Architecture and Industrial Design

A Convergent Process for Design

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Abstract

The use of technology has grown with the way design professions have evolved over time. Changing needs, desires of comfort, and perceptions of the consumers have led to a distinct improvement in the design of both product and architecture. The use of the digital media and emerging technologies has brought a dramatic change to the design process allowing us to view, feel, and mould a virtual object at every stage of design, development, and engineering. Change is often quick and easy since a virtual product does not inherently carry the biases of its physical counterpart. In order to communicate ideas across the team, digital processes are also used to bring together opinions, experiences, and perspectives. These methods encourage decision making based on information rather than prejudice or instinct. Thus, digital exchanges (technology) impact firm strategies at three levels: product, process, and administrative or support activities (Adler 1989).

Digital tools for design exchange in Industrial Design (ID) began much earlier than many other professions. The profession of Architecture is also slowly moving to a similar model with digital exchange finding increasing prevalence in drawing, modeling, performance simulation, design collaboration, construction management, and building fabrication. The biggest problem is the disintegrated use of technology in the architectural profession without a strategy toward streamlining the design process from conception to fabrication. In this paper we investigate how the use of technology has evolved in the professions of Industrial Design and Architecture comparatively in their product, process, and support activities. Further, we will present a set of guidelines that will help architects in the convergence of design process, helping in a more efficient work flow with a strategic use of digital technology.

Introduction

Industrial Design has been practicing a systematic method of (now digital) design exchange and communication in concert with the multi-modal character of its work (flow) model. This has probably evolved as a result of a need to design for manufacturing using machines, for mass production in lieu of single pieces crafted by hand, and the need to manage and communicate a complex organizational setup. Thus, ID designed for manufacturing from the outset of the profession.

On the other hand architecture had a legacy of construction that was separate from design. A de facto fragmented and disintegrated project delivery model has prevailed within architecture since the Renaissance and the breakdown of the Master Builder and Guild system (Barrow 2000). Gradually architectural practice is moving toward a similar integrated ID approach componentized, industrialized construction process (Build-Construct to Fabricate-Assemble). Thus, the question we ask (the basis of this paper) is:

Can architects learn from methods used in Industrial Design to make architectural processes and communications more efficient and systematic?

Architecture and ID – An Evolutionary Perspective

Artisan (Craftsperson)

An artisan, also called a craftsperson, is a skilled worker who uses tools and machinery in a particular craft. Artisans were the dominant producers of goods before the Industrial Revolution. In an artisan mode of working, there is less complexity as the craftsperson is the conceiver, maker, and the distributor of their own work. Hence there is little exchange of information and little communication needed from the very beginning to the end of the design process.

Craftsperson - conceives by self - makes by self - markets by self - sells by self

Industrial Designer

Prior to the 18th century, production was dependant on craftsmen and artisans who typically made the products by hand. The development of machines and the industrial system of mass production brought about specialization of labor and the emergence of middlemen.

Historically, industrial design shapes objects that are manufactured by machine rather than crafted by hand. With the movement of machine-made goods as an economic mainspring, and with relationship between maker and buyer growing increasingly complex and increasingly remote, the designer's importance looms large. (Caplan 1982)

The inherent relationship of design ideation and making (i.e. manufacturing) naturally generated an interwoven relationship between the "design" idea and the "machine" of parts and assemblage. This innately facilitated an integrated business model where businesses typically encompassed all the elements necessary to manufacture industrial products. This enabled, if not required, a much more structured management methodology as compared to the legacy of construction in architecture.

Designer - conceives by self - someone else makes - someone else markets

Architect

"Architecture first evolved out of the dynamics between needs (shelter, security, worship, etc.) and means (available building materials and attendant skills). Prehistoric and primitive architecture constitute this early stage. As humans progressed and knowledge began to be formalized through oral traditions and practices, architecture evolved into a craft." (Wikipedia)

During the Renaissance period of the 15th and 16th century, we see the "designer' separated from the act of "making" at the scale of buildings in architecture. Similarly, as machines introduced mechanization in the 18th and 19th century, we again see the separation of the designer from the act of making at the "product" scale. In the industrial era, the designer created by themselves; someone else made / manufactured the product, and, yet again, someone else marketed the product. Hence, we can summarize by saying that architecture and ID evolved in a similar manner in the sense of fragmentation of the "design-make" process as a result of specialization and mechanization for the production of both small and large artifacts (i.e. buildings).

