CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The globalization of modern world has triggered countries and regions to open their gates for allowing the entry of global players into their markets (Cao and Dowlatshahi 2005; Jagadeesh 1999). Because of this scenario, the world witnesses aggressive competitive situation. This situation entails the customers to occupy highest positions in the markets. As a result, today’s customers not only demand high quality products and services but also varieties (Saisse and Wilding 1997). Many times the varieties are demanded in different volumes too by the modern customers. Hence the contemporary organizations are spontaneously becoming adaptive to the demands of the customers. This kind of paradigm change in organizations drives them to produce products and provide services of different varieties and volumes within a quick span of time. The challenging aspect is that, this task has to be accomplished without compromising the quality and cost. The organizations which are capable of accomplishing this task are able to thrive in today’s globally competitive markets. This paradigm is today addressed by the researchers under the term ‘Agile Manufacturing’ (AM) (Brown and Bessant 2003).

On realizing its importance, researchers started to work on AM arena from 1990’s. Some researchers attempted to identify the criteria that are required to become agile (Devadasan et al 2005). Many other researchers
dealt AM from different perspectives. A considerable number of authors are emphatic in pointing out the need of adopting AM principles. A careful study of these researches would indicate that, there is little evidence of practitioners adopting AM models developed by the researchers (Yusuf and Adeleye 2002). This is contrary to what is witnessed in management field in which many models contributed by the researchers are adopted by the practitioners. For example, Late Peter Drucker contributed a number of management models which are even today adopted by leading companies (Chobanyan and Emblemsvag 2005).

The absence of AM models contributed by the researchers in practical arena does not mean that practitioners have failed to incorporate agility in their operations. In fact, the agility principles are inculcated in certain industrial sectors at a fast pace. For example, in the case of mobile phone manufacturing, all the leading companies bring out new models with many innovative features within short periods of time (Saran 2005). Those models are developed quickly by using advanced technologies and forecasting the tastes of the customers. However, agility is not still taking the root in many of the traditional industrial sectors like those manufacturing pumps, compressors and machine tools (Devadasan et al 2005).

Due to the slackness in imbibing agility, traditional manufacturing companies have been failing to face the competition in the global market. This kind of unbalanced development in global organizational arena leads to an impression that the AM models developed by the researchers are not practically compatible. The reason for this incompatibility is also due to a fact that, today, AM researchers and practitioners stand in different islands. In order to develop a bridge between researchers and practitioners, many researchers developed AM criteria. However those criteria are highly biased
towards management aspects. Those kinds of attempts concentrate very little on enhancing agility through the design of products.

During the past several years, the design field has been witnessing tremendous developments. Both software and hardware features of computers and Information Technology (IT) are exploited in ‘product design’ field (Nandkeolyar et al 1997). Particularly, several ‘computer aided design’ (CAD) models have been under use by the product designers (Holst and Bolmsjo 2001). However there is very little evidence that the practitioners have adopted these CAD models for enhancing agility in organizational arena. This situation reveals the need of a model to facilitate the use of CAD features for imparting agility in organisations. In order to fulfil this need, the research work being reported in this thesis was initiated.

The primary objective of the research work being reported in this thesis is to contribute a model that would integrate design engineering principles with the state of the art technologies like Computer Aided Design (CAD), Computer Aided Manufacturing (CAM) and Rapid Prototyping Technology (RPT) and IT to enhance agility in traditional manufacturing environment. For this purpose, this research work was started by tracing the developments that have taken place in product design and AM areas. The findings identified during this initial stage of research were used to propose a model called Total Agile Design System (TADS).

TADS would aid in designing products quickly and thereby imbibing agility by traditional manufacturing organizations. In order to investigate the practical compatibility of TADS, its growth phases were subjected to implementation studies in a traditional manufacturing environment. The experiences of these implementation studies and the feedback gathered from practitioners and experts indicated that TADS could
be implemented without any difficulty in traditional manufacturing environments for enhancing agility.

1.2 PROBLEM DEFINITION

The ever increasing competition has been enabling the customers to demand varieties of products, processes and services at economical prices. Also, the volumes of such demand against varieties vary widely. This situation prevents the organizations from settling to contribute any one product, process and service. Because of this situation, the modern organizations are required to be agile. This means that the modern organizations are required to react quickly in accordance with the dynamic demands of the customers without compromising on quality, productivity and profitability.

Particularly traditional organizations are required to move towards this state which is denoted in modern literature as AM. However, the products manufactured by traditional manufacturing sectors are not compatible enough to enhance agility in manufacturing. This is due to the absence of a model that would encompass the state of the art technologies and manufacturing management principles for infusing agility while designing products, processes and services.

1.3 OBJECTIVES OF THE RESEARCH

Before beginning this research work, the following two primary objectives were set.

i. To design TADS

ii. To investigate the development of TADS in a traditional manufacturing environment.
After designing TADS during the initial stage of this research work, the following secondary objectives were set:

i. To develop Agile Innovative Total Quality Function Deployment (Agile ITQFD) technique as a data technology for translating customer requirements into design requirements

ii. To develop the financial accounting system for Agile ITQFD technique

iii. To digitise the existing products through CAD software

iv. To interface CAD and CAM by performing mould analysis

v. To interface CAD and CAM by performing finite element mould analysis

vi. To perform computer aided design of experiments

vii. To study the manufacturing feasibility using CAM software

viii. To develop prototypes of the new models using RPT

ix. To amalgamate mass customisation and AM strategies for developing agile customisation programme

x. To design sample products using TADS

xi. To develop a costing system for TADS

xii. To estimate the gap existing between the current design principles and the proposed TADS by determining agility index before and after anticipated TADS implementation

As indicated above, the entire research proceeded with the objective of designing TADS model and investigating its practical compatibility from both technological and managerial perspectives.
1.4 RESEARCH METHODOLOGY

The research reported in this thesis was carried out to fulfil the objectives listed in the previous section by following the methodology shown in Figure 1.1.

