Drawings and the Development of Creativity and Form Language in Product Design Education

Dr. Elivio Bonollo [1]
Emeritus Professor, Industrial Design, University of Canberra

Dr. Carlos Montana-Hoyos [2]
Associate Professor, Industrial Design University of Canberra

Introduction

Drawings have long been the visual thinking tools of designers in all of the professional disciplines including the arts and crafts. This paper reflects a current research interest of the authors in which students from particular discipline backgrounds (in this case industrial design) visualise their ideas in the design process. As a perceptual motor skill, practically everyone can make drawings as marks on paper, or on a computer screen or in many other media, in an informal and meaningful way. For example, Figure 1 shows sketches made by kindergarten children when asked by a design student to make a drawing of a cat. In their innocent minds they have pictured that a cat has three whiskers on each side of its face along with other common perceptions of its features.

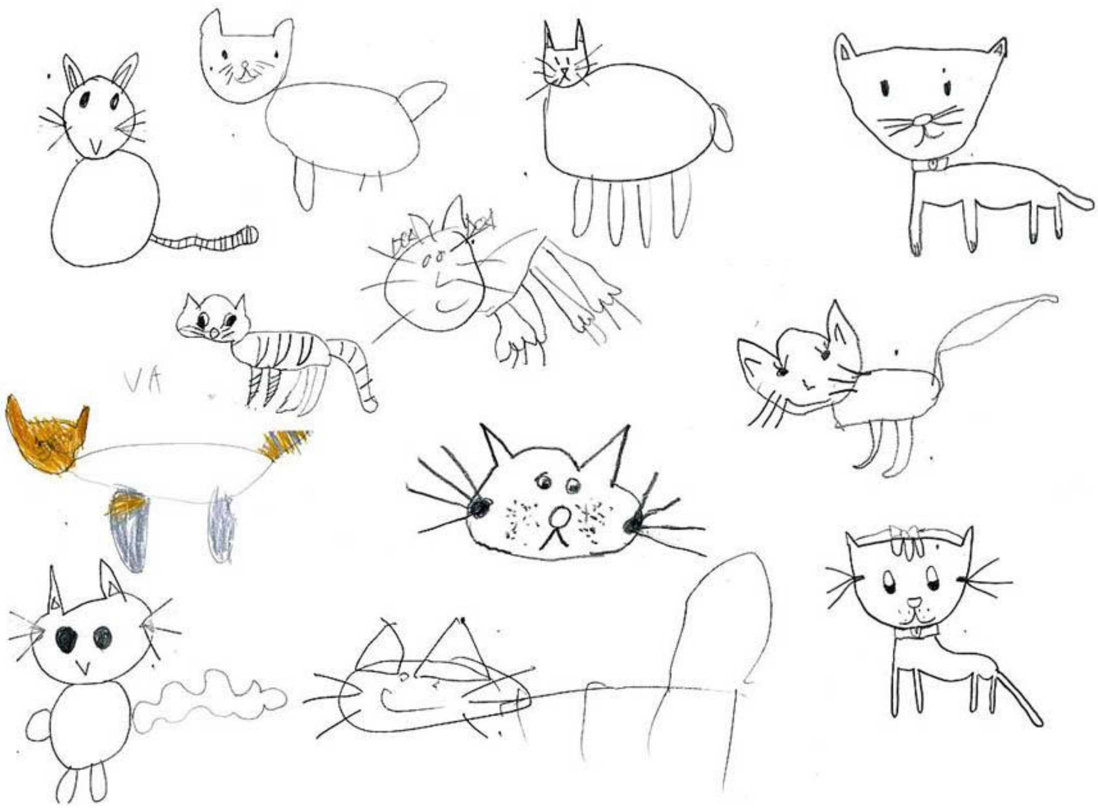

Figure 1: Kindergarten children's freehand sketch perceptions of the features of a cat. Designer: Joanne Teoh.

