A Collaborative Mass Customization Design Project on Electronic Consumer Goods

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Abstract

Mass customization in the electronic consumer goods industry can benefit from the vision of industrial designers to show what is achievable. To research these issues, a mass customization project was carried out with 36 undergraduate industrial design students working in collaboration with Vestel Electronics Company (one of the leading electronic consumer goods manufacturers in the world). Students were required to generate innovative product proposals for four product groups currently within Vestel's design and manufacturing portfolio. The research findings are summarized with key principles for mass customization of electronic consumer goods and identification of problems and opportunities.

Key words: *Mass customization, consumer electronics, user studies, industrial design*

1. INTRODUCTION

There is an apparent and increasing need to produce good fitting products to customer needs. A consumer utilizes a product more when it matches his/her preferences more closely [1]. Consumers want to be sure that the products they purchase meet their specific needs [6]. Products are usually designed and produced for the expectations and needs of the 'average' customer. [4] claim that traditional product offerings designed for average customer needs form gaps between the offering of the producer and the expectations of the customer. Mass customization stands to be an effective solution for filling this gap. Mass customization has various operational definitions in the literature ([2], [7], [8], [4], [3], [5]).A good working definition is that offered by [9], namely "the ability to provide customized products or services through flexible processes in high volumes and at reasonably low costs". Most definitions of mass customization focus on the fulfillment of individual customer requirements with an intended variability of products but staying within the limitations of mass production.

Based on a review of past and recent studies of mass customization, it can be observed that mass customization of electronic consumer goods is relatively under-developed and less prominent compared with customization in other product sectors, This indicates a problem area suitable for investigation and elaboration through research. Accordingly, a customization project was set up with undergraduate industrial design students, specifically to explore and uncover the processes that would occur during mass customization of electronic consumer goods. The intention of this study was to lead us to practical hurdles and key considerations for achieving mass customization in the sector. The project was carried out with 36final year students as a part of the requirements for the ID 401 Industrial Design V course at the Department of Industrial Design, Middle East Technical University (METU). The reason for selecting students in preference to professional designers was to benefit from these students having nearly professional skills but also fresh ideas not yet limited with intensive pressure of industrial studies and production. In other words, these students would conceivably arrive at more imaginative and inspirational ideas, even though those ideas might necessarily be adjusted later on.

2. PROJECT STAGES

The project was carried out during the fall semester of the 2009-2010 academic year. To benefit from the creativity that brainstorming sessions would bring, and to be able to conduct a comprehensive project within a limited timeframe, group working was used instead of individual work. The students were formed into a total of eight groups, equally split between four or five members. Students were free to form their own groups so as to reach the highest level of group motivation.

The project brief was distributed to the students at the first studio hour of the project on 20 November 2009.All stages of the project were planned to have been completed within seven weeks, with the final jury taking place on 6 January 2010. These stages are explained in Table 1, which contains information on submission deadlines and presentation formats for each stage.

Table 1. Project Stages

Project Stages
1. Briefing *20 November 2009, Friday*
2. Form, Materials, Finishes and Graphics Research *Submission and Presentation on 25 November 2009, Wednesday* *Format: PowerPoint presentation (maximum 15 minutes)*
3. User Needs Elicitation *Submission and Presentation on 4 December 2009, Friday* *Format: PowerPoint presentation (maximum 15 minutes)*
4. Matrix Idea Generation Workshops *Workshop I on 9 December 2009, Wednesday* *Workshop II and Submission on 11 December 2009, Friday* *Format: A3 sketch sheets*
5. Preliminary Jury *Submission on 18 December 2009, Friday* *Presentation on 21 December 2009, Monday (at VESTEL, Manisa)* *Format: Oral presentation accompanied by three full-colour printed posters (maximum total 20 minutes, at least 10 minutes for jury members' discussion)*
6. Final Jury *Submission and Presentation on 6 January 2010, Wednesday* *Format: Digital poster show (i.e. JPEG, PDF, PPT etc.)and a CAD animation(i.e. AVI, MPG, MOV etc.) (maximum total 30 minutes for each group, at least 15 minutes for jurors' questions)*
Visit to VESTEL, Manisa *A visit to Vestel's premises took place between 20 and 21 December 2009, including a tour of production facilities and carrying out the preliminary jury .*