![Research Methodology Diagram]

Figure 1.1 Research Methodology
As shown, the research was initiated after identifying the problem that the traditional products are designed to manufacture using the operations adopted in manually operated systems. This aspect impedes the enhancement of agility in traditional environments. Subsequently, the research work was focused towards studying AM principles. For this purpose, AM literature was studied from as many as 12 perspectives. This elaborate and systematic study revealed the absence of any model that would incorporate CAD/CAM and RPT for converting customer aspirations to achieve Mass Customisation (MC) which is the goal of AM. In order to fill this void, TADS was designed.

In order to test implement TADS, an electronics switches manufacturing company by name Salzer Electronics Limited (hereafter referred to as Salzer) was approached. The management of Salzer agreed to depute a team consisting of six employees to participate in TADS implementation studies. Subsequently, 11 modules of this research involving the implementation studies on TADS were carried out.

The first module began by designing and examining the technique called Agile Innovative Total Quality Function Deployment (Agile ITQFD). This technique was used as a data technology to convert customers’ aspirations into technically understandable and innovative solutions. Subsequently, the feasibility of digitalization of all the switches being manufactured by Salzer was studied. Then the feasibility of CAD/CAM interfacing was studied. This was followed by conducting computer aided Design of Experiments.

The manufacturing feasibility of CAD models was studied by using CAM software. Next, the prototypes of two of the components were developed using RPT. Thereafter, the amalgamation of MC and AM was studied. Since, TADS is prone to evolve products consuming varied types and levels of costs, a new costing system called TADS- Activity Based Costing
(TADS-ABC) was designed and developed. Subsequently, the agility index was calculated in the existing system and in the proposed system after the anticipated implementation of TADS. A Decision Support System (DSS) was developed to facilitate easy calculation of agility index and drawing inferences from it. Finally, the reactions of practitioners and experts on TADS were carefully gathered using questionnaire based interviews. The data thus gathered were analyzed and investigated to indicate the practical compatibility of TADS.

1.5 CHAPTER ORGANIZATION

The research work is reported in this thesis in 17 chapters. The organization of these chapters in this thesis is depicted in Figure 1.2. As shown, after this introduction section, the literature surveyed is presented in detail in chapter 2. In the third chapter, the design features of TADS are narrated.

From chapters 4-14, 11 modules of the implementation studies on various phases of TADS are presented. The reader is required to read sequentially these chapters. The reader can read the chapter 15 titled as ‘DSS for agility index determination’ before or after reading chapters 4-14. A reader can subsequently read chapters 16 and 17.

In the chapter 16, the results of this research work are discussed. Particularly, the reactions of the executives of Salzer are presented in both qualitative and quantitative forms. The thesis is concluded in chapter 17 in which the reactions of the practitioners and experts on TADS and its implementation studies are presented. Further, the limitations and scope for future work of this research are appraised in chapter 17. At the end of the thesis, the references and curriculum vitae of the author of this thesis have been attached.
Figure 1.2 Chapter Organisation
1.6 CONCLUSION

Although currently many practitioners are concentrating on adopting lean manufacturing as a promising production paradigm (Abdulmalek and Rajgopal 2007; Sullivan et al 2002), silently both researchers and practitioners are progressing towards implementing AM paradigm. According to the establishment of certain researches in AM, a combination of Flexible Manufacturing Systems (FMS) and lean manufacturing leads to the achievement of agility in an organisation (Sarkis 2001). A few researchers have also contributed significantly towards identifying the enablers and criteria required for achieving agility in organisations. Though both manufacturing technologies and management elements are included by these researches in AM domain, the foundational researches involving the design for achieving agility have been progressing with sluggish trend. Only little traces of research in this direction in AM arena are available in the form of researchers recommending the application of CAD for achieving agility. Meanwhile, it is to be noted with interest that the field of design engineering has witnessed the intrusion of CAD to a significant extent. Today, a design engineer carries out his/her work only with the aid of CAD.

The field of CAD technology has expanded its domain. Because of this expansion, other technologies like CAM, Computer Aided Engineering (CAE), RPT and Reverse Engineering (RE) have also been included under the scope of CAD research and practice. This is due to the advancement of researches which have been enabling the software developers to seamlessly integrate these advanced technologies with CAD. Hence, a conventional approach incorporated with the criteria for design for agility would be inadequate to enable traditional industry captains to put AM on stronger foundation. Hence, a model which would seamlessly and totally integrate the
advanced technologies being used in design engineering field with AM concepts is the need of the hour. In order to fulfil this need, the research reported in this thesis has contributed the TADS model. The details of designing TADS, conducting its implementation studies at Salzer and the reactions of practitioners and experts on it are presented in the subsequent chapters of this thesis.