CHAPTER 11

AGILITY THROUGH RAPID PROTOTYPING TECHNOLOGY

11.1 INTRODUCTION

The growth of Rapid Manufacturing (RM) and RPT fields has been tremendous during the last one decade (Rochus et al 2007; Campbell and de Beer 2005; Furrens 1999). However, RPT still struggles to enter into the organisations due to various reasons. Some of the reasons include difficulty in management and implementation, and high cost of machines, processes and materials (Ruffo et al 2007; Hopkinson and Dickens 2001). This is a concerning situation since RPT has the ability to infuse agility in organisations through the compression of time for developing and testing prototypes and thereby assuring high quality and innovativeness of products and profitability to the organisation (Onuh et al 2006). On sensing its power, RPT is included as a phase in the TADS model designed in the beginning of this research.

It was found necessary to investigate the possibility of adopting RPT phase of TADS in a traditional manufacturing environment with the orientation of enhancing agility. In order to fulfil this imperative, this chapter reports a module of this research in which the Three Dimensional (3D) printing device of RPT was utilised to investigate its potential to infuse agility in Salzer.
11.2 RPT PHASE OF TADS THROUGH 3D PRINTING

The working principle of the 3D printer used during this module of research is briefly described in this section. The photograph of this 3D printer can be viewed in www.solido3d.com. This 3D printer is made by Solido, a company situated in Israel and its model name is SD300. The price of the SD300 3D printer in INR is 1.5 millions approximately, whose equivalence in US$ is 37500 (approximately, INR 40 = 1 US$). According to Solido, the benefits of this printer are affordability, ease of operation, improved design communication, confidentiality and production of durable models (www.solido3d.com). This machine uses additive process of rapid prototyping. This machine builds prototypes by laying sheets of Poly Vinyl Chloride (PVC) and stacking them together in succession.

SD300 is incorporated with software called SD View. SD View imports and checks the correctness of the STL file of the CAD model. If any error found in the STL file, then it is displayed by SD View. The reason for the error in the STL file will also be indicated by SD View. In order to ensure optimum stacking of the PVC material, SD View will orient the position of the model by aligning the smallest dimension in Z-axis. For example, if a model with longest dimension is kept in Z position, it may have to be stacked with relatively more layers. This aspect will be taken care of by SD View. SD View allows the generation of the peeling cuts which are required for easy removal of the excess support from the end prototype upon its completion.

During the time of building the model, SD View will display the progress made and the layers stacked. Even before the building of the prototype, SD View displays the material required, total build time as well as its price in money value. In this research, the software was set to display the value of material in INR. Thus both hardware and software of SD 300 work in
tandem to produce prototypes in a rapid manner with high precision and accuracy.

After studying the features of 3D printing machine, this module of research proceeded to develop new CAD models of knob of ‘S’ type switch. Quiet interestingly, Ruffo et al (2007) have also used the knob of a switch for studying the make or buy comparison for rapid manufacturing.

Creative thinking process was applied by visualising the CAD model of the switch to evolve new models of the knob. The features of the newly evolved CAD models were exposed to the executives of Salzer. Their views were also taken into consideration while evolving the new CAD models of the knob. Thus the ideas generated through these interactive discussions were pooled which were exploited to develop CAD models using Pro/E. Finally six such CAD models were developed. Those models are shown in Figures 11.1 and 11.2.

Figure 11.1 Window showing new CAD models coded as M₁, M₂ and M₃
Figure 11.2 Window showing new CAD models coded as M₄, M₅ and M₆

Subsequently, a questionnaire was given to the executives for expressing their views on the new CAD models being proposed. The overall view of the executives indicated that they are appreciative of the new CAD models of the knob.

11.3 RAPID PROTOTYPING

After ensuring the favourable receptivity of the executives towards the new CAD models of the knob, five of them were subjected to investigation for exploring the application of 3D printing technology in the RPT phase of TADS model and so as to achieve agility. For this purpose, generous knowledge and technological support of a company situated in Coimbatore city of India which is selling SD 300 was availed. The name of this company is VectraFORM Engineering & Solutions Private Limited (hereafter referred to as VectraFORM). This module of research was also
financially supported to a partial extent by VectraFORM. The customers of VectraFORM are major Indian companies like Ashok Leyland, Premier Instruments and Controls Limited, Royal Enfield and Hero Honda Motors.

Two days were spent by the author of this thesis for discussing with the Director of VectraFORM regarding the feasibility of building prototypes using SD300. During this discussion, attempts were made to study the feasibility of building the prototypes for all the six models of the knob. In order to avoid excessive costs, it was decided to run SD300 for one set-up only. It was found that in one set-up, only a maximum of five models could be accommodated. Hence, it was decided to drop a model with low receptivity from building the prototypes. Accordingly, a model named M2 was dropped from the study of building the prototype using SD300. The cost of building these prototypes was indicated by SD View. Since this work was being pursued for research purpose, the Director of VectraFORM was gracious enough to waive the running cost of the SD300. Only the material cost which amounted to INR 1500 (US$ 37.5) was charged by the Director of VectraFORM.

Once the preliminary discussions and proposals were completed, the five CAD models of knob were loaded electronically into the computer interfaced with SD300. The photograph taken during this session is shown in Figure 11.3. Then the SD300 was run. There were 107 layers which took the SD300 to build the prototypes in four hours. Once the building of prototypes was completed, the SD300 prompted the completion by making a beep noise. At that point of time, the magnetic tray containing ‘build stack’ of knob models was removed.
This was followed by ‘post processing’ during which time the excessive support material was peeled off. The ‘post processing’ involving the removal of excessive support material was carried out within an hour. Finally, the photograph shown in Figure 11.4 was taken which displays the prototypes of the new knob models.
Thus the new CAD models developed by referring to the existing model of knobs were finally converted into prototypes within four hours by making use of SD300.

11.4 ANALYSIS

A drawback of RP technologies including 3D printing technology is that the prototypes are not built using the actual materials (Dimitrov et al. 2006). Hence, the mechanical properties of the prototypes cannot be used for studying the performance of actual parts. Hence, during this research, the ANSYS software was used to test the two mechanical engineering properties namely stress and strain. The CAD models of both the existing and new models were subjected to analysis. The results displayed by the ANSYS indicated that both the existing and proposed models of knob are mechanically safe to operate. One of such screens pertaining to a model whose code name is M₄ displayed by ANSYS is shown in Figure 11.5.

![Windows depicting the first principal stress observed in the knob using ANSYS](image)

Figure 11.5 Window depicting the first principal stress observed in the knob using ANSYS
As shown, the values displayed are within the safer limits. Hence, it is interpreted that the knob is mechanically safe.

11.5 CONCLUSION

This chapter has reported a module of the research in which efforts were made to investigate the infusing of RPT phase of TADS model using CAD and RPT in Salzer’s traditional manufacturing environment for achieving agility. During this module of research, six new CAD models of knobs of electronic switches could be designed using Pro/E within twelve hours. Subsequently, the prototypes of five of those new models could be developed using SD300 in just four hours. Thus, the product development with variety, innovation, and quality occurred through these technologies within 16 hours to portray their capabilities in enabling a traditional manufacturing company like Salzer in achieving agility. On the whole, the experiences of conducting this module of research indicated that the journey of adopting RPT phase of TADS model for achieving agility would be smooth in a traditional manufacturing environment.