Enhancing Design Capability via Knowledge Repository

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***Abstract*—A software design tool based on the concept of knowledge repository is developed. The aim is to help small- and medium-sized enterprises (SMEs) increase their design capability (hence their competitiveness as design is one of the key contributors to product competitiveness in most industries today). This paper reports the development of a design tool for apparel producers. Design knowledge and expertise of expert designers are encoded in a computer software in the forms that are easy to understand, retrieve and use. Novice designers as well as others with minimal design knowledge such as the owners and customers can produce designs that are as good as those produced by expert designers, and with great speed, employing this tool. Beta testing of the software showed that the tool performed well and the participants (local small apparel producers) are very happy with the tool.**

***Index Terms*—knowledge repository, design tool, apparel design**

I. Introduction

Design is undoubtedly one of the most important factors contributing to product competitiveness. This is true for most products in most industries and is particularly so for fashionable items such as electronic gadgets, apparels, shoes, jewelry and many others. Well-designed durable goods such as automobiles, computers, watches are more competitive than those poorly-designed ones. Well-designed products are not only attractive and popular among customers but are also easier to manufacture and oftentimes less costly. Firms of all shapes and sizes understand the importance of design only too well, and most are doing their best to increase their design capability.

Increasing design capability is no easy task, however. You need good designers and good design teams. You have to really understand your customers and have insights about the customers' needs. You need proper and effective design tools so that you can increase the efficiency of the design process and design productivity. Speed is of the essence in this fast-moving world. This is a nightmare for small- and medium-sized enterprises (SMEs). Good designers are hard to find and very expensive to hire, therefore are beyond the reach of most SMEs. Without good designers, one cannot do much. Good design tool currently available are often expensive and need properly trained personnel to operate.

Wouldn't it be great if there is a relatively cheap and simple tool, a software or something, that could make life easier for SMEs, a tool that could help SMEs increase their design capability. The tool must be simple to use and not overly expensive, well within the reach of SMEs. The concept of knowledge repository might just do the job satisfactorily. After all knowledge has been coded and put in some forms of repository such as books, codes of practice, standards, and software for a long time. Development of a data schema to specifically support a design repository for reuse has been attempted [1]. The ultimate goal of this work is to develop such a tool. We started with the apparel industry as it consists mostly of SMEs and a large majority of them are struggling to survive (in Thailand at least).

Apparel industry worldwide is facing increasingly fierce competition as a result of the ever changing competitive environment including low cost products form emerging economies, globalization, free trade agreements and many others. Manufacturers resort to various competitive strategies and weapons to stay alive; low cost, product differentiation, design, speed, services are among the strategies popularly employed. For some manufacturers, only certain strategies are appropriate as other socioeconomic factors render some strategies ineffective. Low cost, for example, is not an effective strategy for high-waged economies [2].

Given the situation that the apparel market is now a "buyer's market" rather than "seller's market", and that this is to remain so for some time to come, design and speed strategies are increasingly popular and seem to be quite successful for apparel manufacturers [3]. Fashion changes rapidly. Manufacturers must be able to design and produce fashion items very quickly to have a chance, if not, the window of opportunity is gone, for good [2].

In the future ahead, the competitive advantages can be derived from differentiated products and technologies that can bring new products to market faster than others [2]. The needs of each customer have to be emphasized. And the manufacturing of products in accordance with those needs becomes an important goal of any company.

The first step for manufacturing apparel products according to the needs of customers is the couture or designing step. A number of companies realize that shorten the time in responding to customer's needs is

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highly important. Accordingly, computer technology has been used for helping product designers meet specific personal demand because it reduces the time in product designing, leading to better competitiveness.