> Architect - conceives by self - someone else makes - markets by self (Barrow 2000)

Hereby we can see that both the professions, Architecture and Industrial Design, began with a craft element that was integral to its development. In short, the genealogy of both professions can be traced back to the same roots. However over time, the work flow of the two professions evolved differently:

> Industrial designer – designs with team of people - gets evaluated by team of people – designs it for ease in manufacturing – gets it made by team of specialists - gets it marketed by someone else.

> Architect – design conception by self – parts evaluated by individual experts and specialists – design development for execution – design execution by someone else

The complexities involved in the process of design development led to significant differences in approach within the two professions. To understand the complexity of approach let us divide the process in both professions into three parts:

- Design
- Product
- Process

In the following paragraphs we will evaluate each of these in detail.

Design

Design begins from the time we start ideating and ends only when the product is used. Within this timeline there is always interaction—interaction between the innovators, makers, distributors or the users themselves; interaction that may be physical or virtual; interaction that may be supported by technology or not.

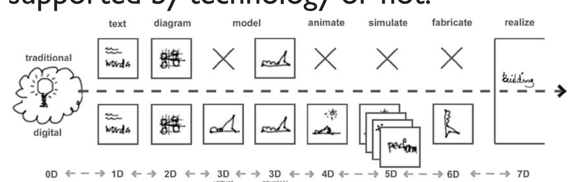


Figure 1. Digital Design Dimensions (Typologies) (Barrow and Mathew 2005).

Architectural theory has evolved over time to reflect the development of new materials, new construction, new structures, new philosophies, new socio-cultural contexts, new scientific findings, and, of course, new technology. Especially, digital technology is not simply a new design tool but a new design medium; in other words, it is not only a new way of design making but also a new way of design thinking (Liu and Lim 2005). Thus it can be understood that digital technology is the medium which we use to design objects. Yet, there is a close relationship between technology used in the process of creation of the product and the product itself.

Technology impacts firm strategies at three levels (Adler 1989):

- Product
- Process
- Administrative/support activities

To understand this, let us analyze each activity in an attempt to understand how the professions differ in their outlook to the specific activity. Such an evaluation will cover most aspects of the professions and, thus, give us an understanding of how differences have led to strategies for digital exchange.

Technology		
Product	**Process**	**Support Activities**
Design principles Design for mass consumption	Design making process Design thinking process	Management Marketing Manufacturing Other specialties

Figure 2. Technology usage divided as per level typology.

Product Technologies

Product technologies include "the set of ideas embodied in the product" (Capon and Glazer 1987) and thus are distinct from the product itself (Bond and Houston 2003). Distinct technologies imbue distinct characteristics and opportunities to the product. Both in industrial design and in architecture, product technologies are relevant and equally important.

There is however a distinction:

ID caters to large number of users who have a choice to buy or to reject the product once marketed. Architecture caters to a large number of users who have limited (often no) say in what is built and how the architect produces the product.

The various *product technologies* used in the two professions are:

Industrial Design:

- strength and durability
- product mechanisms
- material technology
- IT, communication, fuzzy logic, automatic behavior, other embedded technologies
- componentization,modularity, repetition
- mass consumption
- user interactivity, product
- customizability and personalization

Architecture:

- structure and strength technologies
- structural durability
- material technology
- IT, communication
- monolithic and built on site
- custom made
- user interactivity, product customizability and personalization is more experiential (closest example in ID are automobiles, ships and airplanes where you experience space)
- sustainability and passive technology

Process Technologies

Process technologies are "the set of ideas involved in the manufacture of the product or the steps necessary to combine new materials to produce a finished product" (Capon and Glazer 1987).

