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Amalgamation of Mass Customization and Agile Manufacturing Concepts in an Indian Manufacturing Organization

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Abstract: ***This project reports a research work which was pursued with the purpose of indicating the need of amalgamating mass customization(MC) and agile manufacturing(AM) principles for achieving competitiveness in organizations .The research findings and observations on AM and MC were used to design a model named as agile customization programme (ACP). The implementation study of ACP was conducted in an electronics switches manufacturing company situated in India. The practical implications of ACP were studied by gathering feedback from the executives of company. The details of these works are briefly presented in this paper. Further, the practical implications were used to propose a roadmap. The future researchers may adopts this roadmap and implement ACP in various types and sizes of companies. The performance of ACP in those companies shall be measured using AM metrics such as responsiveness, time compression, quality improvement and profitability.***
Keywords – Agile Manufacturing, Mass Customisation, Computer Aided Design, Information Technology, Product design.

I. INTRODUCTION

The terminology Mass Customisation (MC) emerged in the research world during 1990s to envisage that the organisations have to meet the requirements of individual customers in mass [1]. Subsequent to this theoretical enunciation, a significant number of researchers started to work in the direction of achieving MC in organisations [2]. In parallel to the development of MC concept, research on AM paradigm emanated in the world. Though significant researches have been carried out in AM and MC arenas, very little researches have been reported on amalgamating both MC and AM concepts. This chapter reports a module of this research work which was carried out with the objective of bridging the gap between MC and AM in both research and practical arenas. This effort was required to study the requirements of last phase of TADS titled as 'Agile Customisation'. After studying the literature appeared in these arenas, a new term "Agile Customisation" (AC) was adopted in this module of the research work. Digitalisation of products and customer demands processing through electronic channels are the pillars of AC [3]. A programme was devised to examine the practical implications of AC for gathering the individual customer's demands and processing through electronic channels. These processed data were used to bring out the CAD models of numerous electronic switches quickly in response to the individual customer's dynamic requirements.

II. DESIGN OF AGILE CUSTOMISATION PROGRAMME

The rationale followed while designing ACP is described in this section. The conceptual features of ACP are pictorially depicted in Figure 1.

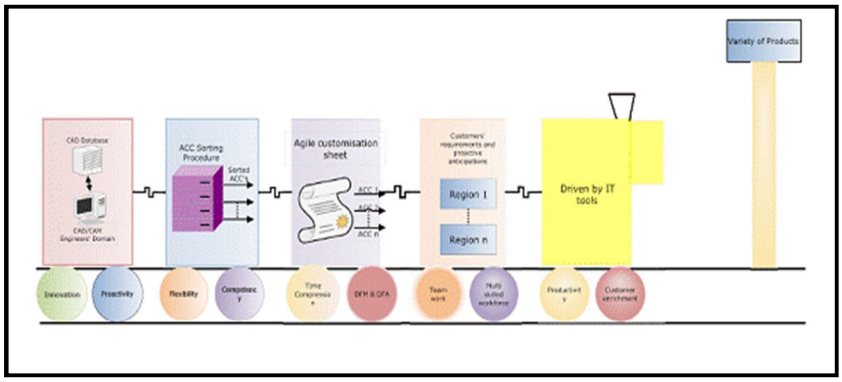


Fig.1 Conceptual features of ACP

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As shown, the ACP consists of five phases which are driven by an efficient IT tool. This IT tool refers to largely software or any automation concept. In the first phase, the customers' requirements and proactive anticipations are gathered. During the second phase of ACP, the company has to consolidate the views and knowledge of the customers. During this phase, a company has to design an automated system which should release an ACS. This will be followed by developing a code for customisation in an agile manner. During the third phase, the agile customisation code (ACC) will be sorted using the hardware of the automated system. This process is required to ensure the easy assembly of the customised products in an agile manner. During the fourth phase, the sorted data are input into the CAD database. The sorted codes would be used to create CAD models using appropriate software. Those CAD models are required to be refined by the design engineers. After finalisation and approval by the CAD engineers, the manufacturing features are generated from the CAD models using CAM software packages. During the last phase, varieties of products generated by CAD models which are finalised and approved by the design engineers are displayed. These displays may be shown to the top management and as well as to the customers for obtaining their concurrence.

