Anachronisms of Digital Fabrication in Architecture: Some Questions of Relevance

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ABSTRACT

This paper takes a critical look at some of the anachronisms of digital fabrication (manufacturing) technologies in architectural discipline. The author raises questions of strategy, economy, societal impact, curricula, relevance, scale, innovation and affordability. The author observes that the late adoption and appropriation of digital fabrication technologies in architecture are anachronistic. By bringing these anachronisms to our attention, the paper hopes to enable constructive action to be taken in education, practice and research of digital fabrication technologies in architecture.

KEYWORDS: fabrication, criticism, affordability, developing world, BoP

Digital fabrication is considered as the cutting edge topic in architectural education and practice primarily in the West and other advanced parts of the world. A large majority of academia and some boutique architectural firms have made significant investments in equipment, maintenance, staffing and research using manufacturing and rapid prototyping methods borrowed from the manufacturing industry and industrial design discipline. However, are digital fabrication technologies in architecture going to have an impact on society at large? Of what value are the new technologies, aesthetic, thinking and methods that are aligned with or derived from manufacturing technologies? What is the true value of digital fabrication to the profession? What kind of impact will these technologies and changes have on the other 90% of the world where extreme affordability is a major issue? Will the three billion people at the "base of the pyramid" (BoP) see the benefits of these new technologies in architecture? Do current curricula address these changes? These are the questions that I wish to briefly outline in this paper.

Few people in the early nineties would have predicted that a resource-intensive wave that shifted the discourse of architecture from theory-based formalism to material and technology-based formalism would take academia and a small portion of the profession by a storm. But it did, for better or for worse! There is a new-found focus on discourse about materiality, virtual modeling and physical making. And yet, the impact on the profession of architecture at large appears to be minimal or missing. For instance, at this year's A*merican Institute of Architects* convention, out of sixty continuing education workshops, none deal with digital fabrication (www.aiaconvention.com, 2010). Three workshops deal with BIM. If this is a measure of the profession's response to and reception of digital fabrication wave, or this is a measure of digital fabrication's impact on the profession of architecture in the United States, the results are rather underwhelming, and not in line with the excitement and hype portrayed in academia and by a relatively small percentage of experimental firms.

While it is easy to read this paper as a case against digital fabrication in architecture, it should really be seen as constructive commentary that raises conscientious objections to the approaches and strategies taken by the discipline, but not as a judgment against the technologies in and of themselves. *If* deployed strategically, digital manufacturing technologies have much to contribute to reframe, reposition, and revive architecture to the center of a design renaissance.

What is Anachronism?

Merriam Webster dictionary defines anachronism as "the state or condition of being chronologically out of place." In anachronism there is an incongruity between the epoch and phenomena. I use the word to mostly describe conditions, discourses, thoughts, actions and phenomena that are a few decades too late, and, I argue, inappropriate responses for the times. By embracing material practices that come with digital fabrication, architects are essentially embracing industrial design, and regain the ground that architecture lost to industrial design (Verganti, 2009) not too long ago. Surely, as Bruce Mau said, "If automotive design were advancing at the rate of architecture, our cars would still be made of wood" (Mau 2004). But catching up with technology should also mean catching up with business and innovation practices of the marketplace of the day, without which there is little possibility of positive impact on society.

Anachronism of Economy: Close the Barn Door after the Horse Has Bolted?

The manufacturing industry has been in doldrums in the United States and the West for the past three decades as manufacturing has substantially declined in the West and moved off shore to India, China and elsewhere in the world. The US Department of Labor projects the following about auto manufacturing industry for the next decade: "Continued productivity improvements and foreign outsourcing of parts production will cause employment to decline over the next decade … Overall wage and salary employment in the motor vehicle and parts manufacturing industry is expected to decline by 16 percent over the 2008-18 period, compared with 11 percent growth for all industries combined" (US DOL, 2010). It is an irony that digital fabrication technologies percolate into architectural discipline nearly five decades after they *peaked* in the West. Perhaps this is an opportunity, not a problem, some might argue. With all the unemployed labor force sitting idle, all the machinery waiting to be sold as scrap, is it not an opportunity to be exploited? Is it not possible to leverage low labor costs of mass production or mass customization by moving the actual job of manufacturing abroad while keeping the ideation and innovation in the West? Perhaps it is an opportunity. But, there is no evidence that such issues are being actively explored in the architectural curricula or architectural profession today. The way architecture has been appropriating these new technologies is incongruous with the way the world economy operates today.

In comparison to manufacturing industry or our academic close cousins in industrial design or engineering departments, architecture schools have always struggled to acquire resources such as personnel, software, hardware and equipment. Architecture schools enjoy some of the smallest budgets on a given university campus. Efficiency, automation, speed, optimization, quality control, lean production and other similar issues dominate the discourses of manufacturing industry. Idle equipment is seen in the industry as a wasted resource, which not only loses value through depreciation, but also by not producing enough to justify cost of operations. The architectural world is replete with small, often obtusely elite boutique projects with slim profit margins, if any. What good is a rocket if you only want to use it to go to the corner grocery store? Would it not be a wasted luxury? While mass customization has been oft-talked, it has not been oft-demonstrated in architecture beyond toying with some ideas and shelving them. The true question is about what value (and by what measure) the society would place on of architects using digital fabrication technologies. Co-founder of Sun Microsystems and a well-known Silicon Valley venture capitalist Vinod Khosla proposed what he calls the "Mississippi Test," by which he meant unless an innovation reaches the average person in Mississippi, it does not demonstrate market penetration, cost effectiveness, or have a substantial impact on the populations of the US (or the world) (Khosla, 2010). Will digital fabrication technologies be effectively deployed by architects to pass the Mississippi Test? Why not?