Fast response, which is the ultimate aim in a ready to wear fashion industry, can be achieved through; 1) An ability to design and change the catalogue of clothes quickly. 2) An ability to create quality designs and make prototypes quickly. 3) An ability to simulate a scene or a background that represents the occasion that the apparels are to be worn. The aim is to assess whether they fit the occasion or not. 4) An ability to alter the patterns, colors, and other features of the apparels on the spot in order to find the most satisfactory ones [4]. The elements of the clothing language are shape, color, texture that reflect different personalities and moods of the wearers such as happiness, excitement, anger, hatred, sadness, shock [5].

There are many tools that have been developed to improve the productivity and competitiveness of firms in apparel industry. Some tools are designed to facilitate apparel designs, some are for coordinating and facilitating rapid manufacturing, some are designed to help both design and manufacturing of apparel products. The C-DESIGN FASHION CAD Software, developed by Zara for fashion design, is capable for both designing and making draft of prototype models and can lay a model in a shop or a showroom, including the patterns alteration and putting the patterns together as a complete product [6]. The 3D Runway Designer Software by Optitex Company can be used by designers to illustrate the patterns and for the retail customers to visualize the picture of finished products. Each and every pattern can be changed and modified until the customer is satisfied. The software can also be used to manage other activities such as pricing and other time consuming matters [7]. The fashion design software developed by PhP Edraw Max is specifically aimed at female fashion with plenty of patterns in the library including manikins, hats, coat suits, buttons, various models of shoes, changeable color of dresses, changeable skin and hair colors of manikins, and accessories for fashion and manikin designs [8]. The Kaledo Apparel Design Software is a software which was created for fashion designers for enhancing creativity process and improve fashion development efficiency, including pointing out fashion trends and colors for each season [9].

The objective of this work is to develop a software design tool employing the concept of knowledge repository. The idea is to encode design knowledge from experience designers in a software in the forms that are easy to understand and use. The primary target market is small-and medium-sized apparel producers in Thailand.

II. Methodology

The approach we used in the design and development of this apparel design tool was the customer-centered approach. We strongly believe that understanding the customers and their needs is critical for the development of the design tool, and for any products for that matter. Having defined our target market, which is small- and medium- sized apparel producers in Thailand, we identified the needs of the customers by in-depth interviews. We chose in-depth interview methodology in the belief that such approach would yield better insights into the needs and the minds of the customers compared with other approaches such as surveys and focus groups.

All of the interviews were conducted "informally" in a sense that no formal protocol was observed. Key interview questions were prepared in advance, however. Each interview was immediately followed by a visit to the facility of the interviewee. All the interviews were recorded and key points regarding the needs and problems of the interviewees were noted.

Once the needs of the customers were identified, the next step was to set the specifications of the tool to be developed. We tried to reflect the needs of the customers in the specifications as much as possible although, admittedly, some parts of the specifications were based on our own insights and ideas. In this work, we treated the specifications as a 'living document' which can be adjusted and improved when additional information and knowledge indicated the need to change.

The tool in the form of a computer program was then designed based on the needs of target market and the specifications mentioned above. There are two requirements that the tool 'must meet'; users with minimum design knowledge must be able to use the tool to design a wide variety of apparels effectively, and the tool can be upgraded continuously so that new data and information on fashion trends and other relevant matters can be made up to date. As a result, the key design concepts are that the tool must be highly user-friendly and it must also be highly modular so that upgrading can be made continually.

The computer program was then written and coded. Prototype program was 'beta tested' periodically to see the responses of target customers. Improvements of the program were carried out continually after the tests and/or when new data and information were obtained. In the latest beta testing, ten local apparel producers were invited to participate in the test. The participants include those who had minimal experience in apparel design. The key objectives of the test were to determine; how easy it for the participants to use the software, how fast could the design be accomplished, and the overall satisfaction of the participants in the software.

III. Result

Based on the 'customers picture' obtained from the interview, a tool was designed and developed in the form of a computer program. We realized that the customers picture obtained was far from complete but it was useful from the tool development perspective nonetheless. The key design requirements for the tool were; first it must meet the needs of our target customers reasonably well and, second it could be upgraded on a continual basis.