The various *process technologies* used in the two professions are:

Industrial Design:

- market research
- conceptual design
- user evaluation
- budget estimation
- design detailing
- testing and evaluation
- design prototyping and models
- design for mass production and customization
- design execution (manufacturing)
- distribution and marketing
- re-evaluation and modifications

Architecture:

- conceptual design
- client interaction
- budget
- design development
- design detailing
- testing and evaluation
- models and sketches
- design execution (construction)
- renovation and revitalization

There are two ways in which we can look at process of product development. One is design thinking, and the other is design making. Later in this paper we will elaborate the step by step process matrix in both the thinking and making of products.

Support Technologies

Administrative technologies include "the set of management procedures associated with selling the product and administration of the business unit" (Capon and Glazer 1987).

Industrial Design:

- management
- marketing
- engineering
- manufacturing
- other specialists
- consultants

Architecture:

- management
- marketing
- engineering
- construction specialists
- consultants

In both professions we see that there exists complexity of the use of support technologies; the difference is in the level of involvement and participation of these technology groups in design thinking and design making.

Product

Modularity and Product Efficiency

Architecture continuously struggles to produce an original master-piece. The profession of architecture thus generally elevates "designers" who produce original one-off masterpieces in lieu of those architects who produce "commodity / mass" buildings. In architecture we have generally seen single piece fabrication that deals with the ability to produce one "original", typically, complexly shaped piece, thus the manufacturing of one part for the sake of that single "original" product with little or no aspiration for repetition or commoditization.

Emerging prefabrication methods in architecture have deployed some principles of modularity and repetition; however, these are sporadic and always have an intrinsic intention to produce one-of products. Because of the elitist nature of architecture, the stake of collaborators in an architectural team tends to be unequal. An architect conceives a design and it is the job of site project managers and engineers to complete that design. In this process the upper hand is often with the architect and very little modification actually happens through design interaction of multiple parties simultaneously as has emerged in ID over the last 10 years and is now slowly emerging in architecture (Barrow 2000)

In Industrial Design collaboration is essential; ideation relative to modularity and repetition, as well as manufacturability and usability are critical to the design process. Minor cost reductions in a single piece effects the economic feasibility of the whole product. Thus, modularity brings the designer, the manufacturing expert, the marketing expert, and the materials expert into the circle of design decisions. Each has his/her role to play in this circle: the designer works to create a product that will be liked by mass (presumed users and buyers), the manufacturing expert works to bring down the cost of the product, and the marketing expert works to create a brand or develop a successful launch of a product. Unlike the architect who has absolute power in the architectural collaboration, each collaborator in the ID process holds the same place in a decision making hierarchy. This difference leads to better design management in the process starting from conception to distribution.

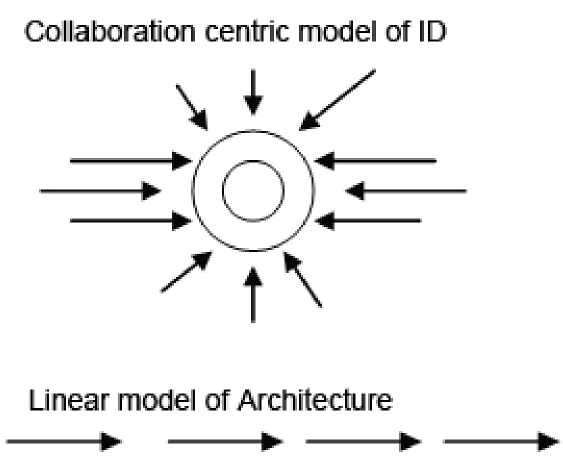


Figure 3. Work flow models for ID and architecture.

Evolution of the collaborative model

During the industrial revolution increased use of machines and automation led to techniques for mass production of commodity products. As a result, ID grew as a profession. Early on ID was primarily focused on how to make machine-made goods aesthetically pleasing, which was required due to the elimination of hand craft and custom made commodity products. Through mass production the number of standardized products multiplied, leading to what has been called the *assembly line* process.

The assembly line process first used in the automobile industry gave rise to the division of labor with expansion of specialty job types and a narrowing of job roles. This led to vertical organizational hierarchies and autonomous work teams.