2.1 Briefing

The project brief was distributed to the students at the introductory stage. Objectives and expectations of the project were explained to the students, along with the rationale for studying mass customization and the specific aim of the project to explore the dimensions of mass customization as applied to electronic consumer goods. Students were required to generate design proposals within four of Vestel's well-established product categories:

- Flat Screen TV
- Netbook
- All-in-One PC
- Universal Remote Control

These categories were selected among the active projects carried out at Vestel and were deemed by company staff to have a high potential for customization. Active product categories are those categories of product being designed, developed and produced within Vestel's Turkey-based manufacturing facilities. By choosing these product categories, students were able to access additional in-house company support spanning industrial design, mechanical design, electronic design and production know-how.

There are different stakeholders for the project. Figure 1 explains the influence of each stakeholder and points to be identified with this pilot project as in the brief. These stakeholders are as below:

- Customer influence: They should know about their customers, their needs and desires for the selected product groups.
- Manufacturing base influence: They should investigate the limitations for customization in mass production.
- Company/Marketing influence: They should know about the product sector and abilities of the production company on customization.
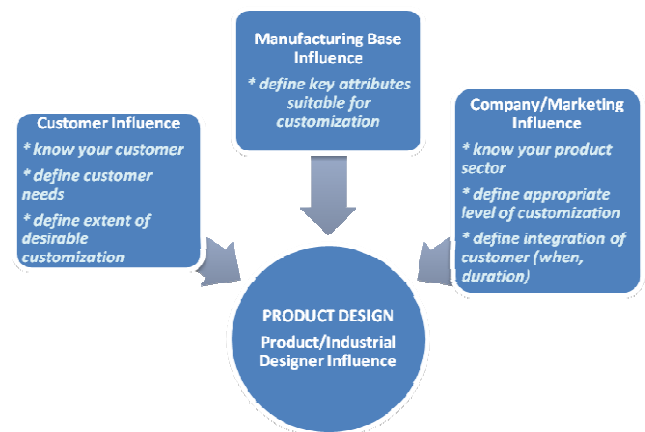

Figure 1. The influence of stakeholders

The main subject areas that students should address and main project dimensions to drive their idea generation are listed below:

Table 2. Main subject areas and project dimensions

Subject Areas	examples
customer-facing hardware	casings, inserts, materials, finishes, colors, graphics
product interaction	graphical user interfaces, other approaches to accessing functions
modularity	components shared across a product family as common 'building blocks'
customization	flexible designs to adapt to specific needs/desires of market segments

Project Dimensions	
ideal function	what functionality best suits your intended customer? what should be left out?)
ideal appearance	what visual language and meanings do your intended customers appreciate?
options+extras	giving customers choices so that their product is distinctive compared with others
dream products	disregard stereotypes and technological barriers: what is possible?

2.2 **Form, Materials, Finishes and Graphics Research**

To fulfill the requirements of this session, students were expected to analyze the variety of forms, materials, finishes and graphics currently used (or projected to be used) within the four product categories. The students were expected to focus on differentiation effects of these product attributes, leading to entry-level, mid-range and high-end market segments. In addition, the students were required to search for associations between product attributes and different market segments. At the end of their investigations, the students prepared a Power Point presentation to be shared with their peers, tutors and Vestel company staff.

2.3 **User Needs Elicitation**

At the beginning of this step the term 'user needs elicitation' was clearly defined for students. It was defined as an activity that seeks to establish the multifarious needs and desires of an individual user – or a group of users – for a new product. Among existing methods for user needs research, the 'extreme user interview method' described within the suite of IDEO Method Cards was adopted for use by students. IDEO Method Cards is a physical collection of 'playing card' style cards. Each card describes a different data generation or analysis method, compiled by a team of designers and researchers at the USA-based IDEO design consultancy. For extreme user interviews, the method, its rationale and a sample study implementing the method are explained as below [10]:

"HOW: Identify individuals who are extremely familiar or completely unfamiliar with the product and ask them to evaluate their experience using it."