III. IMPLEMENTATION STUDY

The implementation study has been carried out in a ABC company. The practical implications of ACP were examined in ABC company with reference to a type of the cam operated rotary switch. During this research, 'S' type switch (hereafter referred to as switch) was chosen. The important operations carried out by this switch are making and breaking the power circuits and diverting the power line to auxiliary circuits. A fully assembled photograph of the switch is shown in Figure 2.



Fig.2 Cam Operated Rotary Switch

IV. IT TOOL FOR CARRYING OUT ACP

During this implementation study, it was decided to drive the ACP using the most efficient software package available in IT arena. Accordingly, one of such software packages by name Adobe Dreamweaver CS3 was chosen. This package enables the developer to visually design, develop and deploy dynamic user interfaces. The framework of this package allows the designers to develop web pages with rich content. This package is incorporated with common user interface components. This software is provided with Cascading Style Sheets (CSS). These sheets enable the users to apply styles which save time in developing the frames of the web pages. Adobe Dreamweaver CS3 also enables its integration with Advanced photoshop CS3 and browser compatibility check.

The Adobe Dreamweaver CS3 is so highly user friendly that it permits the designers to choose the style sheets and design the web pages like developing a PowerPoint presentation slide. The web pages designed using Adobe Dreamweaver CS3 and deployed during the implementation study are described in the following paragraphs. These web pages are collectively referred to in this section using the term 'ACP package'.

The ACP package begins by displaying the home page shown in Figure 3. As shown, it describes the ACP to the users. On proceeding further, the ACP package will display the products being manufactured by the company. The products manufactured in ABC company are incorporated in the ACP package, as it has been developed with the orientation of studying the implementation of ACP at company. The screens showing these features are shown in Figure 4.

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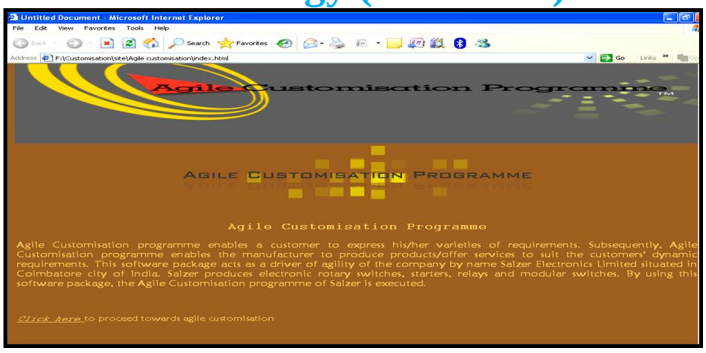


Fig.3 Home page screen of ACP

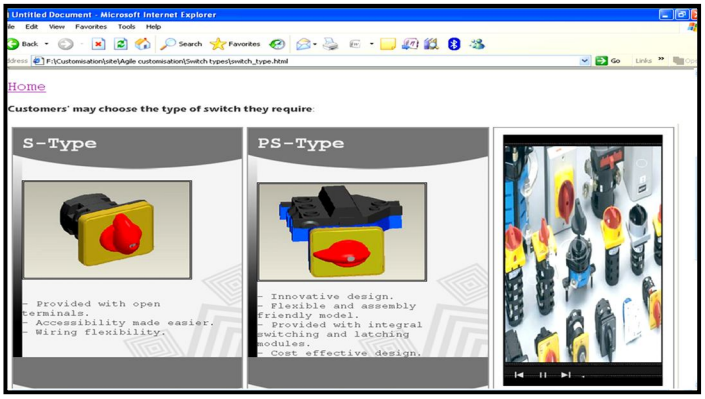


Fig.4 Screen enabling the product selection

Uploading of ACP package in World Wide Web (WWW) would enable a customer of ABC company to study the features of the different types of switches virtually from any part of the world. The customer can begin the customisation process by clicking the type of the switch which he/she considers as a reference model. On pressing the type of the switch by the customer, its exploded view will be shown in the screen. Figure 5 shows the exploded view of 'S' type switch which was clicked in the previous screen (Figure 4).

