Title:
On Conceptual Modeling of Apparel Products

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Introduction:
Apparel can be viewed as a product [1] and it is a generic name for all types of clothes [3]. Like any other product, the apparel product needs the computer support in order to meet the ever-increased demands from the customer. An effective computer support requires an effective communication between the computer and human, and this requires a conceptual model of the underlying application, apparel in our case. Further, the conceptual model needs to be expressed in a way to facilitate the computer's representation. A conceptual model captures basic concepts and their relations, which form a framework of knowledge about a domain of application. Another expectation of the conceptual model is that a conceptual model should be expressed in a way to facilitate the human and human communication, where the human refers to all the personnel involved in development of a product.

In summary, there are three functional requirements (FRs) on the conceptual model. First (FR1) is that a conceptual model must capture all basic concepts and their relationships underlying the particular domain of concerned applications. Second (FR2) is that a conceptual model is a facilitator for the communication between the human and computer. Third (FR3) is that a conceptual model is a facilitator for the communication among all personnel who are involved in product development. In the current literature of apparel design, there is not any conceptual model, which satisfies three requirements, FR1, FR2 and FR3, with a particular attention to the concept of 2D and 3D apparel system, to the best of our knowledge.

This study presents a conceptual model of the apparel product, which satisfies the aforementioned three requirements. The model development tool will be presented first, then conceptual model of apparel, and utilization of the conceptual model will be covered as well.

Conceptual Model Development Tool:
Concepts and their relationship are regarded as data. For data modeling language, we have both diagrammatic way and textual way to represent the model. Particularly, the diagrammatic representation is in favor of human and human communication (FR3), while the textual representation is in favor of human and computer communication (FR2).

In this study, to develop conceptual model, we adopt the modeling language from Zhang and Werff [5] owing to its best to meet the three general requirements for data modeling as mentioned before. In Zhang [4], the basic language grammar or construct is shown in Fig. 1. In Fig.1, the concepts of class, attribute, and type are presumably known to the reader. The construct of "is-a" describes the knowledge that among A, B, C, there may be such knowledge that A represents the common nature of

B and C. The construct of "has-a" describes the data abstraction of an emergent property aggregated from a set of attributes.

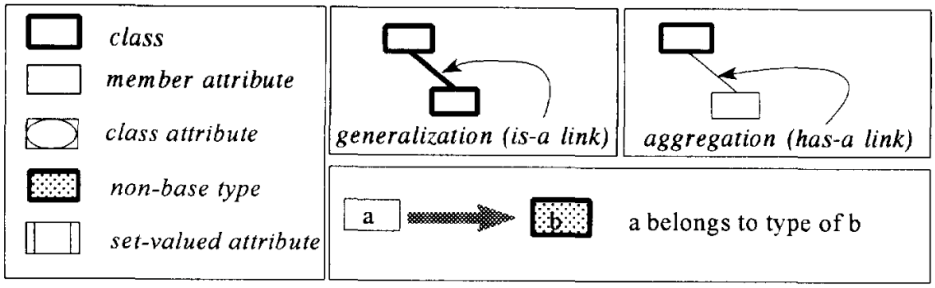


Fig. 1: Diagram representation of basic building blocks [4].

Fig. 2 is a construct called association. Two class objects can be associated by any reason that appears (L1, L2) on the edge that connects A and B. The association may have a direction in that A may be a cause for B (see Fig. 2(b)).

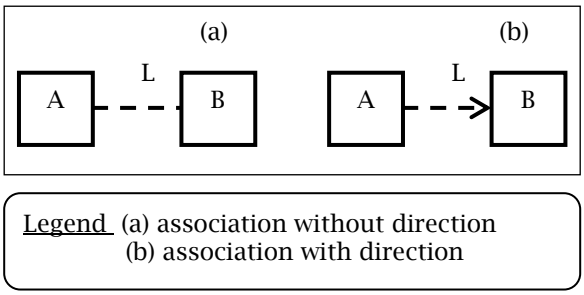


Fig. 2: The diagram representation of association.

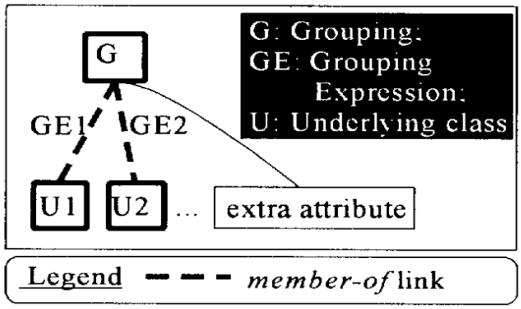


Fig. 3: Definition of grouping [4].

Fig. 3 shows a construct called grouping. Given a set of objects say U1, U2, grouping is applied to them, which leads to the situation that U1 and U2 are put together with some reasons to play a new function or role.