Given that these children may have had some drawing tuition from their teacher, their drawings reflect their perception of what a cat looks like in their 'mind eye'. This perceived visualisation is *informal* in the sense that it is ‘ordinary,’ ‘familiar’ or ‘constructed’ in the absence of any *formal code* or set of rules, and assumes that the children would have at least ‘seen’ a cat before making a drawing of it – in this case, the designer’s pet cat. In the design process, such sketches, doodles or scribbles may have meaning according to their authors’ imagination and intuition, but to observers these sketches may be meaningless because the form of the item sketched is not readily discernable, at least not in the initial phase of the process. This is not necessarily problematic. In this example, the sketches may be regarded as biological analogies of the real entities depending upon the intuition of the designer (as will be shown later in Figure 3 below). This freehand and informal way of visually expressing an idea or concept is a well known characteristic of human thought including that of scientists and designers (McKim, 1980; Pinker, 1994).

In terms of a micro level of activity, these sketches are often small in scale, numerous in quantity, variable in quality and apparently dependent on the visualisation style of individual designers. Little appears to be known about this level of activity in design even if the process is well understood at the macro level. Hence, further studies in this area of research should prove worthwhile. The relationship between drawings, imagination and creativity will now be briefly examined. This will be followed by considering how drawing typology and form development are related in the design process.

Drawings, Imagination and Creativity

Creativity is generally accepted as one of the main objectives of the ‘design disciplines’, which deal with the ideation and creation of the artificial world. Some interesting studies have been reported in the literature on how professional and student designers know, think and learn (Cross, 1997; Durling, 2006; Lawson 1980, 2006; Bonollo, 2010). Although there are similarities, creativity may have different interpretations across disciplines (Reid and Petocz, 2004). Some writings have described creativity as the confluence of intrinsic motivation, domain-relevant abilities and creativity-relevant skills (Amabile, 1996). On the other hand, Sternberg (1985, 1999) has reasoned that creativity is a decision-making process.

It is noteworthy that creativity and problem solving are generally recognized as *cognitive strategies* or higher order thinking skills (Bloom, 1956; Kratwhol *et al*, 1966), which may be enhanced through experiential learning (Kolb, 1984). Not surprisingly, the degree of *originality* and *worthwhileness* of design concepts is often dependent on the perceptions of individual observers or of members of assessment panels. But, apart from the criteria connected to the *characteristics of the product*, creativity from a learning point of view is also related to how designers go about solving design problems in an intelligent way. Hence, designer *personality*, *methods* and *problem-solving styles* are all important in this context, although these may be difficult to assess in general (Amabile, 1996; Bonollo, 2010).

As proposed in this paper, drawing as a visual language is strongly related to contiguous decision making fundamental to achieving a creative outcome in the design process. In design education, what is often looked for in a project is a conceptual outcome that is *original in form* and of potentially *improved performance* — that is, a design which may be perceived as creative with respect to fulfilling *worthwhile use* and *esteem* functions, whilst adhering wherever possible to *ecodesign* and s*ustainability* principles (Fuad-Luke, 2004; Montana-Hoyos(a), 2010). In the design process, students often progress quickly from concept sketching to exploring ideas by using simple mock-ups and models whilst experimenting with materials and processes of manufacture. As pointed out by Kelley (2006, p 43), for example, modeling or "prototyping" is a valuable tool for developing ideas in his organization.

Creativity can also manifest itself differently in the various phases of the design process (see Figure 2). In the initial, divergent phases, creativity is reflected in the ability to generate many ideas or concepts as possible solutions to the design brief or problem. Here, simple sketches (or Level 1 type drawings, as will be explained later) are a powerful aid to intuition and imagination. The ability of constructing mental images, especially of new design proposals, is enhanced through drawings, which inform the creative process. However, in the final stages of the design process, where convergent thinking is used to filter ideas and refine the most appropriate ones, creativity manifests itself as the ability to select the right solutions within diverse design constraints so that *design judgement* becomes an important attribute. As discussed below, it is interesting to track how different types of drawings and models are utilised during this process.

