Practice *Nouveau*

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When the French software company Dassault Systèmes launched the three-dimensional modeling program CATIA (Computer-Aided Three-Dimensional Interactive Application) in 1981, the application was intended for the French aerospace industry. Yet just one decade later, after first establishing itself as the world's leading application in both aeronautical and automotive design, CATIA entered architecture at the instigation of James Glymph, then partner of Frank O. Gehry.[1] Initially deployed as an expedient tool to help resolve the complex geometries of Gehry's Barcelona fish sculpture at Vila Olimpica, Spain (1989-1992) and later to facilitate the realization of several projects including Gehry's Guggenheim Museum, Bilbao (1991-1997) and Walt Disney Concert Hall, Los Angeles (1989-2003), CATIA's contribution to architecture was the way in which it not only transformed how architecture could be *practiced* – from reconfiguring the relationships between architect and builder through 3D digital models to innovating new ways for buildings to be realized – but also how it redefined what could constitute the very nature of architecture. Just as Walter Benjamin argued in his 1936 essay "The Work of Art in the Age of Mechanical Reproduction" that the technological invention of photography not only transformed the "techniques" of the arts but also brought about a transformation in what actually constituted "art," the deployment of CATIA is not simply a technical or formal story, but one that has transfigured model-making practices while also facilitating, from a certain perspective, the re-disciplining of architecture into what might be called a craft *nouveau*; a new mode of working.

Glymph's introduction of CATIA into Frank O. Gehry and Associates in 1991 addressed Gehry's desire to get "into more complex shapes,"[2] and have them realized in an uncompromised manner. Implicit in Gehry's ambition was the need to address three concerns. The first, a *translation* problem, concerned the architectural "working out" of Gehry's paper study models. The second, a *communication* problem, involved the transmission of the models' complicated geometries to building contractors and fabricators:

> From the beginning I've been worried about the translation of ideas through the many people involved in the process of making a building. They frequently drain the strength and power out of an idea.[3]

The third, contingent on the second, was an *authority* problem, explicitly how the architect might begin to regain lost (design) ground in a building industry where architects had more or less lost all control to other building professions.[4] Reflecting on this loss Gehry remarked:

> Architects were often treated like […] little women […] when it comes to the real work, the construction guys, who've been in business for 30 years, inadvertently undermine the power of the architect's work by changing [the design] to save money.[5]

In such an incongruous (and bizarrely gendered) construction climate, the role of CATIA for Gehry can be crudely understood as a means to an end: a tool to expeditiously communicate and ensure that irregular model forms could be realized. As Gehry specifically put it, "[t]he important thing is that the computer gives us a tool, which we use to communicate with the contractors,"[6] software emerging as the unlikely midwife bridging the disciplinary divide between the "little women" who conceive and the builders who deliver.[7]