Conceptual Model Of Apparel Products:

Semantics of Apparel

Definition 1(Apparel): It is a general category that denotes all sorts of clothes (i.e. dress, skirt, and blouse).

Definition 2 (Ease): It refers to the margin between the human's body and apparel. It has two kinds: wearing ease and design ease. Wearing ease allows a body's movement, while design ease is added on the top of wearing ease to create a specific silhouette in a 2D pattern.

Definition 3 (Pattern): It is drafted from the block to add the ease in 2D. Different 2D patterns can be developed from the same block.

Definition 4 (Block): It is the basic fitting template (2D) that closely fits the body without the ease added on. The block has two types: bodice and skirt. The bodice block covers the upper part of body from the shoulder down to the waist (including the waist). The skirt block covers the part of body from the waist and hip. The bodice block has an interface for the sleeve and collar patterns to be developed, and the skirt block has an interface for the trouser pattern to be developed (Fig. 6b).

Definition 5 (Dart): It refers to a tapered seam of material in order to form a three-dimensional shape [7].

Definition 6 (Gather): It is the state with shortening the length of a piece of material to attach to a shorter piece of material.

The Conceptual Model

Fig. 4 expresses that a piece of apparel, such as a dress, a sleeve, and so on. The expression can be applied to the whole meaningful apparel, such as a jacket, but also to a part of the whole apparel, such as sleeve. In Fig.4, it is also expressed that an apparel product consists of a set of 2D patterns. Fig. 5 expresses that there are a variety type of apparel, and apparel is a generic notion for all types of apparel, e.g., a dress is a kind of apparel, a skirt is a kind of apparel and so on.

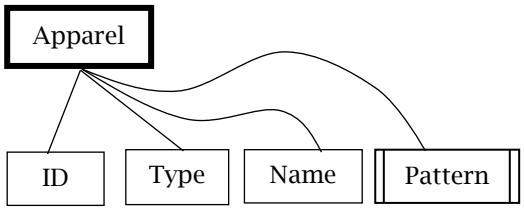


Fig. 4: Data representation of apparel.

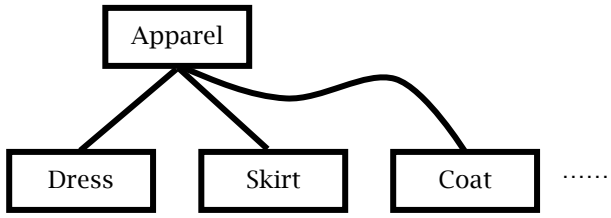


Fig. 5: Data representation of types of apparel.

Fig. 6 shows that a particular pattern is developed by starting with a block and thus a pattern has the information of block. Further, a pattern may have several eases, darts, or gathers. Fig. 7 expresses the information of the block. Particularly there are two types of blocks (skirt and bodice) (Fig. 8), and for a particular piece of block, its complete geometry is determined by several dimensions of human body, such as waist, and so on.

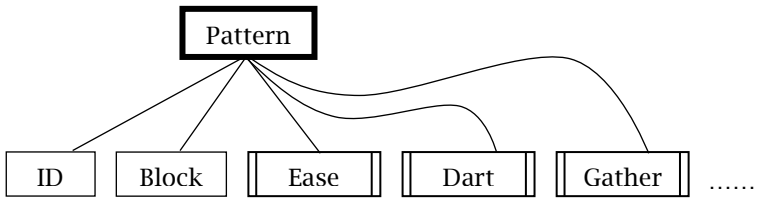


Fig. 6: Data representation of pattern.

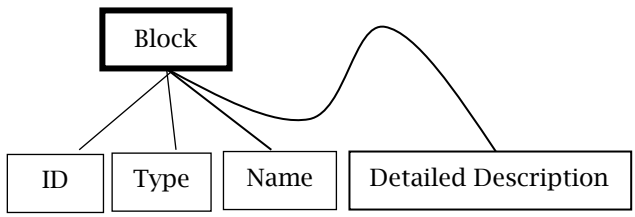


Fig. 7: Data representation of block.

Fig. 9 shows the relationship among the block, ease, dart, and gather. Particularly, the ease expanded from the block, resulting in the block-ease, that is the block-ease is a "sum" of the block and ease. The dart and gather are associated with the block-ease in that both dart and gather are defined on the top of the block-ease in the same reference coordinate system.

Fig. 10 represents that an apparel product it is made from the 2D pattern. A complete apparel product may contain more than one pattern, which is represented by the set-valued attribute. Fig. 10 also represent how the 2D pattern and 3D apparel are associated such that they share the same attributes of 'ID', 'Name', 'Type', 'patterns'. The 3D apparel product includes the pattern-pattern assembly, details of which are represented by another data model 'Pattern-Pattern Assembly' (Fig. 11).

