TITLE: Investigations on the implementation of agile manufacturing paradigm in the production of desiccant compressed air dryer through the application of cad based assembly sequence planning

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ABSTRACT

During the past two decades, the world has been witnessing the intensification of competition. As a result, companies manufacturing products have been adopting several strategies. According to one of those strategies, manufacturing companies have been striving to produce innovative products quickly in accordance with the dynamic demands of the customers. A section of researchers recognised these developments in the later part of the twentieth century. These researchers named the characteristics of the companies which have been able to produce innovative products quickly in accordance with the dynamic demands of the customers as agility. These researchers have named the company possessing agility characteristics as agile companies. These researchers have been propagating researches under the field named as ‘agile manufacturing’.

While the researchers working in agile manufacturing field have been bringing out the definitions and strategies, some of the companies like those manufacturing electronic gadgets and mobile phones have been able to bring out innovative products in an agile manner. On the other hand, companies manufacturing traditional products have been slow in acquiring agility characteristics. This is due to the reason that digitisation of traditional products has been a challenge as these traditional products were designed by the engineers who have designed those products before computers began to aid the design process. Lack of digitised data of traditional products has been preventing companies manufacturing those products from acquiring agility characteristics. Hence, a need has arisen to explore the way of digitising the traditional products. Since the field of ‘computer aided design’ (CAD) has been developing amazingly, the digitisation of traditional products through the development of their

CAD models needs to be investigated by conducting researches.

One of the enablers of acquiring agility is the time compression. During the past several years, researchers have been claiming that the assembling of components consumes major portion of lead time of manufacturing the products. Hence, reducing the assembly lead time in the manufacturing of products will facilitate to achieve time compression. Achieving time compression in turn would facilitate the companies to acquire agility characteristics.

On realising the need of reducing the assembly time, many researchers have been working on utilising the CAD models of components to generate the sequences of assembling the product that would reduce the lead time and cost of manufacturing. These research activities are carried out intensively under the field called ‘assembly sequence planning’. Quite interestingly, few researchers have pointed out the need for adopting the approaches followed in assembly sequence planning to achieve lead time compression and thereby acquiring agility characteristics in manufacturing the products.

On observing the developments that are mentioned above, the doctoral work reported in this thesis was begun. The above developments indicated the need to carry out researches in two directions. The first research direction is the digitisation of the traditional products using CAD technology. The second research direction is the conduct of investigation to examine the challenges of achieving time compression and thereby, acquiring agility characteristics through the development of feasible and optimum assembly sequences by applying CAD in the case of manufacturing traditional complex products. The doctoral work reported in this thesis was carried out in these two directions with the objective of evolving methods and logics for infusing agility in the manufacturing of traditional complex products.

In order to attain the objective of pursuing the doctoral work being reported here, a product called ‘desiccant compressed air dryer’ was chosen as the candidate traditional product. While carrying out the initial phase of the doctoral work reported

in this thesis, developing the digital forms of the components of the chosen candidate product through the application of CAD was investigated. This investigation was carried out by gathering appropriate information from a company by name Trident Pneumatics Private Limited. One of the desiccant compressed air dryers which iscalled in this company as Dryspell Plus was chosen as a candidate product. After gathering appropriate information, the assembled CAD model of Dryspell Plus was created by using Creo Parametric 2.0 software package. In order to develop the CAD model of the final assembly of Dryspell Plus, the information about the components and the method of assembling them were gathered from Trident. With these information, the CAD models of the components and subassemblies of Dryspell Plus were developed by using Creo Parametric 2.0 software package. Finally these CAD models were assembled by using appropriate assembly constraints to develop the CAD model of finally assembled Dryspell Plus. Subsequently, this CAD model was used to virtually examine its features by using Creo Parametric 2.0 software package. Thus, these efforts made to digitalise the Dryspell Plus which is a traditional product were novel and successfully carried out in Creo Parametric 2.0 environment.

After developing the CAD model of Dryspell Plus, a methodology was developed to investigate about the determination of feasible and optimal assembly sequence of manufacturing Dryspell Plus. From the CAD models of components, the bill of material was prepared. From the bill of material, 930 ordered pair of components were developed. Against every ordered pair of components, the connectivity and precedence constraints were extracted from the CAD model using the numeral 0 and 1. The numeral ‘0’ was used to indicate that there is no connectivity and/or no translation between the components corresponding to the ordered pair of components, Similarly, the numeral 1 was used to indicate that there is connectivity and/or translation between the components corresponding to the ordered pair of components. By examining the connectivity and precedence constraints corresponding to the ordered pair of components the selection of successor component was determined for the generation of feasible assembly sequence of Dryspell Plus.

The selection of the successor component was carried out by following the prioritisation rule during the generation of feasible assembly sequence of Dryspell Plus. The generation of feasible assembly sequence of Dryspell Plus was carried out by applying five prioritisation rules. Based on the five prioritisation rules, five distinct feasible assembly sequences of Dryspell Plus were generated. The entire process of generation of feasible assembly sequences was coded using php scripting language. Using this computer program, five feasible assembly sequences of Dryspell Plus were generated. Then several visits were made to Trident and the data on consuming time to assemble the Dryspell Plus were gathered. By referring to these data, the lead time of assembling the components of Dryspell Plus by applying the five feasible assembly sequences were determined.

As time compression is the criterion chosen for acquiring agility in this doctoral work, the feasible assembly sequence which consumes the least assembly time was recognised as the optimal sequence of assembling Dryspell Plus. Further the current lead time of manufacturing Dryspell Plus at Trident was compared with that of the five feasible assembly sequences generated while pursuing this doctoral work. This comparison indicated that the optimal assembly sequence will consume 26 minutes lesser than that is consumed currently by following a non-optimal assembly sequence. Thus, the investigations on CAD modelling and on achieving time compression for acquiring agility in the case of manufacturing Dryspell Plus revealed that such approach will enable the companies producing similar traditional complex products to acquire agility characteristics and competitive strength.