In order to meet such design requirements, the modular architecture was employed in the design of the program. Modular architecture design would enable the inclusion of additional subprograms in future updates. Updating or

modifications of existing subprograms could also be carried out with relative ease. Modular design would also meet the needs of the producers better as one could choose whatever subprograms that served one's needs at the moment. When more subprograms are available, more needs can be served. The tool therefore consisted of a main program and several subprograms, each subprogram performed a specific function.

Individual subprogram was designed to be a repository of relevant data, information, and knowledge in certain dimension that are important to apparel design. The aim is to help designers and producers access relevant data, information, and knowledge as quickly as possible. Design possibilities could be explored rapidly and design decisions could be made within a short time, thus improving design productivity. Novice designers and manufacturers would be able to perform design activities as effective as expert designers once individual subprograms are fully developed.

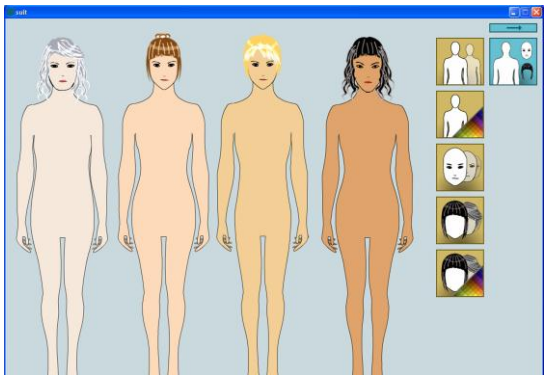

Figure 1. Manikin models.

At present, there are 4 subprograms in our tool; model building subprogram, select-what-you-like subprogram, mix-and-match subprogram, and scene subprogram. The model building subprogram enables designers to create approximate models of the customers. Such models are used to test whether selected apparels fit well and how they will look when particular apparels are worn. Several features of the models can be altered in order to create the models that are as close to target customers as possible. These include face shapes, hair styles and hair colors, body shapes, and skin colors. Models can be created fairly quickly. Users simply select various features from the library. Examples of the models created by the are shown in Fig. 1.

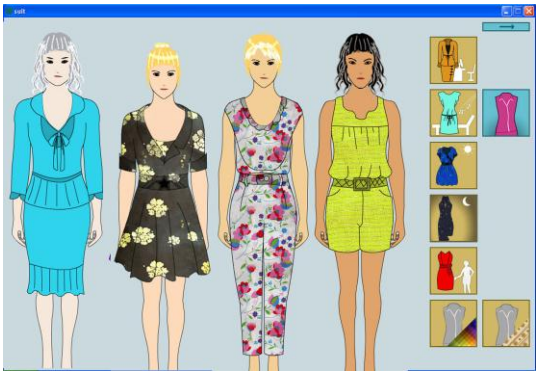

Figure 2. Select-what-you-like apparels.

The select-what-you-like subprogram contains a library of 'ready-made' designs of apparels typically use in various occasions. These include attires and dresses for official engagements, social outings, parties, as well as clothings for office workers and leisure wear. A variety of colors, textures, and patterns of the apparels can be selected from the library Examples are shown in Fig. 2.

The mix-and-match subprogram enables users to create designs from apparel 'parts' stored in the library. Numerous designs can therefore be created by selecting, mixing, and matching these 'parts.' Customers can design their own apparels using this subprogram. Examples are as shown in Fig. 3.

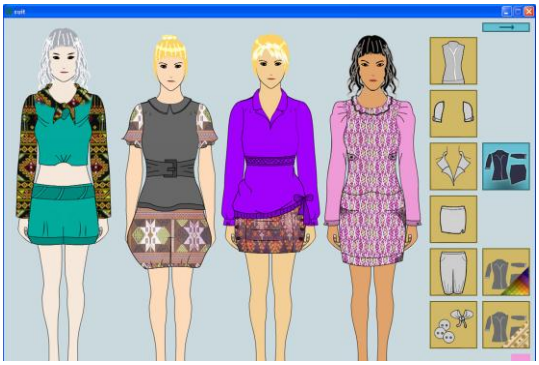

Figure 3. Mix-and-match apparels.