Anachronism of Scale: Small Is Beautiful, But Is It Relevant?

Computer Aided Design and manufacturing techniques evolved in response to large -scale demands for mass production from growing population. The manufacturing industry has developed very advanced systems of just-in-time production, robotic manufacturing and other innovations to meet the demands of very large-scale production of things on a 24/7 globally distributed basis. However, when we notice most of the research in digital fabrication in architecture does not focus on large scale production or value chain automation for upscaling production (with such exceptions as the Philadelphia architectural firm Kieran and Timberlake). Rather, much of it focuses on small to mid-scale, finely-crafted, labor-intensive, boutique productions that can be custom produced by boutique manufacturing outlets at interior, residential or public building scale (say, a museum). Bruce Mau's notion of *massive change* refers to the massive scale of problems today (Mau, 2004). Even after embracing digital fabrication technologies, the dynamics and logistics of scale are seldom systematically addressed in architectural curricula and reflected in the organizational capacity of architectural firms. Can you think of a good example of successful mass customization innovation in architecture? (If "none yet" is your answer, you are not alone). What resources are needed to achieve scale of production and mass customization? What organizational design and processes are needed to build capacity to meet potential demands? How do our values shift from the magnitude of one-off, small scale projects to a magnitude of production on massive scale?

Anachronism of Dead-end Invention: "Gymansts in a Prisonyard"

There is confusion in architectural circles when it comes to understanding the crucial difference between *invention* and *innovation*. For most in architectural discipline the words are synonymous if not the same. But, innovation is a process of realizing an invention by taking it into marketplace and reaping the benefits of it in the form of cultural impact and economic payback to the inventors, thus creating recurring and exponential value (Andrew and Sirkin, 2007). Architects in the profession and academia produce many inventions, most of which happen to be one-off inventions with nowhere else to go beyond a single application or project. Often, little design knowledge is captured, little intellectual property worth repeated commercialization is patented or otherwise protected, and no market penetration for large scale impact is ever achieved. In other words, there is little interest or understanding of innovation in architectural circles where "innovation" is used as an adjective, not as a noun or a verb. Innovation requires knowledge of markets, commercialization process, entrepreneurship, finance, and management. These are the areas not valued or covered in architectural curricula today, twenty years after digital fabrication technologies were first popularized through Gehry's fishes. Ironically, much of architects' explorations end up being inventions that seek as yet unknown problems or, worse still, solve problems of little interest to the industry and the public at large. *Patenting* is often seen as a four letter word, right up there alongside the word "sin!" In the entire CuminCAD database, there is only one paper that talks explicitly about commercialization. That is perhaps so because digital fabrication is seen as a technical and technological problem to be solved, not necessarily as a systemic problem of innovation, production and commercialization. There are hardly a few examples where such an idea has been taken into commercialization phase (Barrow, 2006; Barrow & Al Arayedh, 2007).

Anachronism of Affordability: What About the Other 90% of the World?

GDP per capita: Current US$ per person						
		2006	**1990**	**1980**	**1970**	**1960**
Chile	CHL	8858	2395	2468	938	551
Colombia	COL	3367	1155	1178	320	240
India	IND	792	369	267	111	82
United States	USA	43468	22480	11991	4878	2796

Table 1. GDP Per Capita. Source: EarthTrends Searchable Database Results

Manufacturing is an expensive and capital intensive enterprise. A number of up-front and fixed costs mean raising significant amount of capital to establish the labs, train new staff, and manage the operations, and provide raw materials. A number of engineering colleges have traditionally established such workshops and trained budding engineers in the ways of the industry. Those colleges operate on multimillion-dollar grants, industry consortia, and create knowledge for industry's advancement and commercialization. A return on their investment is often substantially higher than that of an architecture school. To a large measure such a return is based on the intellectual property generated and commercialized.

Gone are the days when states lavishly spent money on education. At a time when state resources available to educational institutions has been averaging 20%, how easy is it for architecture schools today to afford expensive infrastructure to prepare professionals who will have little or no access to such technology once they graduate? Worse still, are we preparing our graduates with sound knowledge and skills in the innovation process as a whole, rather than on the use of mere technologies and techniques? While it is relatively easier for the architecture schools in the United States and the West to acquire such expensive resources, what will the schools of architecture in the rest of the world do where the GDP is a fraction of what it is in the West (see the table above)? What does digital fabrication mean to developing countries where the question of massive scale is one of their biggest challenges? At what cost and to what effect should such expensive technologies be made available to architecture schools and toward what end?

Conclusions

In summary, this paper presents a critique of the way digital fabrication is being approached in architectural academia and the profession, and raises questions of relevance that must be raised conscientiously so that constructive trails can be blazed toward curricula and practices that can be best aligned with the true problems of the world and be of true service to the world: are we equipping ourselves to face a world of 9 billion people and their problems? How can we best re-strategize the role of digital fabrication in architecture?

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