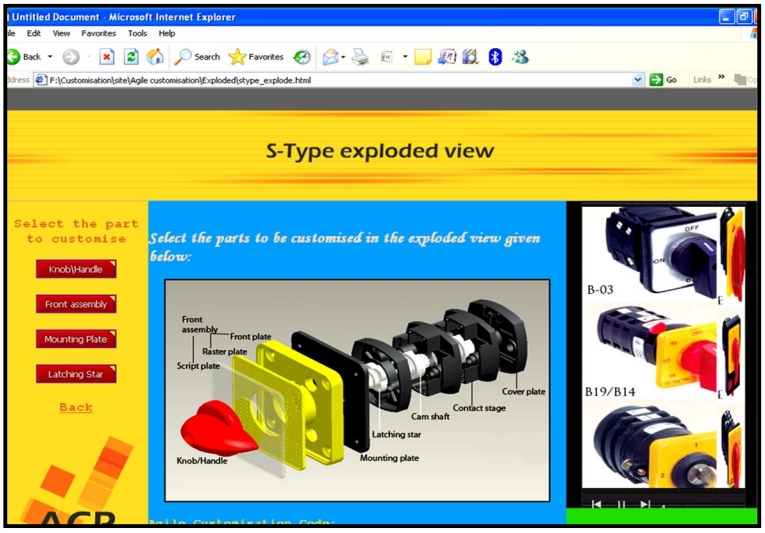


Fig.5 Screen appeared on clicking the exploded view option

Now the customer can press the components against which specific changes and refinements are required. It can be done by clicking the exploded view in the screen of the menus listed in the side of it. Figure 6 shows a screen which appeared after pressing the knob in the screen shown in Figure 5.

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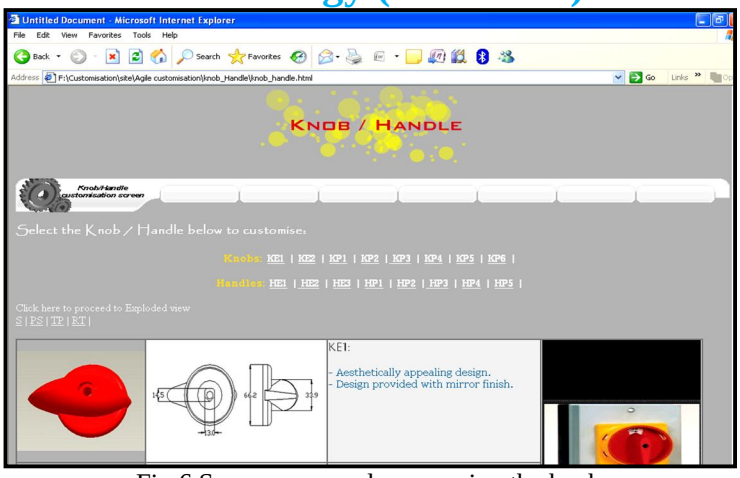


Fig.6 Screen appeared on pressing the knob

As shown in Figure 6, different varieties of knobs are displayed to the customers. Accompanied to them are their drawings. A customer possessing technical knowledge may deeply study the features of the knob and choose the one he/she prefers. Likewise, a customer can view all the components to which customisation features are attached. The customer may also choose different combinations according to his/her preferences. Each preference is marked by its code. Those codes are now entered by the customer in the screen shown in Figure 7.