Some outcomes of mass production:

- Use of standardized parts
- Interchangeability of parts
- Use of division of labor
- Large volumes of production in less time
- Small variety in production
- Higher quality control
- Efficiency of work flow

Gradually, because of the higher perceived benefits of mass productions, designers started looking at other aspects of the product which would make it *better* for human use. In this process, an integrative-inclusive collaborative model took precedence over a singular hierarchical model.

Mass production proved a boon to many aspects of manufacturing (function, time and cost). Collaborative teams realized that they could utilize the benefits of mass production techniques while considering user specific needs and preferences. This was possible primarily through the use of flexible (computer-aided) manufacturing systems that enabled custom output on the same assembly line that was now used for mass production. These systems combined the low unit costs of mass production processes with the flexibility of individual customization. Thus, as is necessary for the leveraging of technology (Barrow 2000) we can say that three basic things changed to allow the leverage of technology: a vision for "better" products, organizational process changes, and the adoption of congruent technology.

Process

Design thinking

Anne Beim and Kasper Jensen have developed four approaches (Pragmatic, Academic, Management, and Conceptual) for action, which help to categorize and structure the different ways in which designers try to control the design process and the end results. Figure 4 explains Beim and Jensens's model (Beim and Jensen 2005).

Pragmatic	Academic	Management	Conceptual
Project oriented Conditional Intuitive Evolutionary	Process oriented Autonomous Explicit knowledge Evolutionary	Process oriented Conditional Explicit knowledge Innovative	Project oriented Autonomous Intuitive Innovative
Craftsman	**Scientist**	**Manager**	**Artist**

Figure 4. Four approaches to the design process.

Considering the complexity of the design, and the process and support activities involved in the design and development of a product, we believe that today's growing industrialized context needs a conscious strategic approach for design. We challenge the role of the architect, not by discarding the traditional role, but by making the architect more conscious of his/her own choices and the architectural consequences of these choices. Akin to ID, there is an immediate need to manage all four approaches into a single unified and coherent system. Such a system can only be brought together through an interdisciplinary and collaborative organizational setup.

Thus there exists a need for communication via new organizational models and adoption of congruent digital information exchange in the search for a rationale to evaluate what designers refer to as "intuitive." Such exchange is paramount to any design process. In an attempt to promote innovation and systematic thinking, Edward De Bono describes a "six thinking hat" (Bono 1999) concept that allows the thinker to deal with one thing at a time. De Bono reveals a technique which allows any business to create a climate of clearer thinking, improved communication, and greater creativity. Bengt Palmgren claims that design is a description of how an object shall look, how it should feel to handle, how it should work. The description can consist of text, sketches, technical drawings, physical models, digital models, animations. (Palmgren 2005)

In a growing 'digital', 'collaborative', 'industrialized' model of architecture it becomes all the more important to make decisions threading *rational* thinking along with *intuitive* thinking. In a field where intuitive decisions are what ultimately become reality, it is necessary to understand the need for such congruent philosophies.

Chakravarthy and Albers (Albers, Chakravarthy et al. 2001) have shown that digital design exchange enhances effective design-make interaction. They claim that the tangible nature of represented idea generate doubts and discussions about the product. Knowledge and information sharing is effective in collaborative teams; ideas gain impetus that results in innovative product generation.

Chakravarthy and Albers's model for innovation consists of two intervened processes: the new product, concept management process and the collaborative teaming process. They divide the collaboration into three levels of teamwork:

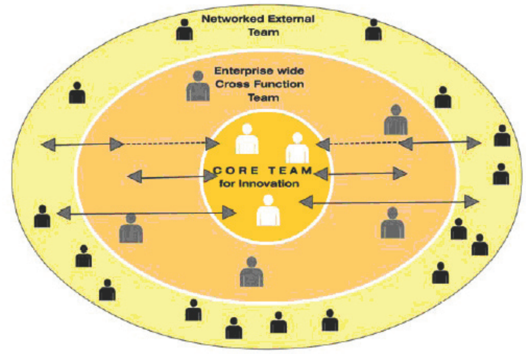


Figure 5. Collaborative model of innovation(Albers, Chakravarthy et al. 2001).

