Chapter 23
Computational Methods and Technologies: Reflections on Their Impact on Design and Education

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ABSTRACT
Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education surveys five major categories of contemporary computational technologies and explores their applications in, and interactions with, design and design education. The five categories of technologies are: Generative and parametric design systems; BIM; collaborative virtual environments; virtual and augmented reality systems; and interactive and intelligent environments. This final chapter reflects on the impact of these computational design methods and technologies, using Ostwald’s System-enabler Model as an underlying conceptual structure. The chapter explores changing relations between the representational, proportional, indexical, and operational systems in the design process, as well as emerging opportunities and challenges that arise from these methods and technologies. The impact of these new technologies and approaches is also discussed in the context of design education. The chapter draws together this significant body of work in order to provide a point of reference for the interpretation and critique of the new design knowledge and phenomenon encompassed in the five categories.

INTRODUCTION
By the time a person has finished reading Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education, they will have been immersed in the domain of computational design, observing and exploring the latest developments, methods and technologies. The 22 chapters they will have completed survey a range of technologies and explore their application in, and interactions with, design and design education. For ease of understanding, these
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contemporary computational technologies can be generally classified into five categories including generative and parametric design systems, BIM, collaborative virtual environments, virtual and augmented reality systems, and interactive and intelligent environments. However, many of these categories combine common ideas and have similar goals meaning that these five groupings may be a useful way of thinking about a complex field, but they are not necessarily definitive. Another way of considering this point is to realize that, to understand all five categories in isolation is important, but to fully appreciate their impact on design and education a broader perspective must be taken. This is, in part, the purpose of the present chapter which provides a critical reflection on the collective impact of these recent computational methods and technologies on design practice and education. Such reflection is essential for assisting readers to contextualize the knowledge presented throughout this work and to discuss the overall impact of these methods and technologies in such a way as to highlight the future challenges for the design field and their potential for transforming design practice and education.

In order to reflect on the overall impact of computational methods and technologies on design and education, the chapters revisits a variation of Ostwald’s System-enabler Model (presented in Chapter 1). The System-enabler model is a conceptual way of thinking about the architectural design process from the point of view of the frameworks that support and define the design process. Such reflection is essential for assisting readers to contextualize the knowledge presented throughout this work and to discuss the overall impact of these methods and technologies in such a way as to highlight the future challenges for the design field and their potential for transforming design practice and education.

THE SYSTEM-ENABLER MODEL

Traditional design models typically focus on simulating or replicating the different stages of the design process. These stages, such as conceptual design, developed design, documentation, review and reflection, have been well documented in the literature (Schön, 1983; Cross, 1997; Lawson 2005). Although these traditional models provide a sound foundation for designers and researchers to understand and reflect on the design process, they provide very limited insights into those methods, techniques and technologies that enable and support the design process. Ostwald’s System-enabler Model takes a different approach that

“...is focused on the relationship between the meta-conditions of design (representation, proportion, information, operation) and the tools, devices and technologies that enable these conditions to be met. Thus, this is a framework recording the relationship between conceptual systems and practical enablers and therefore could be described as a system-enabler model of the design process.”
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