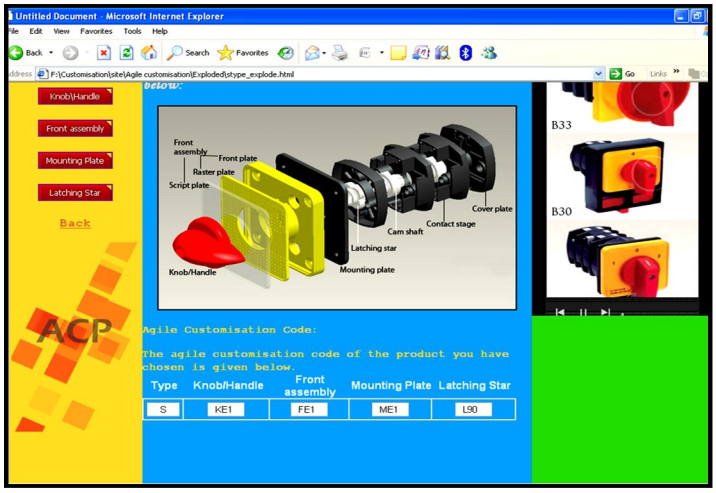


Fig.7 Screen enabling the entry of ACC by the customers

V. DEMONSTRATION AT ABC COMPANY

After developing ACP package, the Application Engineer of Customer Service Department of ABC company was requested to provide the list of customers of the switch. He named 14 customers who are residing in and around Coimbatore city of India. Those customers are the companies which have used rotary switches of company. The first author approached those 14 companies. Surprisingly, two of them did not admit that they are the customers of rotary switches manufactured by ABC company. The list of remaining 12 companies who admitted that they are the customers of rotary switches of Salzer is furnished in Table.1.

Table.1 List of customers responded to ACP research

Customer code	Name of the company
C1	Larsen & Toubro Limited, Coimbatore
C2	Golden Electronic Controls India Private Limited, Coimbatore
C3	Lakshmi Machine Works Limited, Coimbatore

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C4	Lakshmi Electrical and Control Systems Limited, Coimbatore
C5	The General Engineering Company Limited, Coimbatore
C6	Craftsman Electric Company, Coimbatore
C7	Modern Plastics and Equipments, Coimbatore.
C8	SS Systems, Coimbatore
C9	Roots Multiclean Limited, Coimbatore
C10	SGS Equipments India Private Limited, Coimbatore
C11	Aquabsub Engineering, Coimbatore
C12	Kentex Control Systems, Coimbatore

As shown, each company was given a customer code for easy identification. The first author demonstrated the ACP package to the representatives of these 12 companies in their premises. After that, those representatives were requested to complete the ACS. Each representative completed five ACSs.

The five ACSs filled by each customer were designated using the alphabetical letters A-E. Using this combination, each ACS was identified. For example, an ACS with the alphanumerical identification C2B indicates that this ACS is given by an executive whose identification number is 'C2' and his/her indicated options in that ACS are collectively designated as 'B'. Each customer viewed the ACP package and entered their options using the codes shown in it. Those codes are named as ACCs. These ACCs were manually tabulated. After that, the sorting of ACCs was carried out. The order followed to sort the ACCs is shown in the Figure 8.

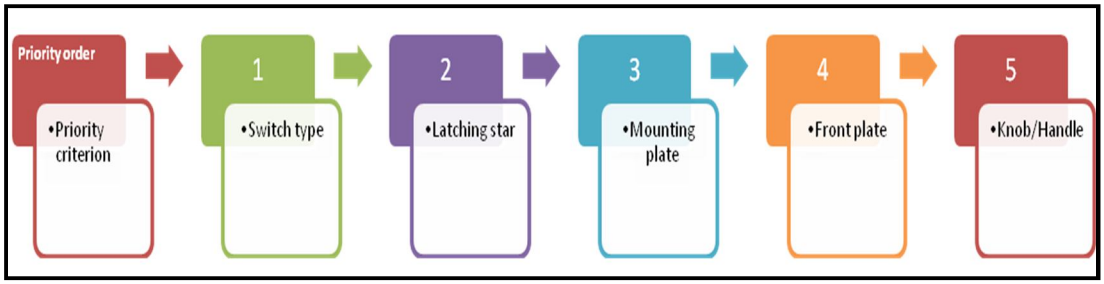


Fig.8 sorting order of Agile Customisation Codes

Since the number of ACCs gathered was 60 which cannot be presented here due to page length restriction, an excerpt of these is shown in Table 2. to illustrate the sorting procedure followed. Sorting helps in forming groups for designing the switches with the priorities. For the purpose of illustrating the sorting process followed, the reader is advised to refer to the first two rows of the column titled as 'ACC (Before sorting)' in Table.2. As shown, before sorting, ACSs with identifications C2A and C1D were closer. Now the reader is advised to refer to the first two rows of the column titled as 'ACC (After sorting)'.