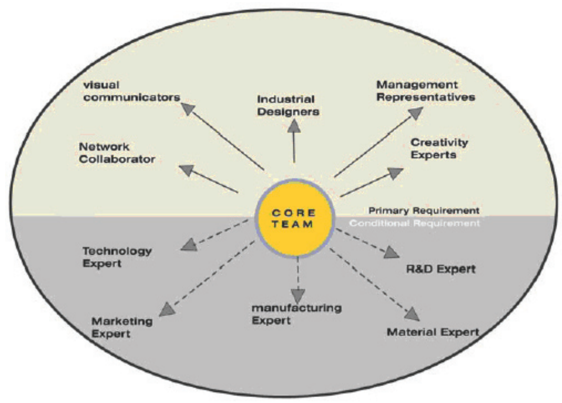


Figure 6. Composition of the Core Team (Albers, Chakravarthy et al. 2001)

- Core Team (for innovation)
- Cross Functional Team (enterprise wide)
- External Team (networked)

We have shown that design exchange is an extremely important part of the design process. Once again, when we compare ID and architecture, we see that communication and representation is an integral part of the initial design process in ID, which allows intuitive to be evaluated and analyzed at an early stage of product design. On the contrary, in architecture often communication and representation happens at the end of the design process

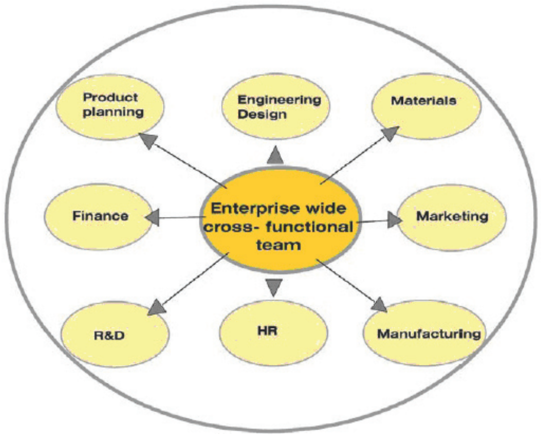


Figure 7. Composition of the Cross-Functional Team (Albers, Chakravarthy et al. 2001).

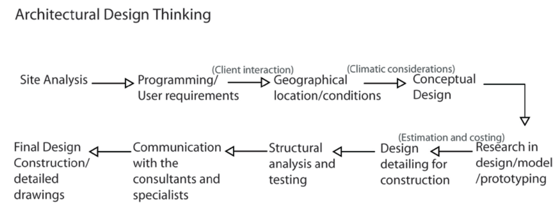
Figure 8. Composition of the External Network Team (Albers, Chakravarthy et al. 2001).

once critical design decisions have been made. In fact most such representation is only a means to communicate the "final" design to the client. It is important to note that we are now seeing more integrative design teams in architecture. For example, performance based design (i.e. green architecture) is increasingly facilitating a shift toward integrated design processes. However, the important point here is that these examples are still exceptions, not the rule.

To better understand this in the next section we will analyze the design process in both ID and architecture. This allows us to see a broader and elaborate picture of the entire process.

Design thinking in Architecture

Figure 9. Architecture - design thinking process matrix.



Design thinking in Industrial Design

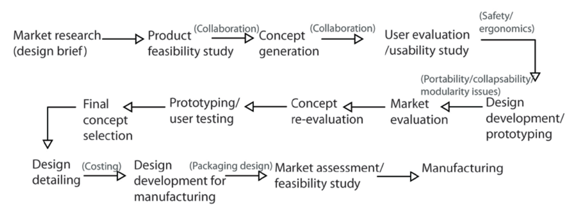


Figure 10. Industrial Design - design thinking process matrix.

It can clearly be seen that thinking processes in ID are not linear, but iterative. Meanwhile, architecture uses a linear model of thinking that is non-iterative.