Drawing Typology and Form Development in the Design Process

Some attempts have been made to classify the various types of drawings that designers, and design students, typically use. For instance, Fraser and Hemni (1994, in Lawson 2004, (b)) have suggested five types of drawings, namely, referential drawings, diagrams, design drawings, presentation drawings and visionary drawings. Relatedly, Lawson (2004, (b)) has also proposed various categories including presentation drawings, instruction drawings, consultation drawings, experiential drawings, diagrams, fabulous drawings, proposition drawings and calculation drawings. Although similar in nature, these categories may differ according to the respective design disciplines especially at the micro level of visualisation.

The typology of drawings as a visual language and their meaning, in terms of the design process and the development of form, are worth investigating in the educational context especially as aids to promoting self-reflection, creativity and a basic understanding of design thinking phenomena in design education. The emphasis in this paper is on studying the nature and characteristics of the types of drawings and related models *per se* and how they contribute to a creative outcome in the design process, especially when designing simple products. In this regard, the obvious types of drawings used to initiate the design process are often referred to simply as *thumbnail sketches*, and these are typical of the design thinking that occurs early on in the concept generation phase of the process. For reference, a simple model of the design process is given in Figure 2 (after Lewis & Bonollo, 2002), bearing in mind that this is an iterative process and that the boundaries between phases are often fuzzy and not clearly defined.

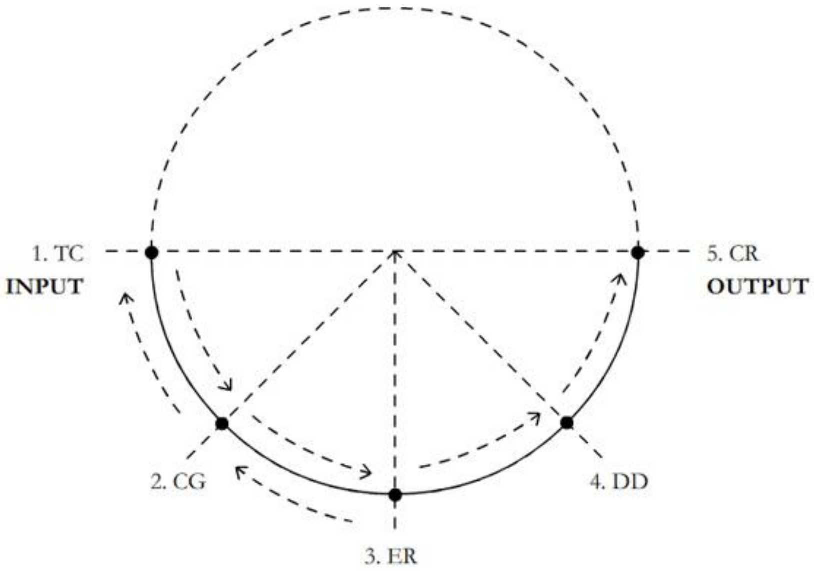

Figure 2: Diagram of a generic design process model: TC (denotes task clarification), CG (concept generation), ER (evaluation and refinement of design concepts), DD (detailed design) and CR (communication of results).

In terms of a rough classification, these *thumbnail sketches* may also be referred to conveniently as *Level 1* type sketches, for argument sake, since their *information content* and *detail,* in terms of interpreting the *semantics* (Sebeok, 2001) or *meaning* of the form and other stimuli embedded in the syntax of the perceived object, is relative low and personal to the designer (Bonollo, 2010). In other words, the student designer can visualise and imagine certain elements of the form from these two-dimensional sketches and proceed to develop the form in a contiguous manner, but this may not be so clear to other observers. In general, it is apparent that the *Level of the drawing* is indicative of its *content, detail* and *meaning*.

Another way of looking at this phenomenon is that these *informal* sketches acquire meaning as part of a conversation with one's self, in order to slowly develop the final solution (Schön, 1983). These types of sketches usually occur in the zone between Phase 1 and Phase 2 of the design process in Figure 2 (as elaborated upon below). In some cases, students may prefer to progress their ideas with mock-ups or simple models rather than sketches as favoured by some professionals (Kelley, 2006).