Table.2 ACCs before and after sorting process

ACS Identification	ACC (Before sorting)					ACS Identification	ACC (After sorting)				
	Switch type	Latching star	Mounting plate	Front plate	Knob/Handle		Switch type	Latching star	Mounting plate	Front plate	Knob/Handle
C2A	S	L90	MP3	FE2	HP5	C2A	S	L90	MP3	FE2	HP5
C1D	TP	L45	ME1	FP2	HE3	C11A	S	L90	MP3	FP3	KP1
C3C	PS	-	-	FE3	HP1	C8A	S	L60	MP4	FP4	KP1

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ACS Identification	ACC (Before sorting)					ACS Identification	ACC (After sorting)				
	Switch type	Latching star	Mounting plate	Front plate	Knob/Handle		Switch type	Latching star	Mounting plate	Front plate	Knob/Handle
C5C	TP	L30	ME1	FE2	HE2	C12B	S	L45	ME3	FP1	KE2
C7E	PS	-	-	FE2	HP3	C3C	PS	-	-	FE3	HP1
C8A	S	L60	MP4	FP4	KP1	C7E	PS	-	-	FE2	HP3
C8D	RT	L45	MP1	FP1	KP4	C11E	TP	L90	MP3	FE2	KE2
C9E	RT	L30	ME1	FE3	KP2	C1D	TP	L45	ME1	FP2	HE3
C11A	S	L90	MP3	FP3	KP1	C5C	TP	L30	ME1	FE2	HE2
C11D	RT	L90	MP3	FP1	KP3	C11D	RT	L90	MP3	FP1	KP3
C11E	TP	L90	MP3	FE2	KE2	C8D	RT	L45	MP1	FP1	KP4
C12B	S	L45	ME3	FP1	KE2	C9E	RT	L30	ME1	FE3	KP2

As shown, after sorting, ACSs with identifications C2A and C11A have been brought together due to their many commonalities. According to ACS with identifications C2A and C11A, the switch type, latching star and mounting plate are common with the codes S, L90 and MP3 respectively. Only changes indicated in the options are front plates and knobs. Hence, in this case, a CAD engineer could design switches bearing ACSs with identifications as C2A and C11A with same switch type, latching star and mounting plate. The CAD engineer can make changes only in the cases of front plates and knobs to design switches bearing ACSs identifications as C2A and C11A. This sorting process enables the CAD engineer to design the switches in the electronic environment in an agile manner. Following this procedure, the CAD phase of ACP was carried out manually using Pro/E. Finally 60 varieties of agile customised switches were designed. A sample of 12 switches thus designed is shown in Figure 10. As shown, all the switches are incorporated with different features and were designed in the electronic virtual environment in an agile manner.

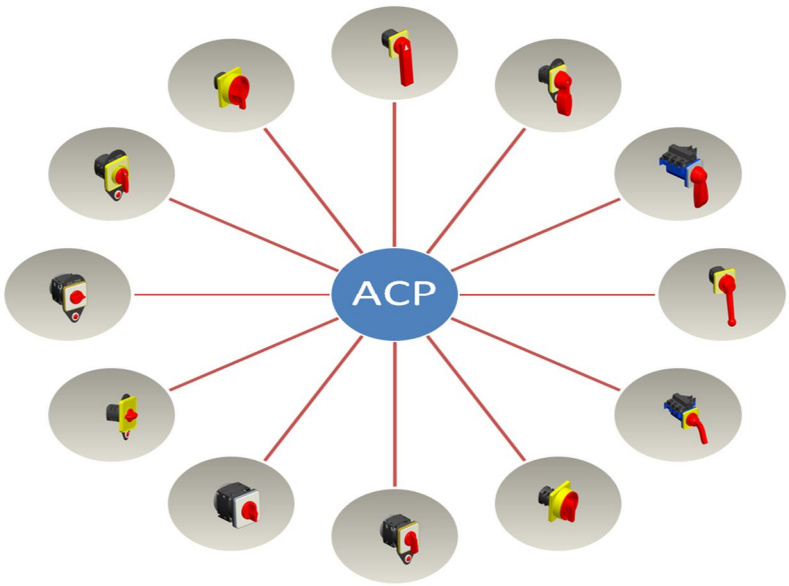


Fig.10 Sample of agile customized switches with their corresponding ACS identification

