A framework for structuring design knowledge in terms of first principles

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Research Summary

The aim in the research described here is to construct a model for design processes for technical systems that should help to uncover the principles behind design phenomena and structure the relevant design knowledge. The approach taken in this research can be best described as trying to regard design as an (applied) exact science, rather than as a craft or an art (Alberts et al. 1991a). Up to this point there is no such thing as a complete design theory in any of the design domains. So for the time being experience-based design knowledge will keep on playing a central role. However, we propose to structure this experiental knowledge in terms of the underlying technical and physical principles.

We suggest to regard the entire design process from conceptual design to physical realisation as a synthesis process on the basis of *primitive generic components* (Alberts et al. 1991b). These components are grouped together at different levels of abstraction, called *technology-layers* after the available technological 'vocabularies' that they represent. Primitive generic components represent the possibilities for detailing the design description in a certain stage of the design process. They contain the generalised technical-principle knowledge, required to bridge the gap between an abstract system specification and a physical realisation.

A hierarchical framework for a product centered description of the design process is thus obtained. The primitive generic components are the primitive elements which serve as the basis for representing both experience-based and theory-based design knowledge. To be more specific: primitive generic components allow for a theory-founded systematic decomposition and structuring of knowledge, in terms of "what is useful or required" (behaviour) versus "what is possible or what are the costs" (form).

The framework was extended with a the concept of *prototypes* (Alberts et al. 1992a) for the representation of experience-based knowledge. Prototypes represent the (experience with the) application of technical principles, represented as primitive generic components, in
a particular design context or situation.

Thus, primitive generic components provide for a universal vocabulary for describing design and representing design knowledge (Alberts et al 1992c). Furthermore, they allow for directly reasoning from first principles in cases where there is no experience available (Alberts et al. 1992b).

References

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