"WHY: These individuals are often able to highlight key issues of the design problem and provide insights for design improvements."

"EXAMPLE: By understanding the role and mindset of the youngest family member, the IDEO team uncovered new product design opportunities for household cleaning."

1. Identify Extreme User Representatives: For the student project implementation, students were expected to select extreme users of their product categories. These extreme groups were explained as possibly being very young or very old; housewives or businessmen; and technology lovers or haters.

2. Conduct User Interviews: Students were then expected to make interviews with six defined users. They were let free to use supplementary materials such as images or products during the interviews, to be able to bring out information more easily from interviewees. The students were recommended to ask questions to users about how they would like to change or adapt their existing products to fit to their needs and expectations. Questions were directed towards hardware and software attributes that could be desirable to customize.

3. Gather visual data: In their presentation of the research results, students were required to collect visual data about usage and customization scenarios, along with interactions between target users and their products. These visual materials would intentionally feed creativity during conceptualization and design development processes. Students were advised that any kind of customization idea should be recorded without prejudice, since even a seemingly impractical suggestion could later on spark a creative leap or new design direction.

Students prepared a PowerPoint presentation to communicate the analyzed results of their user needs elicitation research. They were expected to prepare a presentation that included characterization of 6 users, focusing on their current experiences, needs and future expectations. As a result of their analyses, the students were expected to define their own product differentiation strategy that could be implemented during the design phase of their mass customization project. This strategy could plausibly be based on issues such as location of use, technological proficiency, lifestyles and interests. These examples were given to the students to make the demands on them as clear as possible.

2.4 **Matrix Idea Generation Workshops**

Two matrix idea generation studies were carried out with the students, following on from the research results stage. These studies aimed at bringing out conceptual ideas, by combining analyses of the outputs of the research stage with creative thinking.

Matrix Idea Generation Workshop I: First workshop was composed of two stages. In the first stage student groups are required to define their four target user groups. In the second stage they made a sketching exercise based on defining product dimensions of ideal function, ideal appearance, options+extras and dream products.

Matrix Idea Generation Workshop II: In the second workshop students have evaluated the design ideas they have created in the first workshop. This evaluation

leaded students for developing customization ideas based on idea generation workshop I.

2.5 **Product Analysis Exercise**

Prior to the preliminary jury, students carried out a product analysis exercise aimed at stimulating students' comprehension of existing Vestel products across the four chosen product categories. The exercise was also intended to push students to think with a practical eye about which product attributes could and could not be open to customization. They commenced the exercise with a search of online sources and continued with appraisals of physical product samples. Vestel supported this phase by sharing product samples for each of the chosen product categories. Students first analyzed visual attributes of the products, and then followed-up by disassembling the products and investigating their inner components, technical features, assembly methods etc. The product disassembly was carried out as a group activity, for which each group reported its findings to all other groups.

The students were expected to record their findings for the product analysis exercise in the form of sketches and written notes. They were requested to detail their research on external parts, internal parts and customization possibilities of the products. The findings were categorized according to the definitions of three groups:

Non-Customizable Elements– those elements and features that cannot be changed or adapted in any way.

Customizable Elements– those elements that users could make selections on, from amongst a range of offered alternatives.

Optional Elements – those elements that users may add as a non-compulsory extra.

2.6 **Preliminary Jury**

The preliminary jury was performed at Vestel's facilities at Manisa, Turkey. It had the aim of providing students with feedback from professionals of consumer electronics product design and development, and was considered a critical step for provoking students to develop their design ideas to a higher level of thought and realization.