Visual Analogies and Form Development

CASE 1 Biological analogies

As foreshadowed in relation to Figure 1 above, the eyeglasses design shown in Figure 3 hereunder was inspired by the eye characteristics and whiskers of the design student's pet cat as perceived by kindergarten children (Bonollo, 2010 p 158).

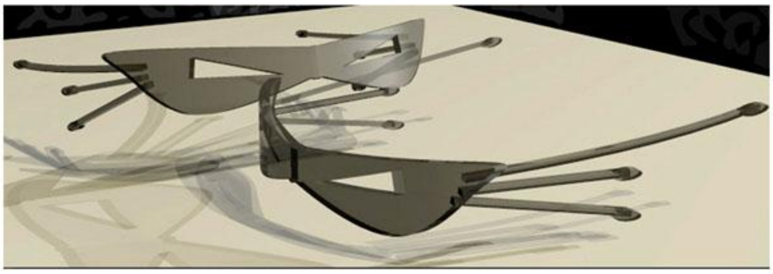

Figure 3: Sunglasses concept based on a biological analogy with the eyes and whiskers of a Cat (see Figure 1). Designer: Joanne Teoh

This type of analogy is generally referred to as biological, as it comes from a living creature, and can be understood as a simple type of *Biomimicry* (Benyus, 1997). Biomimicry theory proposes that nature is a rich source of ideas and potential innovative solutions for human problems (Montana-Hoyos, 2010, (b)). Biological analogies (Guyler, 1970; Wake, 2000) are generally useful as a design method for stimulating creativity. The following case illustrates another approach for using analogies as an aid to creative design whilst tracking the evolution of drawings in the design process.

CASE 2 Other visual analogies

In more detail, an interesting example follows in Figure 4 where the student designer's brief was to develop a novel folding stool which could be used for picnics and similar purposes (Bonollo, 2010, p171). This figure shows the designer's concept sketches based on the form of a Malaysian kite and appropriately entitled 'Fly with me.' The designer here has started with sketches that may be interpreted as an *informal visual language* in which the form of the object needs further development. The fact that the sketches may not be particularly clear to an observer or tutor is not important at this stage. These freehand sketches (Level 1 type sketches) are clearly part of the *creative knowledge* (Pedretti, 2004) and *visual language* that the designer has used in a personal way to record and communicate design concepts along with any *verbal language* (i.e., words and phrases) that may be required for further explanation.