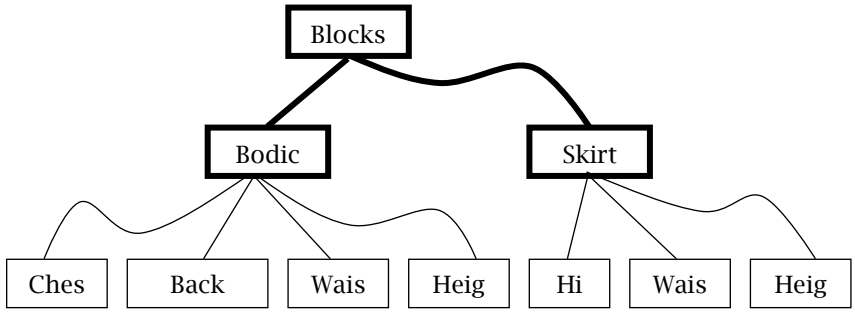
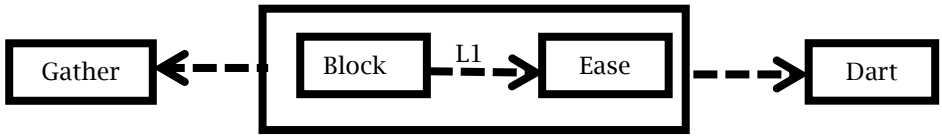


Fig. 8: Data representation of types of block.



L1: expanded (ease is expanded from block)

Fig. 9: The relationship between block, ease, dart and gather.

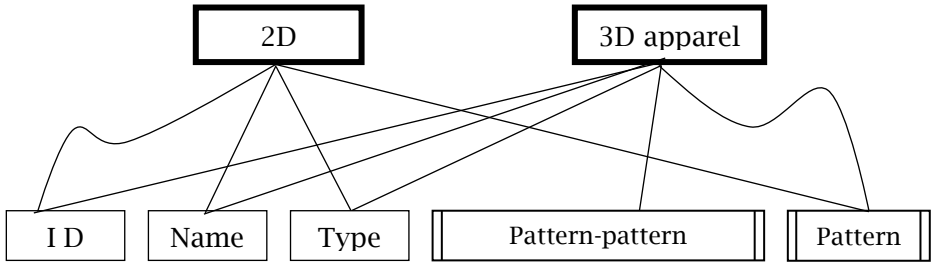


Fig. 10: Data representation of 2D pattern and 3D apparel.

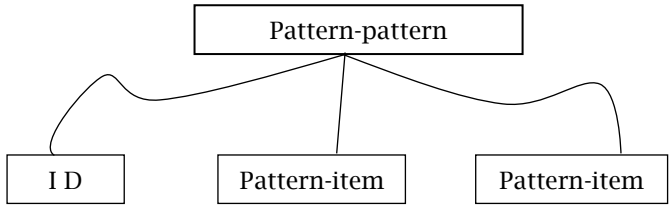


Fig. 11: Data representation pattern-pattern assembly.

Utilization Of The Conceptual Model:

One important application for the conceptual model is to facilitate integration of various software programs for the apparel design and manufacturing. In the apparel design field, several commercial software programs are available, e.g., Marvelous Designer, CorelDraw, C-DESIGN Fashion, OptiTex, and Fashion CAD. First, these software programs may not easily integrate to one another. For instance, Marvelous Designer has the format *.ZPrj, which cannot be recognized by CorelDraw. Secondly, no software program among them is powerful enough to perform all the functions of apparel design, which thus calls for integration of several instead of developing one super-powerful software system.

For instance, both C-DESIGN Fashion and Fashion CAD can support 2D pattern design; Marvelous Designer and OptiTex can support 2D pattern design as well as conversion of 2D pattern to 3D apparel; Design Concept 3D can convert 3D apparel into 2D pattern. Even though the software system such as marvelous Designer can do both 2D pattern design and 3D apparel simulation (thus simulation-based 3D apparel design), its 2D pattern design module is not as strong as the software program such as Fashion CAD, which only provides support to 2D pattern design.

The above discussion has clearly shown a need to have a unified format to represent the data in the life cycle design of apparel, and this requirement can be satisfied by the conceptual model (as the first step) and subsequently various external models represented by the language such as UML. Note that the conceptual model as developed above can be easily substantiated with UML and becomes the UML model.

Conclusions:

In the study, we proposed a conceptual model for apparel products. The model describes the basic concepts and their relationships in the domain of apparel design and manufacturing. The model is generic in that it provides a template while particular apparel under design can be substantiated with the temperate. The model is also general in that all types of apparel are covered by the model. The model is a semantic one that meets the requirement of facilitating the human-computer communication. The model can be further developed into a UML model that allows the detailed specification of data. The UML model is then used to develop various external models. Details regarding the concept of conceptual model, external model, and internal model can be found from the standard database text, particularly the so-called SPARC database architecture [2].

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