The jury was composed of METU studio instructors and representatives from different departments of Vestel (i.e. industrial design, foreign trade, marketing, software engineering, mechanical design). Students prepared both soft copy and hard copy formats of their presentations. The hard copy was composed of a characterization of selected user groups, their needs and expectations, and images of product designs showing customization ideas. The soft copy was supplemental to the hard copy, to show ideas for interaction and dynamic product features.

During the preliminary jury, students also benefited from a tour of Vestel's production facilities, to increase students' awareness of production methods, product materials and product finishing choices.

2.7 **Final Jury**

The final jury was held at METU, being composed of studio instructors and Vestel staff, similar to the preliminary jury. Students were expected to explain their design proposals on mass customization with a full array of presentation materials (i.e. printed presentation posters, digital posters, mockups, customization catalogues).Their presentations were expected to reflect information on their selected target user group, defined customization strategy, standard, customizable and optional elements and customization examples of the proposed product idea. They were also expected to provide technical details of their project.

Figure 2. Flat Screen TV group customization ideas presentation board
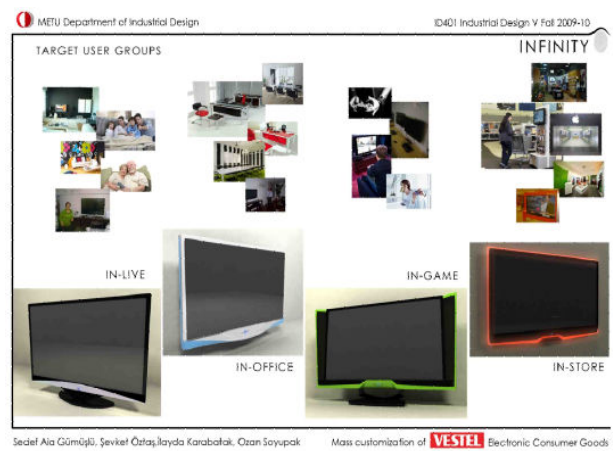
3. PROJECT OUTCOMES

Each student group defined and named their four user groups and provided definitions of the user groups' expectations and needs, as shown in Table 1 (flat screen TV customization), Table 2 (netbook customization), Table 3 (all-in-one PC customization) and Table 4 (universal remote control customization). They have prepared their design proposals for each user group according to these expectations and needs.

Table 3. Customization expectations and needs for four flat screen TV user groups

	In-Live	In-Office
FLAT SCREEN TV - GROUP 1	Should; • fit to the interior • have smooth forms • have soft look Avoid; • Cable mess problem	Should; • have serious and classy look • have Internet connection • be used as a monitor • help a tidy environment • Avoid; • connection problem
	In-Game	**In-Store**
	Should; • have sound system • have modern interface • have preview interface	Should; • reflect corporate identity • fulfill advertisement need • give information

FLAT SCREEN TV - GROUP 8	Hair Dresser	Business Meeting Room
	Should; • attract customers by using modern technology and programs instead of conventional magazines	Should; • provide presentation feature • provide archiving • provide video conference • provide digital marker board
	Game Cafe	**Cafe- Bar - Club**
	Should; • prevent mixing sounds • have a space for game console • prevent cable mass	Should; • provide entertainment • enrich environment • have interactive services

ALL-IN-ONE PC - GROUP 4	Computer Addict User	Dummy User
	Should; • support regular long term usage of computer • support medium to high technological proficiency	Should; • support minimum or no computer experience (user can be afraid to use electronic devices)
	Fancy User	**Stylist User**
	Should; • attract by fancy additional features (there is no crucial need for computer)	Should; • respond to desire for self-expression (user is a style conscious person)

Table 4. Customization expectations and needs for four netbook user groups

Table 6. Customization expectations and needs for four universal remote control user groups

NETBOOK - GROUP 2	Business	Fashion
	• Main concern is the status • Responsible user • More reputation than the self-expression	• Pursuit for being unique • Being under the spotlight all the time • "world is an accessory to show who I am"
	Kids	**Students**
	• Easily changing will all the time • Careless about their belongings and other things • Everything for him/her is a new TOY	• Changing and growing needs and tastes in life • The most common slogan "be free, express yourself"