Here we acknowledge the shift in project delivery models in architecture. The below graph shows the project delivery models in Design-Bid-Build vs. Design-Build & CM architecture over a period of time; we can see that there is a slow transformation in architecture that parallels ID. However, the graph also supports the fact that architecture project delivery is changing and lagging well behind ID.

Thus we can see that a linear design-make process lacks coherence—almost requiring an integrated approach for

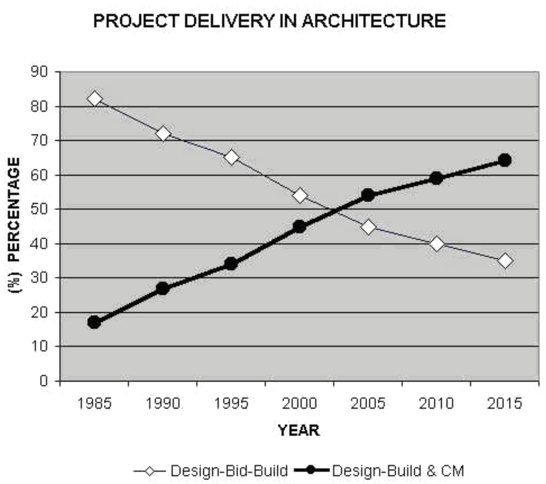


Figure 11. Architecture project delivery model (Barrow 2000).

assessment/evaluation of the design starting from the initial problem statement to the solution.

Design making

Design making refers to the "making" aspect of the two professions: manufacturing and building construction. In short, that which results as a tangible outcome of design exchange. Here we see that both ID and architecture have taken a more collaborative approach. This is evident from the similarities in structure of the process flow:

Design making in Industrial Design

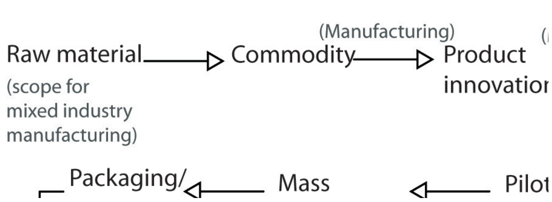


Figure 12: Industrial Design - design making process matrix

Design making in Architecture

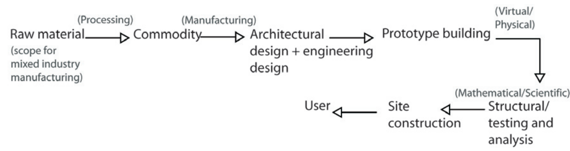


Figure 13: Architecture - design making process matrix

One can see that design making in architecture is as complex as in ID. Once we understand that design thinking is integral to making, we can deduce that (in architecture) it is the design thinking model that needs evaluation and re-working so that it can lead to better design making. In a climate where architects are slowly adopting a more industrial design approach to their design processes, we claim that architecture should learn from ID and incorporate some of the successful aspects of collaborative workflow that is intrinsic to ID.

Design Management

Communication and Collaboration: Before, during and after conception

A designer is not required to be an expert of all the processes involved in and around the product development. What is required is that a designer knows enough about each attribute/process so that he/she can communicate efficiently and have the ability to predict/assume subsequent stages of development. The designer must also be able to communicate this from conception to execution to the people involved in the team. In fact, some have argued that the evolution of architecture will dictate that some architects take on the role of the "hub-firm" for the central management of "design-specialists"(Barrow 2000).

The question arises—how does one evaluate systematic thinking/communication (digital) methods? How can they be adopted into existing architectural project delivery models?

It is important that we recognize in ID, digital exchange is one of the critical factors for the collaboration and communication between the people in the team. Because of digital exchange and a congruent organizational model, there exists a systematic collaborative process of communication. Through such means, each interdisciplinary partner is brought to a common level of understanding of the project. Remember, an interdisciplinary partner in ID refers to an equal stake of contribution and decision making. Thus digital exchange becomes the means for the design team to convert intuitive thinking into rational and tangible products.

