Abstract. This paper participates in the current digital architecture debate taking into account the introduction of CAD-CAM technologies in architecture and focusing on the way this could further change the process of architectural production. It proposes a mode of integration based on associative parametric environments and explains that new conditions for developing architectural projects indeed emerge from this digital framework. Finally, the research developed at DAw is presented as an academic laboratory where the arguments of this paper have been tested and stimulated.

Keywords. Design Process; Parametric Design; Digital Fabrication; CAD-CAM; Architectural Education.

Introduction

The end of the century was the beginning of the integration of Computer Aided Manufacturing (CAM) processes into architecture; by then, mechanical engineering, automotive and aerospace industries were using powerful digital tools that could develop building technologies in new directions. This cross-disciplinary vision opened a new field for a generation of architects that were working at the cutting-edge of digital design. A few of them attempted to extend the impact of the computer in their work by including digital production processes that would lead to a built physical object.

Nowadays, this tendency has become a widely spread reality. Not only architectural practices but also many schools of Architecture have started to integrate digital production equipment as part of their facilities, challenging the specific potential of the digital for the “making” of Architecture.

This paper participates in the current digital architecture debate by taking into account the introduction of CAD-CAM technologies, and focusing on the way this can further change the process of architectural production. The research developed at DAw (Digital Architecture Workshop) will be presented as an experience to test how the use of a single integrated CAD-CAM package offers stimulating conditions to influence design production and promote innovation.

From conception to construction: a linear sequence

Traditional process

Traditionally, an architectural project is developed through a sequence of design steps that unfolds linearly, from conception to construction. Design and manufacturing are separated stages, each with their own mode of representation. To move from one to the other requires multiple processes of conversion and transformation of information. By shifting between different media and techniques the continuity of the whole
process is interrupted: not only from phase to phase of a project, but also at the level of interaction among the different specialists around it.

The integration of CAD/CAM

Coming from the context previously described, the integration of CAD/CAM technologies into Architecture is due to the desire of accomplishing digital continuity in the “making” of projects. The overlap between data and digitally driven equipment is an attempt to minimize information gaps between conception and fabrication. With “file to factory” processes, CAD/CAM digital environments are designed to suppress intermediary analog representations (2D drawings, 3D visualizations, 3D physical models, written specifications or other), taking advantage of a common digital language. As stated by Mitchell (2001): “more advanced CAD-CAM processes (...) begin to eliminate, rather than automate, traditional construction documentation”.

The analysis of current architectural practices using digital production strategies highlights that although design has come closer to manufacturing—production problems (and limitations) still exist. Indeed, architects tend to operate between different computer applications in a way that prevents fabrication parameters from influencing design information. Using different software for CAD and CAM implies a process of moving back and forth that is not so different from other modes of developing a project. Although greater levels of accuracy have been achieved in the translation of digital information into physical form, architectural projects are still developed linearly. This reveals that the process of going from design to built artifacts has not changed drastically yet.

Emerging conditions for the design process

Associative parametric CAD-CAM environments

Originally conceived for other design-related fields such as mechanical engineering, advanced integrated CAD-CAM products are software packages that offer a wide set of design and manufacturing tools, which share a same user interface and associative database. Parameterization and associativity are the two fundamental operative concepts: they provide the flexibility and interdependence among different project documents. That means that drafting, designing, simulation, analysis, engineering or manufacturing facilities run under a common descriptive language. Given these features, relationships like general/specific, conception information/fabrication data or large scale/local scale all become possible entryways into the process of design, at any given stage. Associative parametric environments thus promote a flow of information necessary for a truly interactive design process.

Towards a hyper [D-M] process

The implication of using these “inclusive” applications is the possibility of a new dimension of convergence, which reconfigures both the mode of representation and the nature of disciplinary collaborations (Malé-Alemany and Sousa, 2003). The 3D digital parametric model plays a central role: it becomes a document that includes all representations at once, as a meeting point for all different design consultants and specialists. Simultaneously, computer numerically controlled machines can turn this digital model into physically fabricated objects.

Conception and fabrication knowledge co-exist—fully intertwined—under a unique digital model, in a condition that resembles that of hypertext and/or hypermedia (where single docu-
ments offer multi-linear choice possibilities for web-navigation). This non-linear relation and mutual influence can be described as a “hyper process”, where design and manufacturing [D-M] are interactively linked in a real-time updated workspace. Associative parametric environments thus can be used to encourage a convergent, multi-dimensional idea of design; providing a kind of “hyper-experience” of the architectural object, one that can flow from design foundation, to representation and technical description, which also includes fabrication programming to manufacture real scale prototypes at 1:1 scale.

In short: while conception and fabrication have been traditionally separated, true associativity among design and manufacturing information opens the possibility of not privileging one upon the other, turning a vertically established relationship into a horizontal, less hierarchical one.

On architectural education: the research at DAw

The integration of CAD/CAM to “hyper-link” conception and fabrication -is being tested at the DAw – a design studio of the academic program of the Masters in Genetic Architectures at the ESARQ-UIC in Barcelona. The DAw is dedicated to the research of these topics, using computer design tools and digital production facilities.

This year DAw’s agenda revolved around the idea of “emergency” in multiple dimensions. Associative parametric design was used to generate a solution that would “emerge” from relational data constructions, with an interactive model that could adjust itself to respond to different situations. Simultaneously, the manufacturing of prototypical parts of the project at 1:1 scale was expected to “emerge” from this “hyper [D-M] process” that connects the 3D digital model with CNC production equipment.

Student projects were developed using TopSolid -an advanced associative and parametric CAD-CAM package- to serve as a tool along all phases of production. The works included manufacturing parameters from an early stage of the project, defining a production process based on networking different scales and stages of design. For instance, by considering parameters like the specific limitations of the CNC equipment and materials available, students were able to experiment on specific strategies of fabrication and assemblage to drive their design proposals.

Figure 1. From design to manufacturing: associative parametric processes (studio works).
Pedagogical relevance

Although getting familiar with the software was slower than with other traditional CAD systems (given that a wider range of issues has to converge into the 3D digital model), it proved to be an interesting media to merge creativity with control opportunities. It revealed that associative parametric CAD-CAM single platforms are an interesting pedagogical instrument for architectural education (Burry and Murray, 1997, Malé-Alemany and Sousa, 2003); besides providing students with a “hyper-experience” of the architectural project, it also stimulated awareness about new ways to develop—at both conceptual and technological levels— an architectural process proper of the digital era.

Conclusion

Understanding this emergent rhyzomatic condition for the architectural design production, it can be argued that the use of these “inclusive” CAD-CAM environments can lead to a “more experimental logic where, by rigorous analysis, design opportunities are discovered that can be exploited and transformed into design innovations” (Speaks, 2002).

It is relevant to notice that this “hyper [D-M] process” moves away from a linear sequence of problem-solving tasks, chronologically addressed to different specialists, which still characterize most of the current practices that deal with digital architectural design and production. The conventional mode of collaboration can be replaced by a network mode, which not only improves efficiency and productivity, but most importantly, it opens design opportunities that stimulate the unexpected and the new to come. In other words, it can definitely contribute to develop innovation in architecture.

Acknowledgements

To the ESARQ-UIC students of the Master in Genetic Architectures for their participation and hard work at the DAw / CAD-CAM parametric design studio.

References


