The Character of Design Tools

A framework for describing the character of design tools and their relationship to industrial design practice

James Self, Professor Hilary Dalke

School of Design, Kingston University London
London, UK, K0729860@Kingston.ac.uk

Abstract: Design tools are used by industrial designers to embody design ideas. It can be a challenge for novice or less experienced design students to understand the relationship between the character of the design tool and its application during practice. This is because practice is dynamic and progresses from conceptualisation towards the development and detailing of design ideas. The paper proposes a framework for the taxonomy of design tools and the measurement of their character. The aim is to provide novice designers with a more informed understanding of the relationship between the idiosyncratic character of design tools and there use in supporting practice.

Key words: Design Tools, Industrial Design Practice, Design Tool Characteristics

1. Introduction

Industrial designers use a variety of design tools to embody abstract design ideas during practice [14]. These tools may include sketching, conventional model making, hi-fidelity prototyping; a variety of conventional, digital and hybrid processes. Understanding the ways these various tools, with their idiosyncratic characteristics, influence the embodiment of design ideas is critical to design practice. Experienced designers have an ability to make this judgment [20]. Inexperienced designers are less able, resulting in constraints on creativity and the early crystallisation of design ideas [5]. Based upon literature review, this paper proposes a framework for measuring the character of design tools. The review resulted in two outcome constructs that together informed the framework. First, a Taxonomy of Design Tools within a model of design practice that progresses from initial concept design to development design and on to detail design [1, 2, 22]. And second, 5 Universal Design Tool Characteristics (UTC's) used to measure the character of the design tools identified in the Taxonomy. The work-in-progress framework was then used to inform a survey of design practitioners. The resulting survey data was then employed to build a character description of individual tools, helping to make explicit the idiosyncratic characteristics of various tools and their influence upon design practice. Initial results suggest the framework has use in examining the character of design tools and the relationship this character has to design practice.

2. Method: Framework for Measuring Design Tool Characteristics (UTC's)

2.1 Taxonomy of Design Tools

Various design tools are used to embody design ideas during industrial design practice. Before these design tools could be measured and their support of practice assessed, it was important to classify them. A 3 stage model of practice was used in the Taxonomy of 11 design tools. These 3 generic stages were termed; concept design, development design and detail design [1, 2, 15]. The 11 Design tools: Sketching, CAD, rapid prototyping, digital

modeling for example, were then categorised according to their use during these 3 stages of practice [3, 11, 13, 14, 19]. These 11 tools were then measured in terms of their defining universal tool characteristics (UTC's) against the purpose of their use in practice; to support concept, development and/or detail design.

2.2 The 5 Universal Tool Characteristics (UTC's)

Along with the Taxonomy of design tools, an approach to measuring each tool's characteristics was developed. 5 UTC's were identified through literature review of cognitive design and design representation. In particular, the role sketching plays in the support of practice [5], a series of papers on design representation by Goldschmidt [6-10] and Visser [22], Johnson's comparative study of digital and conventional tools [12], Schon's text on reflective practice [18], Dortra's [4] work on hybrid design tools during concept design and Purcell's [16] review of literature on the role of drawing in design. The 5 UTC's are summarised in Table 1.