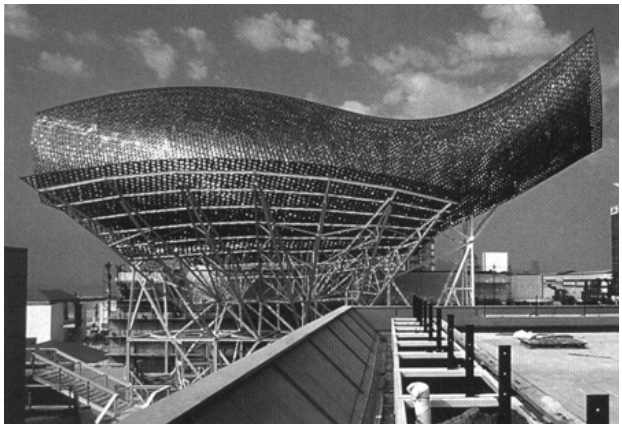

Figure 1. Frank Gehry, *Fish sculpture,* Vila Olimpica, Spain 1989-1992

Gehry's Barcelona fish sculpture at Vila Olimpica, Spain (1989-1992), marks the first application of CATIA within architecture and serves as an early example of how the aeronautical design software was initially deployed. While Gehry and his collaborators continued to "design" in the traditional sense, relying on hand made physical models for schematic design and design development; CATIA was introduced into the design process midway to translate form – the curved surfaces of the sculpture's skin – into drawing. Reducing the physical models to geometric points and polar coordinates through a 3-D tracing, CATIA could represent Gehry's form visually and mathematically, while allowing further formal manipulation to take place onscreen.[8] Rather than being reduced to plan and section, Gehry's design was represented as a digitally interactive 3-D model. After analyzing the data generated from the digitized models, geometric information could be passed on to contractors and fabricators for manufacture. Describing how CATIA was deployed, Randy Jefferson and Glymph reported:

> The concept of bringing the computer into the office was to introduce it in a way that it did not change Frank's design process. The criterion was to try to augment a process which has evolved here over the past 30 years. The computer had to relate to the three-dimensional models that Frank is used to work with.[9]

And further:

> Our idea was to create a process for controlling geometries and dimensions and for documenting these projects, which is an entirely different realm from the concept of using computers for presentation. We did not use the computer for that at all. […] We used it in order to facilitate what was an extremely fast construction period and a very tight budget. […] It had nothing to do either with the design process, because the design was already finished. Unlike many other architects who use the computer rendering and animation programs to convey ideas to the client, we began past that stage, so the only applications that we were interested in were those that would assist manufacturers and contractors in producing the job cheaper and more efficiently.[10]

The feedback loop between physical model and digitized model can be understood as a hybrid design practice: one that collapses the high tech (i.e., CATIA software) with the low tech (i.e., handmade models)[11] to streamline form and optimize costs. Through this high-low technique, Gehry's paper models (i.e., virtual buildings) evolved into real buildings. And, in so doing, an anticipatory quantity surveying takes place: cost calculation fast-forwarded into design, a pre-emptive value engineering. As Gehry explained:

> Now we can budget jobs in the earliest design phases. Also we know that if we use flat materials it's relatively cheap; when we use single curved materials it's a little more expensive and it's most expensive when we warp materials. So we can rationalize all these shapes in the computer and make a judgment about the quantity of each shape to be used.[12]

As a geometric problem of skin – leaving aside the sculpture's all too visible structural scaffolding – the design development of Gehry's Barcelona fish closely resonates with the way in which a very nascent CATIA was deployed some twenty years earlier by Dassault Aviation to shape the outside skins of airplanes in three dimensions,[13] and later, almost in parallel with Gehry's Fish, in the development of NASA's next-generation space suit in 1994, another example of skin-as-design-problem. While the latter, designed by engineering company Hamilton Standard, relied on CATIA to resolve the suit's geometrically complex "Hard Upper Torso" (HUT), it did so without preliminary "sketch models." As Gehry collapsed high and low modeling techniques (sketch models preceding geometric models; final models output digitally), Hamilton Standard sustained a high tech approach: the digital model preceding the physical model, which was later generated with computer-numerically-controlled (CNC) machining.[14] Despite differences in method, both Gehry's and Hamilton Standard's forms are predicated on the presence of an original: a sketch