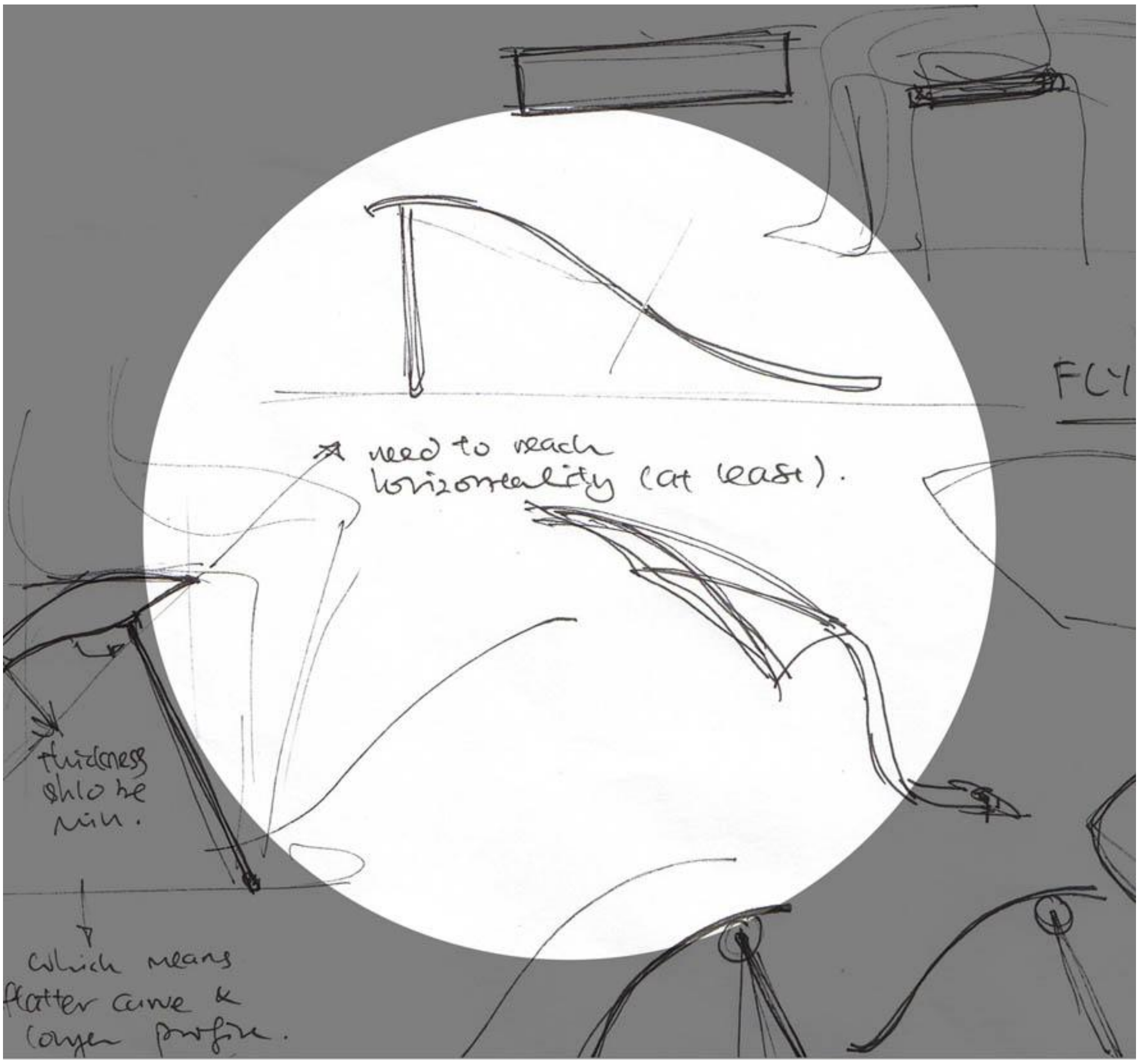

Figure 4: Concept sketches of a folding stool based on an analogy with a Malaysian kite. Designer: Tan Keng Khoon.

This visual language is an observable, characteristic output of the designer's *visual thinking*, meaning the *mental images* and *graphical constructs* which he has used to generate concepts and related information, mainly in the concept generation phase of the design process, but also in other phases as required. In general, *visual language* is a term often used in the field of art and design to differentiate and describe the drawing and painting techniques of artists and designers namely, their ways of communicating ideas and issues by means of graphical dimensions (de Lucio-Meyer, 1973).

Returning to Figure 4, at the stage of development shown by these sketches it is possible to discern, albeit vaguely, some of the basic *shapes* and *profiles* of the stool concept in a two- dimensional (2D) context, but the *form* of the stool in three dimensions (3D), although no doubt clear as an image or graphical model in the designer's mind, still needs to be communicated more clearly for the benefit of an observer's perception. Ideally, this phenomenon of *form giving* (a cognitive process) should manifest itself as a creative *form language* in a model or prototype (or final product): It's interesting to see how this may apply in this case.

To continue, Figure 5 indicates how the designer has developed the *form* of his stool concept by means of polystyrene formers and cardboard seat templates. He modified the profile until he was satisfied with the *form language* of the seat (the major component).