NETBOOK - GROUP 6	Sportive Users	Teenagers
	• Internet • Multimedia • Easy to carry • Durable • Easy to clean • Sport news	• Internet • Multimedia • Communication • Sharing • Technologic • Durable • Easy to clean
	Elderly Users	**Trendsetters**
	• Internet • Communications • Newspapers • Simple interface • User friendly • Smart • Serious	• Internet • Communication • Watching TV series • Graphics • Elegant

UNIVERSAL REMOTE CONTROL - GROUP 5	Basic User	Conservative User
	• Not familiar with high technologic products • Only use numeric and cross buttons • Rarely use setting controls • Classic interface with bigger controls • Exaggerated numeric and cross buttons numeric • Hidden setting control	• Do not want to change their habits • Do not trust technologic products • Do setting controls more rarely • Classic appearance with classic interface • No use of relatively new technology • Button feedback is preferred
	Everyday User	**High-Tech User**
	• Mainly young or young adults • Used to technologic products • Aware of innovative products • Owning the latest technology is not vital • They tend to use high tech products • High variety of products to be controlled • Old fashioned remotes are not preferred	• Follows new trends • Interested in technology, innovations • Use setting controls more often • Cost is not important when product is technologic • Fast interaction is needed • Using latest technology would be ideal • Appearance also need to be modern

Table 5. Customization expectations and needs for four all-in-one PC user groups

ALL-IN-ONE PC - GROUP 3	Secretary	Manager
	Should; • ease the process of writing • be easy and comfortable to reach the case while using USBs (adjustable monitor) • occupy minimum space on the desk	Should; • be a portable computer • have a portable monitor • have an adjustable monitor • be colorful • be a fun product • occupy minimum space on the desk • have a tidy look (no cables)
	Travel Agency	**Hospital**
	Should; • occupy minimum space on the desk • have hanging options • be dust-free • have an adjustable monitor	Should; • occupy minimum space on the desk • have a tidy look (no cables) • have an elegant and attractive appearance • have an adjustable monitor

UNIVERSAL REMOTE CONTROL - GROUP 7	Elder	College Student
	• Unfamiliar with technology • Possible inefficient eye sight • Deteriorated motor controls • Less complicated layout • Pronounced buttons • Strong feedback	• Wide range in interest of technology • Fixed income • Need of purchasing their most affordable and the best product • Dynamic outlook
	Technomaniac	**Fashion Follower**
	• High interest in technology • Smooth blending into new technology • Pioneer user • Less inconvenience due to complexity • High variety in terms of usage scenario • Wide controllability on all electronics	wide range in interest fixed income high desire in harmony among owned goods

4. OUTPUTS

Below the general implications of the project, based on a review of Table 1-4 content, are listed and explained.

4.1 Importance of Software Customization in Electronic Consumer Goods

It is revealed from the analysis of the project that software is an important element of customization in electronic consumer goods for the chosen product categories. It supports the achievement of higher level customization options. By comparing Group 1 and Group 8 flat screen TV projects with reference to their customization strategy and customization level, this issue can be explained more clearly. It is observed that the level of customization that Group 1 offered is higher than that offered by Group 8, since Group 1 offered both hardware and software customization while Group 8 offered only hardware customization.

A lack of software customization in the presented product categories of electronic consumer goods may lead to two deficiencies mentioned below:

- in such technological products, customization may remain limited with the lack of software customization (such as customization by only replacement of graphic features or colour changes);
- customization carried out with only hardware components in these product categories may bring load to production processes. Increases in both duration of production and cost makes it available only for wholesalers and not for individuals.

4.2 Correlation between Personal Products and Expectation of Visual Customization

It is observed that in personal products such as netbooks, reflection of the individual character of the user onto the product is expected intensively. Students working on the netbook revealed through their interviews that users expected visual customization on their products, since those products were seen as a self-expression tool. Accordingly, personal products can be associated strongly with visual customization. Visual hardware customization (i.e. forms, colours, materials, finishes, graphics, textures etc.), and visual software customization, can be used as a tool to reflect self-expression of an individual user or a user considered as a member of a group.