Table 1: Showing 5 UTC's, descriptors, references and terms used

5 UTC's	Descriptors of 5 UTC's	Reference	Terms
1. Mode of Communication	How the design tool supports communication of design ideas to others. How the design tool supports self-reflection and the emergence of design ideas.	Dortra [4]	Self-reflective mode
		Schon [18]	Representation, analysis, emergence
		Goldschmidt [7]	Dialogue with self
		Johnson [12]	I-representations
2. Levels of Ambiguity	To what extent the design tool supports the more ambiguous embodiment of design ideas. To what extent the design tool supports the more unambiguous embodiment of design ideas.	Goldschmidt [7, 8]	Unstructured nature
		Goel [5]	Ambiguity/ Density
		Visser [22]	Unspecific
3.Transformational Ability	To what extent the design tool supports movement from one design idea to a new idea, horizontal transformations. To what extent the design tool supports movement from one idea to a variation of the same idea, vertical transformations.	Goel [5]	Mode of Transformation
		Visser [22]	Duplicate, add, detail, concretize, modify, revolutionize
4. Levels of Detail	To what extent the design tool supports a high or low level of specific detail in the embodiment of ideas. To what extent the design tool supports an overall or artistic impression of general detail in the embodiment of ideas.	Brereton [6]	Different kinds of information available
		Visser [22]	Precision
		Goldschmidt [7,8]	Less/ more specific
5. Levels of Commitment	How the design tool communicates a higher or lower level of commitment to design ideas.	Goel [5]	Crystallisation/ completeness
		Pipes [14]	More Committed
		Tovey [21]	Uncommitted/ more committed

The Taxonomy of Design Tools, based upon the 3 stage model of design practice, and the 5 UTC's are the constructs upon which the framework for measuring design tool characteristics against design practice is based. The framework was then employed to inform the design of a survey of practitioner.

2.3 Survey

Eight questions, measuring designer attitudes towards the character of the tools they use to support practice, were included in the survey. Relating to one or more of the 5 Universal Tool Characteristics (Table 1), these questions used a five point Likert scale ranging from strongly agree (+2) to strongly disagree (-2) [17]. The 8 questions (originally 10 but for the omission of 2, which were considered after a pilot to be unnecessary) resulted in a total of 8 values for each of the 11 design tools identified in the Taxonomy and used in the survey.

3. Results

The survey received 49 responses. Each response consisted of values describing the design practitioners' attitudes towards the 11 tools identified in the Taxonomy. These values were the result of the 8 questions measuring the character of these design tools. The sum of each of these 8 values (value x 49) was then calculated to come to a total value for each. These 8 total values were then used to describe each tool's universal characteristics; the strengths of their UTC's. These descriptions were compared to the purpose of the design tool's use; concept, development and/ or detail design. Relationships between common Universal Tool Characteristics and the purpose of the tool's use during practice were then analysed.

4. Discussion

The results of the survey suggest a number of common characteristics between design tools, used at the same stage of practice. For example, tools used during detail design supported the embodiment of design ideas with high values of UTC 4: Levels of Detail. They were also characterised by the unambiguous embodiment of ideas, UTC 2: Level of Ambiguity. However, results also showed other tools, such as sketching, have a spread of characteristics that suggest the medium is equally useful for a variety of purposes. Value trends of Universal Tool Characteristics between tools used for similar purposes, to conceptualise, develop and detail design ideas, suggested that common universal characteristics exist in relation to practice. Through the application of the framework these common characteristics emerged to inform a description of the relationship between the character of industrial design tools and their support of design practice.

5. Conclusions

This paper has described an approach to measuring and making explicit the character of design tools and their influence in supporting industrial design practice; a framework for measuring the characteristics of design tools. This framework has two constructs: the Taxonomy of design tools around a 3 stage model of industrial design practice and 5 Universal Tool Characteristics. The framework was used to inform 8 survey questions, measuring the attitudes design practitioners' have towards the character of the tools they use during practice. This resulted in the identification of common universal characteristics between tools used for the same or similar purposes during industrial design practice; to conceptualise, develop and/or detail design ideas.

The relationship between the character of design tools and design practice is critical. Considering this, if the tool/practice relationship is broken, through the use of tools with characteristics that do not best support practice, that practice may be compromised. However, more work is required in the validation of this hypothesis and the development of the framework. In particular, the framework requires the contribution of experts in the field to

inform, refine and progress its design and use. Further research will include the interviewing of industrial design practitioners and the analysis of design tool use by novice designers during practice, through experiments with student designer participants. Future work will include the use of the framework to inform the construction of a digital resource, for novice and less experienced designers, describing the critical relationship between design tools and design practice.

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