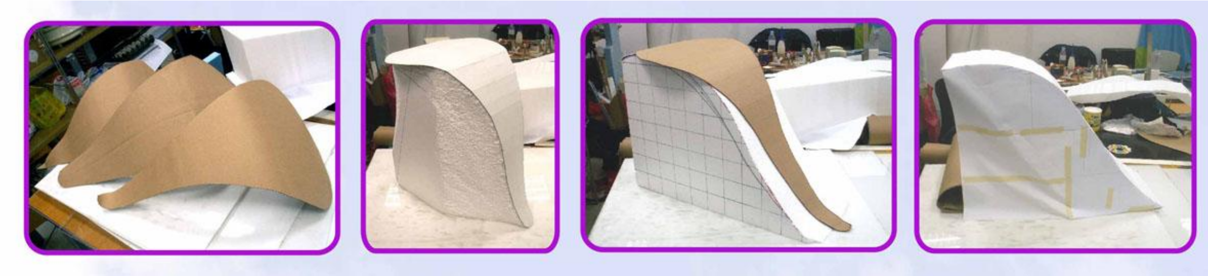

Figure 5: Development of the form of the seat of the stool concept by means of polystyrene formers and cardboard seat templates. Designer: Tan Keng Khoon.

Figure 6 shows the final prototype with a FRP (fibreglass reinforced plastic) seat; the intended seat material is moulded plywood.

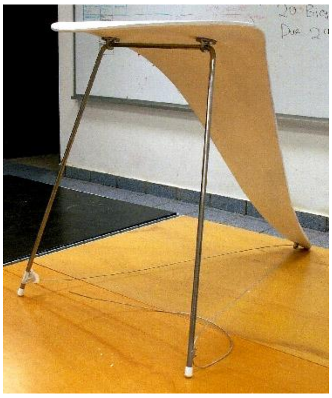

Figure 6: The final prototype of the *Fly with Me* folding stool. "The 'kite' analogy not only puts forward a design statement, but also makes the stool lightweight and easy to carry by hand." Designer: Tan Keng Khoon

The technical drawing of the stool is shown in Figure 7. It follows that there has been a progression from an *informal visual language* (i.e., the Level 1 sketches and rough mock-ups) to a *formal visual language* (i.e., the technical drawing and prototype) which may be referred to as *Level 3* drawings as used for communicating the characteristic of the design to others (clients, manufacturers, etc.). At this *Level* the *information content* is high, the *detail* is comprehensive and the *meanings* imbedded in the form are very clear.