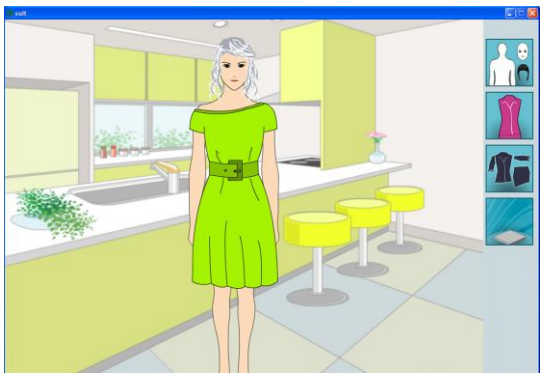

Figure 4. Scence and background.

The scene subprogram is use to create or simulate the scenes, the occasions, and the locations that the apparels are to be worn. Examples of such scenes include the office, the party, official engagements, showrooms, living rooms. The scenes can be created simply by clicking those stored in the library. The aim is to see whether selected designs are appropriate and look good for the occasions. An example of a scence created by this subprogram is shown in Fig. 4.

The outputs of all these subprograms are graphical displays on the monitor. The displays of the designs can be viewed by all the people involved including the customers.

Beta test results were promising. Novice designers were able to learn and use the tool vary quickly. Design productivity in terms of speed and number of designs completed per day increased dramatically compared with traditional design method. Apparel producers who participated in the beta test were very happy and satisfied with the tool.

IV. Discussion

As the competition in apparel industry become increasingly fierce and global, manufactures need to adjust their competitive strategies to stay alive. Apparel designs play a crucial role in improving competitiveness of apparel producers. Some kinds of design tools are necessary to improve design capabilities of apparel producers who are mostly small- and medium-sized enterprises. The software apparel design tool developed in this work provides at least part of the solution in improving competitiveness of these firms.

The tool would first of all increase 'design productivity' reducing the idea-to-prototype time considerably compared with traditional design process. The time from ideas to prototypes is particularly important for fashion items which change rapidly.

The tool would also ameliorate the lack of good and experienced designers, a very common problem for small and medium sized firms. Relevant information could also be accessed using the tool. This would help the producer get up-to-date data and information such as design trends, needs of customers from various sources in various parts of the world. The customers also benefit from the tool as they can access numerous possible designs stored in the library. The customers can even design the apparels themselves so that specific needs and tastes of individual customers can be catered for.

The database and relevant information are rather limited at present. Addition of data and information can, however, be performed with ease due to the modular architecture of the tool. More subprograms can be added to cater for diverse needs of customers. Information about the cultures and tastes of oversea customers can be added. Knowledge of expert designers can be codified and added to the tool on a continual basis. When the tool is fully developed, it could enhance the capability of novice designer and local apparel producers considerably.

V. Conclusion

A software tool for apparel design based on knowledge repository concept is developed. The tool serves the needs of small and medium sized apparel producers in many fronts. These include improving design productivity, reducting the time from ideas to prototypes (hence time-to-market), mitigating lack of experienced designers problem, improving access to relevant information, all of which are critical to the competitiveness and survival of the enterprises. The tool is designed in such a way that the database and information can be improved continually to meet the diverse and changing needs of the customers. Beta testing showed that the tool performed satisfactorily as intended. Participants in the test were fairly happy with the tool. Although the data and information are limited at present, additions of relevant data can be accomplished easily. The tool is expected to be very useful and beneficial to apparel producers, particularly small and medium-sized ones, in Thailand and in other countries.

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