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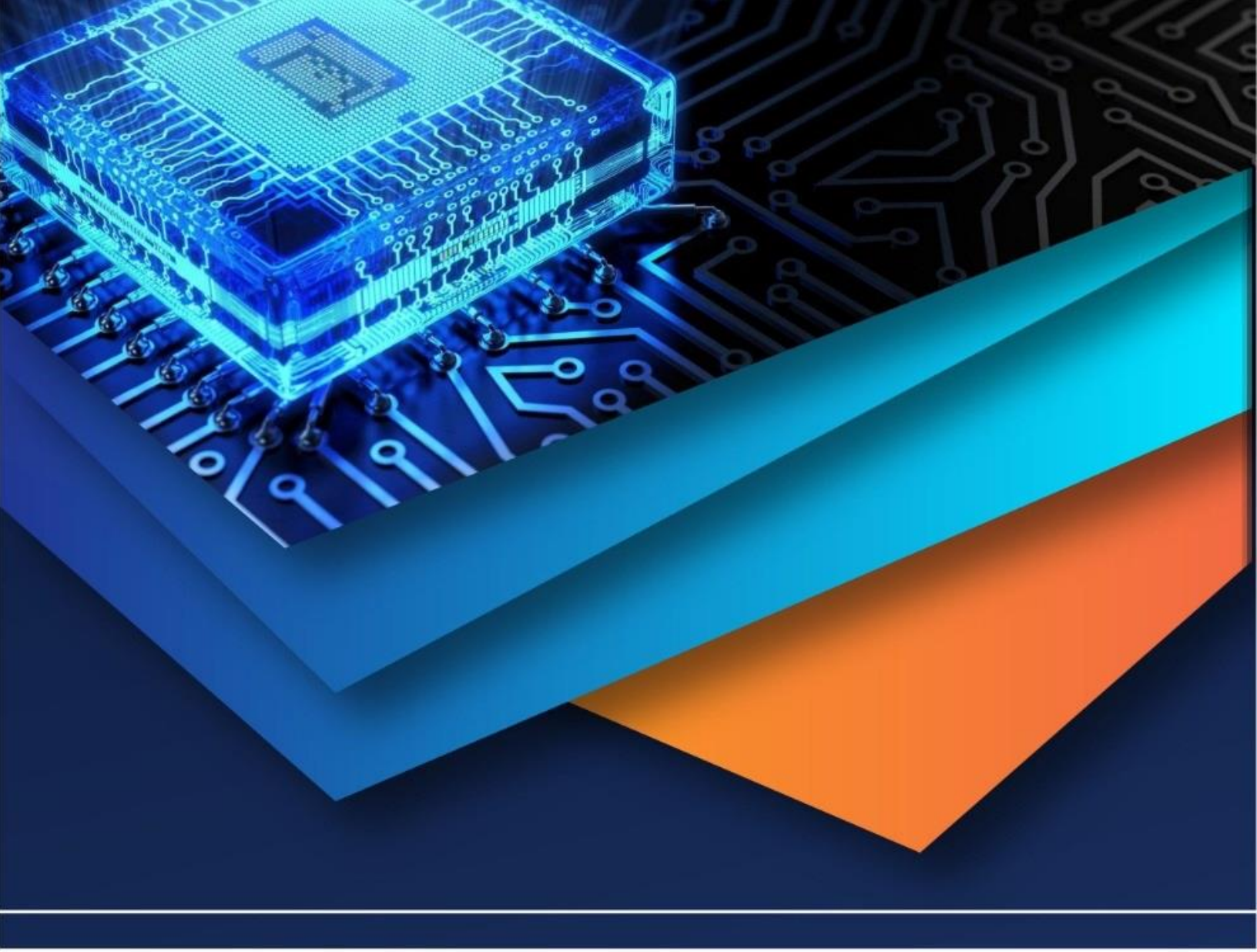
VI. CONCLUSION

In this paper, a new model under the title ACP has been developed to facilitate the investigation of the agile customisation phase of TADS through the amalgamation of AM and MC concepts. The features of AM and MC have been tactfully interwoven in ACP. The implementation study reported in this project could be carried out smoothly which indicated the practical propensity of applying ACP in the agile customisation phase of TADS in a traditional manufacturing environment. In order to further affirm the practical validity of ACP, a feedback session was conducted at ABC Company. The responses and subsequent analysis also confirmed the practical validity of ACP designed during this research. Hence, it is a prerequisite that the organisations shall take action to interface CAD, CAM and CAE solutions strongly for quickly responding to the customers' dynamic desires and requirements through the implementation of ACP.

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