Design Rationale Capture in Detailed Design Stage

UTC for Computational Engineering

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Background

The design decisions made during various stages of the design process have a profound impact on the product lifecycle cost. As indicated in Figure 1 only approximately 25% of design knowledge is available by the end of the preliminary design stage, while committed cost accounts for more than 80% of the total product life-cycle cost (Verhagen et al., 2012). Therefore, the effective and efficient product data management is crucial in the product development process as it defines the longevity of the project, which in turn, affects the cost. Moreover, in the early stages of design it is essential to provide effective tools to the designer for better-informed decision making and for better exploration of the design space because often in early design stages the knowledge of the product is unclear, incomplete, and difficult to represent.

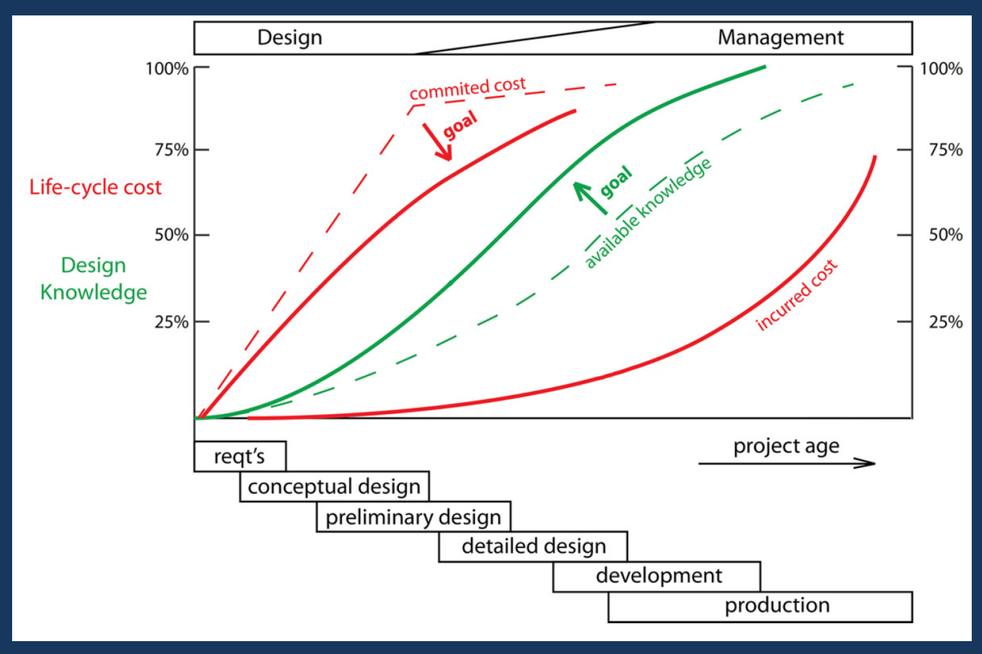

Figure 1. Prediction of Product Lifecycle Cost with increased available knowledge in early design stages. Adapted from Verhagen et al. (2012).

Challenges of Knowledge Capture

It is believed that re-using knowledge will increase the preliminary design knowledge, reduce or even eliminate the duplication of data across systems and reduce the product life-cycle cost (See Figure 1). While benefits of the tool that supports knowledge capture, representation, and reuse are evident, the development of such a tool seems to remain a challenge.

Majority of the current knowledge reuse tools are specific applications with descriptive or prescriptive approaches (See Figure 2). Prescriptive approach is bounded and restricted by a method used, therefore is too restrictive and inflexible. Descriptive approach, however, does not impose any restrictions on design and decision, yet is too general. Moreover, the majority of Design Rationale capture tools are generic prescriptive in nature.

	When	What	Whose	Who	Where
Prescriptive	During	Known	Individual	Designer	People
					Processes
	After	Unknown	Group	Observer	Product

	When	What	Whose	Who	Where
Descriptive	During	Known	Individual	Designer	People
					Processes
	After	Unknown	Group	Observer	Product

Figure 2. The aspects that characterises the prescriptive and descriptive approach.

Objectives and Future Work

The relatively ideal approach should be generic descriptive (See Figure 3). Generic means that the approach is not restricted to a particular product and is applicable to any design process. Descriptive means that the methodology used to capture the design rationale should not restrict or bound the designers by a prescribed method.

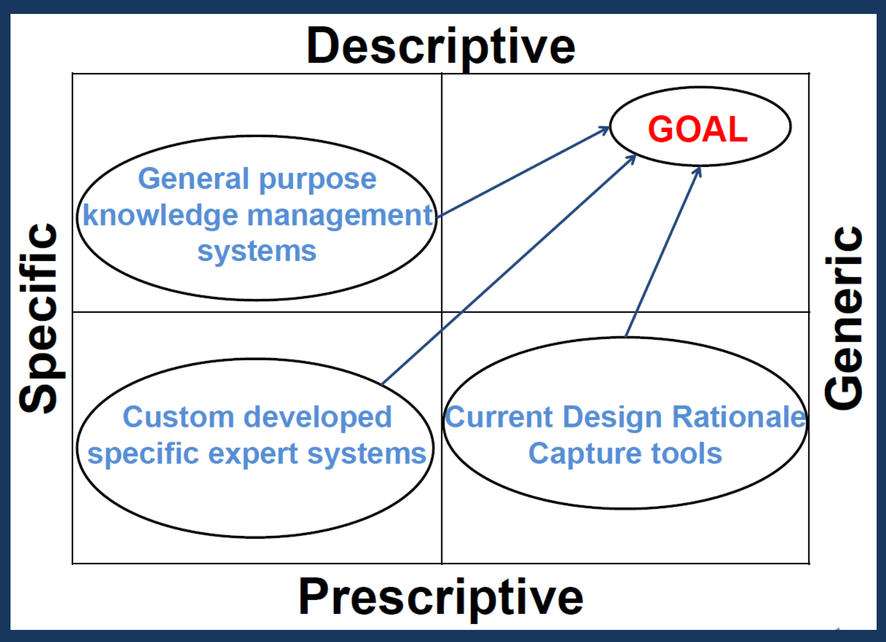

Figure 3. The knowledge capture tools currently used in the product design process.

It is interesting to note, however, that none of the currently used approaches capture design rationale from product (See Figure 4). Cross (2006) argued that design knowledge also resides in products and is expressed in the forms, fits and materials which embody design attributes. Research has identified that up to 90% of new designs are based on existing designs (Kim et al., 2007). Therefore, product knowledge of existing designs can be reused in future product designs as a result improving the productivity and efficiency of the design process.

	When	What	Whose	Who	Where
Prescriptive/ Descriptive and Generic/ Specific	During	Known	Individual	Designer	People
					Processes
	After	Unknown	Group	Observer	**Product**

Figure 4. The aspects addressed by the prescriptive and descriptive approaches to design rationale capture.

Future work will be focused on gaining better understanding of the Rolls-Royce design process through observations, questionnaires, interviews and workshops. It will help to clarify the factors that might influence the decisions in the development of the design support tool. These activities will be followed by the development, integration, testing and evaluation of the design support methodology and software tool that aids the Design Rationale capture in detailed design stage.

Acknowledgement

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