4.3 Inverse Correlation between Complexity of Products and Priority of Customization

It is revealed through the customization projects that there is an inverse correlation between the complexity of the product and the priority of customization expected. That is, when then complexity of a product increases (such as having a universal remote control in place of a conventional remote control), the priority of expectation of customization decreases. Other issues such as ease of use or ability to fulfill main functions become more important when compared to customization.

4.4 Inverse Correlation between Age and Level of Customization Expected

It was observed from the user research of students that there is also an inverse correlation between users' ages and the level of customization they expect. In other words, when the age of users increased, the expectation of customization on products decreased. There was a high level of customization expectation from 'kids' who participated in the user research phase. For the netbook project groups, their research mentioned about kids' expectation of an everlasting customization process. This would enable kids to continue customizing their netbooks at anytime, with their changing moods or needs. This was desirable according to kids because otherwise they may get bored from a product in a very short time interval. Continuity or renewal of customization options can be achieved by following a post-purchase customization activity. When the user age increases, the expectation to customize a product decreases. The main reason for this can be stated as the complexity of products (such as netbook and remote control) and usage problems associated with them.

Different customization strategies may be offered for customization of these product groups for different age groups of users.

5. CONCLUSION

The mass customization project carried out with industrial design students for this research helped us reveal the above implications that may be helpful for drawing a route on how to better establish mass customization in the electronic consumer goods sector. In accordance with the implications gathered, the following points should be considered carefully while designing electronic consumer goods within the context of mass customization.

- Integration of mass customization in complex sectors such as consumer electronics seems problematic. However it is revealed that software elements can be used as a powerful customization tool for this sector. It can be used in two ways: as a customizing tool for the graphical user interface of products, and as a customizing tool for electronic features of products. Both ways may create excellent opportunities for customization while not needing extra physical components and/or mold manufacturing costs and time intervals.
- The expression of the individual character of the owner of a product is a highly valued expectation on personal products. Different levels of mass customization can be facilitative for achieving self-expression on personal product groups within the electronic consumer goods sector.
- Mass customization should never counteract ease of use in complex product groups, for which electronic consumer goods may be considered a member. It is revealed with the research that if ease of use could not be achieved to an acceptable level, mass customization becomes out of concern for users of electronic consumer goods. An age factor is also related with the ease of use concept. So while designing electronic consumer goods for older users, and especially complex products such as remote controls or notebooks, special attention should be given to this issue.

Further research is planned with a possible mass customization project of Vestel Electronics Company by professional industrial designers. The output of this current research will be used for planning and implementing the further study.

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Projekat kolaborativnog dizajna kastomizovane industrijske proizvodnje za elektronske proizvode široke potrošnje

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Rezime:

S obzirom da kastomizovana industrijska proizvodnja (Mass Customization) nije dobro uspostavljena u industriji elektronskih proizvoda široke potrošnje, može da donese koristi od vizije industrijskih inženjera kako bi se pokazalo šta se može postići. Kako bi se istražila ova pitanja, projekat kastomizovane industrijske proizvodnje je sproveden sa 36 studenata osnovnih studija industrijskog dizajna koji su radili u saradnji sa kompanijom Vestel Electronics (jednim od vodećih proizvođača elektronskih proizvoda široke potrošnje u svetu). Od studenata se zahtevalo da generišu predloge inovativnih proizvoda za četiri grupe proizvoda iz trenutnog portfolija dizajna i proizvodnje kompanije Vestel. Rezultati istraživanja su sumirani sa ključnim principima za kastomizovanu industrijsku proizvodnju elektronskih proizvoda široke potrošnje i identifikacijom problema i mogućnosti.

Ključne reči: *Kastomizovana industrijska proizvodnja, potrošačka elektronika, studije korisnika, industrijski dizajn*