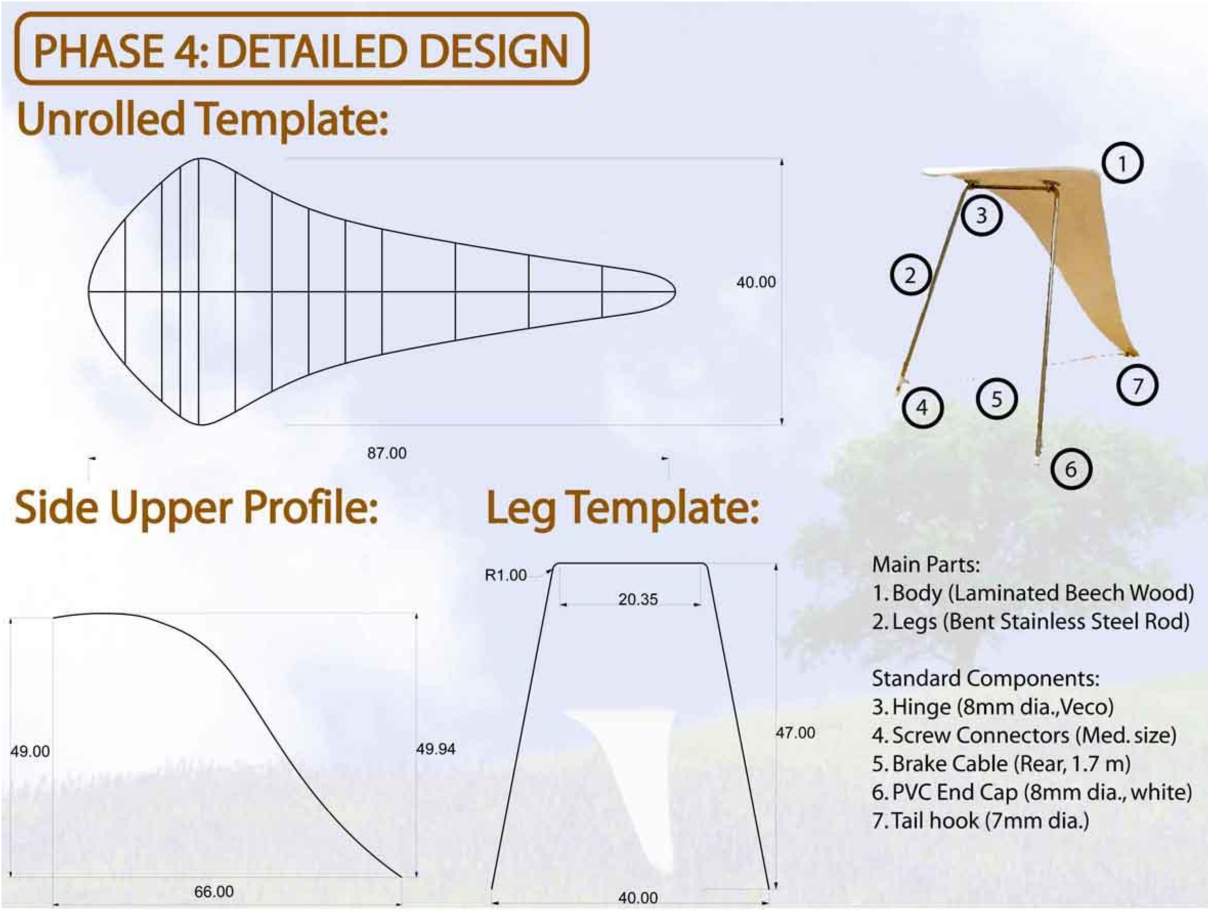

Figure 7: Technical drawing panel, extracted from the designer's folio, showing the stool prototype with dimensions and parts list (detailed design phase). Designer: Tan Keng Khoon

Interestingly, *visual language* can often be seen as an outcome of an *informal*, cognitive process as in Figure 4 or a *formal* process wherein the various views drawn of an object are constructed by designers according to strict rules and conventions - such as prescribed for engineering or technical drawings based on orthographic projection (Williams, 1991; SAA 111, 1993. Similar standards are used for constructing formal Architectural drawings. As is well known, there are also formal rules available for constructing perspective and isometric views of objects in drawings (e.g., Gill, 2006; Vero, 1980), and this adds to the *set of codes, or visual languages* available to product, architectural, engineering and other designers for specifying and communicating design information.

In summarising this case, as the student designer has worked his way forward through the design process by employing the *visual language* of drawings, models and prototypes, it may be seen that the *information content, detail* and *meaning* of these communication media increases markedly. Hence, it is usually possible to perceive the *whole form* of the product much more clearly in relation to its intended use and esteem functions and the related syntactic, pragmatic and semantic properties. That is to say, it is possible to perceive the *form language* of the product or object more clearly as the evolutionary design track approaches the model or prototype stage: this follows lucidly from the content of Figures 4 to 6 and 7.

From this process it is reasonable to intuit that *form language* - as used in the common design vernacular - is a special case of *visual language* which focuses on communicating the *three dimensional features* or *syntax* of a design model or prototype in a clear and perceptible manner. Bearing in mind that these features may include meaningful stimuli in the way of *tactile, auditory, olfactory* and *gustatory* properties; that is, they may convey certain meanings (semantics) to an observer or user. It follows that the *form language* of a product should communicate its functional purposes (use and esteem functions) in a clear and unambiguous manner (Norman, 1998).

CONCLUDING REMARKS

In closing this paper, it is worth briefly reviewing the above discussion with reference to Figure 8 below, which summarises how the different levels of drawing and modelling evolve during the design process, and the zones where these levels of drawing often apply. As utilised by the design students in the examples above, this model is a framework which can be used to *plan, carry out* and *manage the design tasks* in a flexible and adaptable manner. This interactive model is non-prescriptive in terms of design methods; it is only concerned with the macro level of the process and does not restrict nor direct how individual design students go about finding solutions to design problems in their own unique ways. Figure 8 illustrates, in a general way, how the different types (or *Levels*) of drawings, mock-ups, models and prototypes evolve and are utilised during the design process.

