triggering the customers to keep buying them. Because of this kind of agility propensity, the mobile phone industry continues to flourish even though
the number of mobile phones manufactured and delivered to the customers has become more than the population of the world (Pramis, 2013).

The results of fuzzy AHP based study reported in previous chapter revealed that the functional, aesthetics and ergonomic characteristics infused in the mobile phones have been enabling the exhibition of agility in mobile phone manufacturing industry. While pursuing the doctoral work being reported here, in the DAFEA model these prioritized aspects which can be efficiently carried out by making use of digitization technologies are incorporated. Then by seeing the model virtually in the computer screen, brainstorming sessions are required to be conducted by involving all the concerned personnel to infusing agility characteristics in the candidate product by enhancing its functional, ergonomic and aesthetic features. After getting the knowledge through the conduct of these brainstorming sessions, these features are required to be incorporated in the existing 3D models in the computer screen to create models of the new designs. The product agility level (PAL) of the organization is to be calculated by anticipating the manufacturing of these new designs and selling the same in the market. After seeing these new models on the computer screen, the practical feasibility of manufacturing these new designs is required to be examined.

A new design with very high practical feasibility is to be chosen and the pilot project is to be initiated. After the execution of the pilot project, the new design is required to be analyzed for its capability in meeting the agility requirements. Particularly, the capability of the product in manufacturing it with very little lead time and delighting the customers to purchase it is required to be explored. After analyzing this new design, it is required to indicate whether any refinement is to be made in the new design. If there is no need to carry out any refinement, the manufacturing of the product
with this new design is begun. If there is any need for refining the new design, then the features of this new design are to be analyzed by conducting brainstorming sessions from the perspective of functional, ergonomic and aesthetic features. These steps are required to be continued till there is no need to refine the new design of the product. After developing such a product with agility characteristics, its cost of manufacturing is required to be estimated. Further, the manufacturing aspects are to be evaluated after taking actions to produce this product with new design from the perspectives of least cost and easiness of manufacturing. If the results of evaluation indicate that the infusing of agility in the new product will be successful, then this product is to be manufactured in the company and brought to the market for selling.

4.7 CONCLUSION

In the case of mobile phone manufacturing industry, the companies have produced countless delightful models over the past three decades. A careful study of the practices followed by these companies would indicate that the products are digitized and virtually new models are created and analysed electronically (Vinodh et al. 2011b). The absence of digitization of the products has been slowing down the growth of pump industry. Hence it is high time that avenues should be found out to impart agility characteristics in pump manufacturing industry.
Enlightening the concepts of agile manufacturing in the company

Studying the manufacturing aspects of the different products manufactured in the company

Identifying the candidate product to infuse agile characteristics

Modelling the individual components of the product using CAD packages

Assembling the CAD models of components to digitize the candidate product

Functional agility through digitization

Ergonomics agility through digitization

Aesthetics agility through digitization

Assessment of Product Agility Level

Practical feasibility of manufacturing the agile products

Pilot project

Any refinement is needed?

Cost estimation

Manufacturing of the new products

Figure 4.1 Conceptual framework of DAFEA model
In order to impart agility in pump manufacturing industry, it is required to digitize the existing models and virtually incorporate functional, ergonomic and aesthetic characteristics to impart agility in products in electronic medium. This is going to be a challenging task in the pump industry as the pumps that are produced today were developed to suit the manual operations. In order to enable the contemporary pump manufacturing companies to face these challenges, the DAFEA model presented in this chapter was designed. While pursuing the doctoral work being reported here, the practicality and effectiveness of DAFEA model were investigated in three different companies by considering three different pumps. These investigations are reported in the following three chapters.