The understanding of how technology can be used in design making is as old as technology itself. However the understanding of how technology can be used in *design thinking* is a relatively new concept (Barrow and Mathew 2005). The use of technology in creating products brings about *efficiency* in terms of function, cost, and time. The use of technology in thinking brings about collaborative thinking of intuitive processes.

Apart from digital technology (hardware and software) used in the process of *design* (2d digital sketches, 3d models, tablet PCs, smart boards) it is communication technology and changing project delivery models that is enabling real time flow of design information between teams. The internet (through its siblings—email, FTP, file sharing) has reduced distances between us. It has made digital transfer of files a simple button press activity. Additionally, communication technology has leaped since the beginning of the century; internet-intercom and voice and video conferencing facilities have allowed us to attend meetings in Tokyo sitting in Batesville, Mississippi. These and other technologies afford a minimal time lag between the conception of a design and being able to see it as a physical/virtual product.

Communication and Collaboration: tools

There are various tools and techniques commonly used in design that enable concept management. Some like QFD, six thinking hats model, contextual inquiry, kano model, image boards, affinity diagram and may others have found use in architecture also. However, its use is again sporadic and minimal.

Oxman (Oxman 2005) mentions "four components" for a successful digital design exchange:

1. *Representation*—representational media
2. *Generation*—generative processes
3. *Evaluation*—evaluative analytical and judgmental processes
4. *Performance*—performative processes - programmatic and contextual considerations

Below we have analyzed what these mean to the two professions:

Industrial Design + Architecture:

Representation
- Paper/digital sketching
- CAD drawings
- Scale physical models
- Virtual computer generated 3D models
- Physical hand made models

Generation
- Sketching
- Physical 3D models
- Virtual 3D model

Evaluation
- 3D models
- Drawings

Performance
- 3D animations
- Virtual simulations + analysis
- Virtual testing
- Physical scale (prototype) testing
- 1:1 prototype testing

We propose a fifth component to the above model—that of communication. It is paramount that communication is considered integral to the whole process of design exchange because of the complexity of collaborative product development. Thus:

Communication
- Capturing existing situation—digital photography, ethnographic stud
- Concept generation—2D Sketching
- Concept generation—3D modeling using sketch tools (Alias Sketchbook, SketchUp etc.)
- Concept generation—3D Sketching (Sketch Up, Rhino, 3DS Max)
- Market research—internet
- Mock ups—hand made models using PU foam, paper, cardboard paper and tape, wood
- Mock ups—3D computer models (Laser cut, CNC routed, 3d Print)
- Ergonomic/Anthropomorphic study—relationship with the human body
- Form study—3D modeling and prototyping using 3D printing (virtual, CADCAM, physical)
- Design evaluation—use of mixed media

Thus, for the first time in history, digital exchange technology enables us to communicate in a complex organization of interdisciplinary teams that may be spread all around the world. Moreover, because of this rapidly evolving technology, we can now afford to make our organizational models more efficient.

Mass customization – a model of opportunity

Tseng and Jiao define *mass customization* as "producing goods and services to meet individual customer's needs with near mass production efficiency" (M.M. Tseng and Jiao 2001).

Joseph Pine II describes this paradigm through a business model which he calls the 8-figure-path. The model describes a process that starts with invention, moves to mass production, to continuous improvement, to mass customization, and back to invention.

This dictates repetition and reuse in order to add value to products. Pine's four typologies of mass customization (Pine 1999):

- Collaborative customization—firms talk to individual customers to

determine the precise product offering that best serves the customer's needs. This information is then used to specify and manufacture a product that suits that specific customer.
ID: Custom-made footwear and clothing lines
Architecture: Residential homes designed for a specific client

- Adaptive customization—firms produce a standardized product, but this product is customizable in the hands of the end-user
  ID: Bicycle height adjustments, chair adjustments
  Architecture: Windows and doors, movable and adjustable partitioning system
- Transparent customization—firms provide individual customers with unique products without explicitly telling them that the products are customized. In this case there is a need to accurately assess customer needs.
  ID: computer
  Architecture: none
- Cosmetic customization—firms produce a standardized physical product, but market it to different customers in unique ways.
  ID: mobile phone covers (same phone with different cover designs); swatch
  Architecture: Exterior paints, user customization (awnings, curtains)

As companies look for ways to stay competitive in the global marketplace, the concept of mass customization has appeared as a potential advantage. Armed with new manufacturing and information technologies, companies are trying to determine the amount of variety that they should offer to optimize profits. Design for Variety (DFV) research focuses on methodologies which will help companies quantify the costs of providing variety and will qualitatively guide designers in developing products that incur minimum variety costs (Martin and Ishii 1997).