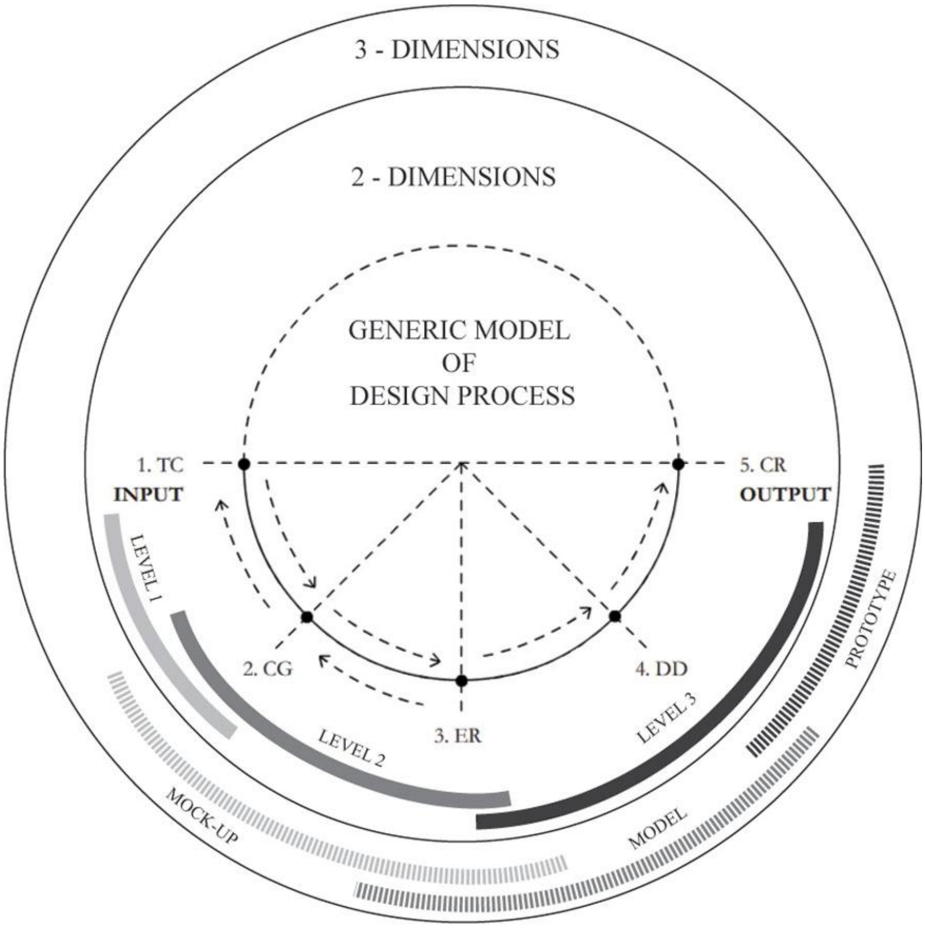

Figure 8: Diagram of a generic design process model: TC (task clarification), CG (concept generation), ER (evaluation and refinement of design concepts), DD (detailed design) and CR (communication of results. As commonly used in the various phases and zones of the process, this shows the types of 2D communication tools (drawings), namely, Level 1, Level 2 and Level 3, as well as types of 3D communication tools, namely, mock-ups, models and prototypes.

As mentioned at the beginning of this paper, this design process often starts with an *informal* visual language and finishes with a *formal* visual language so that the product form language, including use and esteem functions, are properly described. This paper has attempted to establish an initial position on a study of the nature and semantics of drawings *per se*, especially those at the early stages of the design process that appear to be so indicative of design thinking and creativity in education; more research is needed in this area with respect to individual as well as a variety of design disciplines.

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