In sum, we understand that ID evolved from craft to mass customization through the industrial era. Architecture, however, is still struggling at a stage stuck between craft and mass production. At a time when ID extensively utilizes the advantages of function, cost, and time, architects are still looking at specific needs of custom design with an aesthetic based design approach. However, we believe this is changing as we see the emerging "performance" based approaches in architecture, particularly in the area of "sustainability." Ultimately, the emergence of mass customization will prompt architecture to adopt and use efficiencies of mass production and technologies that aid in custom output. It is important to develop convergent methods of digital processes that facilitate common design thinking and making as used in ID. Digital architecture is the means to a conscious realization of mass production techniques that will at the same time fulfill identity/individuality and specific needs of the user/consumer.

Conclusion: Architecture < > Industrial Design

In this paper, we have evaluated the professions of Industrial Design and Architecture. Through this evaluation, we have mapped similarities and differences in their historical evolution. We can hence infer that parameters and attributes have heavily influenced and can further influence the methods and concepts of digital exchange.

In conclusion let us summarize the various factors which work in the evaluation of the product and the process of its creation:

History: Both professions, ID and Architecture, have evolved from craft. Over time, Industrial Design evolved in response to the demands of the industrial age and mass consumption. Architecture, however, still remains largely "craft" based in process and product.

Technology: ID uses technology as an integral tool for communication and collaboration in addition as a thinking tool. Architecture uses technology mostly for communication. Architecture should learn from ID in adopting new methodologies and technologies for the purpose of design thinking and collaboration.

Product: Mass customization in architecture is finding increasing prevalence. It is important to learn from the use of mass production and mass customization in ID as a model for architecture to make mass produced custom products.

Need for modularity/ repetition/ product efficiency in ID versus need for identity/ individuality/ originality/ craft element in Architecture have dictated design approach and collaborative methodologies in the design.

Need for mass consumption/ mass production in ID versus singularity in architecture has defined the shape and nature of the process and the final product.

Process: Componentized assembly RTA approach to architecture would evolve faster delivery methods and eventually lead to reduced costs due to possible mass production for the different components.

Process of design thinking:

Like in ID, architecture needs to evaluate the stake of each team member in a collaborative team based on their role in the design thinking process. This model, in lieu of the current hierarchal and sequential model, will encourage creativity and innovation at each phase of the design process (form study to manufacturing).

Process of design making:

Coherence and integrity in design comes by integrating both the design thinking and making in to the design development of the product. This should come in the form of iterative processes that are irrespective of the complexity of the product.

Support: Deployment of collaborative and more systematic decision making methods and technology will allow rational thinking within the team that will lead to more intuitive creativity.

Collaboration: Collaboration is traditionally accepted and practiced in both professions. In architecture, however, this only exists in design "making". What is needed (and more challenging) is to enforce collaboration in the process of design "thinking" that

links to "making". This change will in turn reflect in the final outcome of the design. Design "thinking" collaboration can only be possible through an extensive use of digital exchange for collaborative networking.
Communication: to be able to exchange tangible and intangible ideas over the cross-functional and multidisciplinary team, it becomes critical to use the best understood and easiest to use tools to communicate.

Contemporary architecture seems to be ruled by a mixture of different quality standards of external conditions (product demands, value-chain definitions, technologies, and desires of end-users) that are *detached* from the specific architectural context (Beim and Jensen). In view of an increasingly changing paradigm of architectural practice, one that is slowly shifting towards an industrial design approach for commodity architecture, it is paramount that we learn from our ID counterparts and adopt their collaborative and organizational communicative digital design-make methods.

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