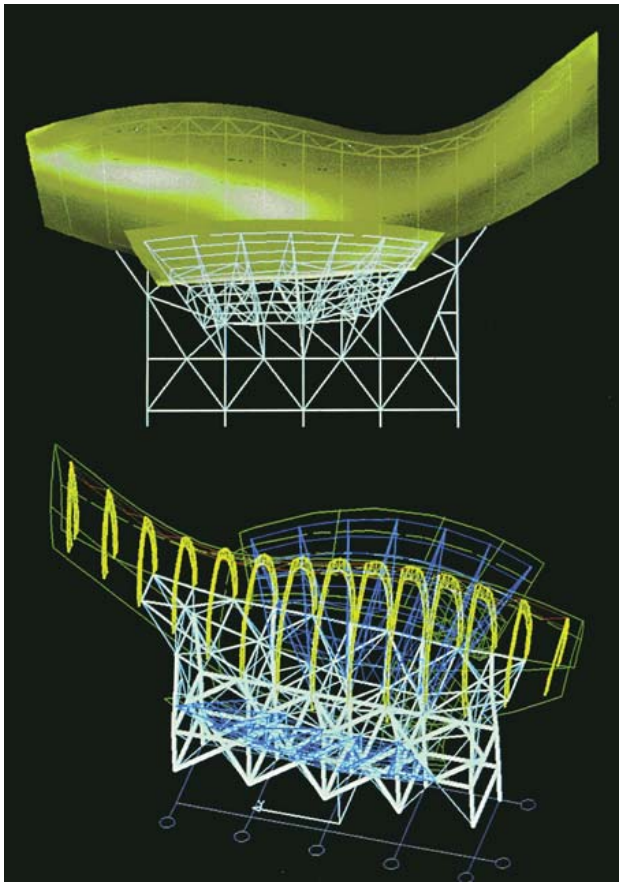

Figure 2. Frank Gehry, *Fish sculpture,* 3-D CATIA Model.

model in Gehry's case, the human torso in NASA's. Irrespective of "technique," both architecture and aeronautical design employ CATIA not as a form giver, but a form facilitator.

While the facilitation (i.e. translation) of form, digitally, is one possibility offered by CATIA, perhaps even more innovative (for architecture at least) was the way in which the digital 3-D model – referred to as a "master model" by Gehry et al – functioned beyond form per se. Operating as a performative model (as opposed to a representational one) in Gehry's Guggenheim museum Bilbao, Spain (1991-1997), the first major building designed with CATIA, the master-model served as a platform for the co-coordination of topological relationships between building systems during design and construction processes. Digital files, passed electronically to other members of the project team operated as either design templates or manufacturing instructions[15] and elevated the master-model to a *site* where information could be updated and people could be organized. According to Gehry, "[t]he new computer and management system allow[ed] us to unite all the players – the contractor, the engineer, the architect – with one modeling system."[16] As Glymph explained, the master-model was the means through which to communicate:

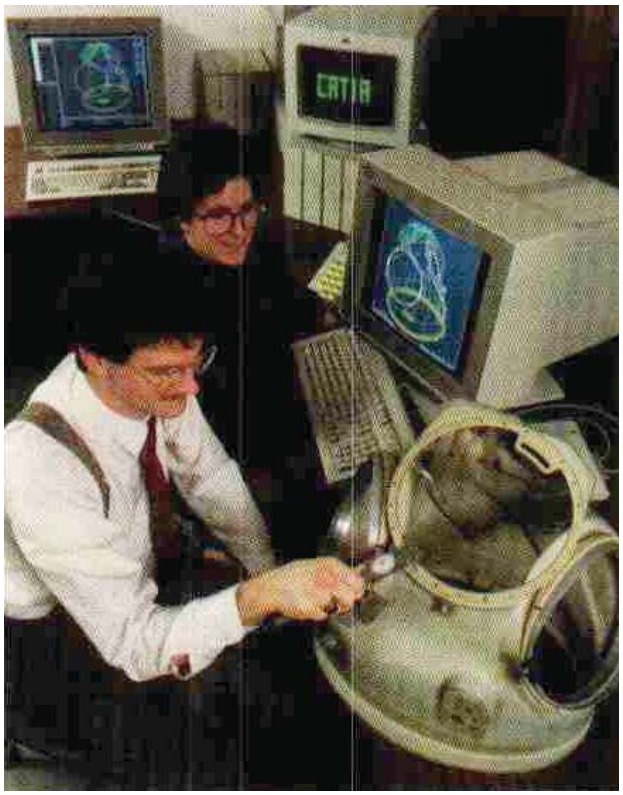

Figure 3. Hamilton Standard, *NASA's next-generation space suit*, 1994

> Typically this model will describe the primary geometric characteristics of the project and, in the case of components that are 'digitally contracted,' also the scope of the work as a quantity output from the model.[17]

The master-model also brought lucidity to the process as Gehry reported in 2003:

> The computer demystifies the building to such a degree of accuracy that builders know exactly what they're building. You can see the joints and connections. It's like having a 3D model. The clarity, the definition, is more precise. It leads to fewer mistakes and a better-organized process. It also saves time. The dream is to go paperless.[18]

The shift in the role of the architectural model as a digital performative marks an attempt to regain

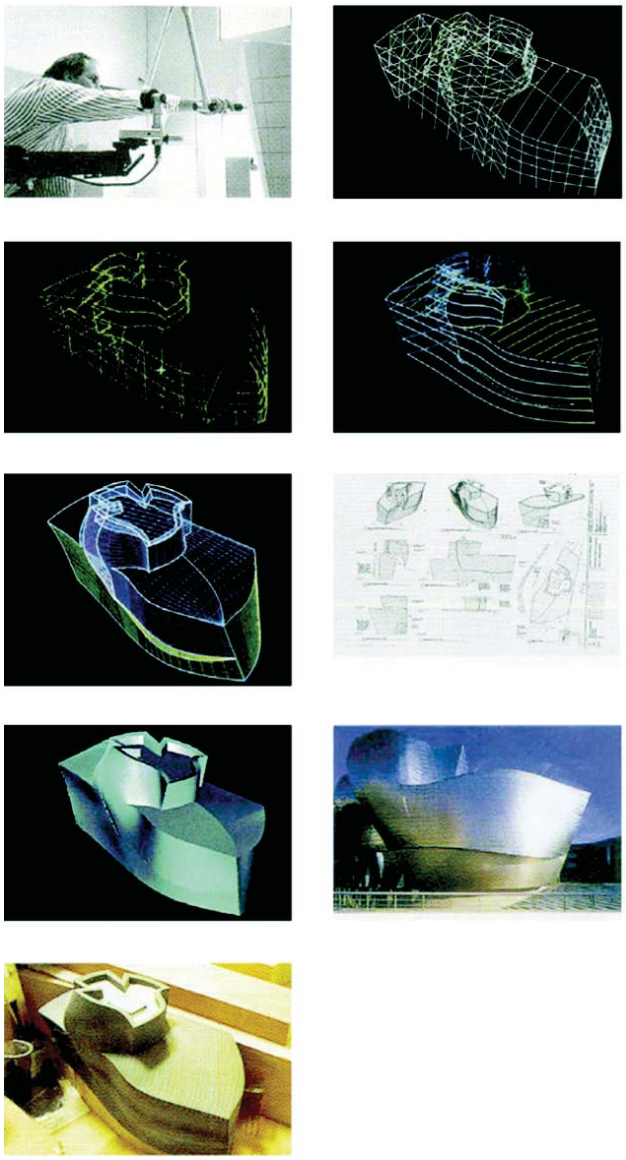

Figure 4. CATIA process of *Guggenheim Museum,* Bilbao Spain 1991-1997:

a CATIA engineer tracing model for digital input
b digitized points form basis for 3D computer model
c surface model is created from digitized points
d shaded model is created
e CNC fabricated milled model to verify accuracy of 3D computer model
f primary structure is created
g secondary structure is created
h cladding pattern and 2D drawings are created from 3D computer model
i finished building

authority by redefining the architect-builder-engineer relationships. In many ways, Gehry's use of CATIA resonates with the way in which the software was used for the design of Boeing's 777 airplanes in 1994, a collaboration between Boeing, IBM, and Dassault Systèmes. While CATIA geometry drove all aspects of the airplane's part and assembly design, along with the visualization of the airline, it did so in the absence of drawings. The design process was, according to Bill Creel, Boeing's director of information systems, "less a computer problem than a people problem." Rather, the challenge was "about 80% cultural change and just 20% technical."[19] The cultural change to which Creel refers was a process of working: the software instigating a complete restructuring of how the airplane should be designed and built. The managers reorganized the program into 230 design-build teams, each team containing no more than 20 people. While past practices in aeronautical design had seen separate disciplines function as stand alones and had relied on experts to be brought in at the appropriate moment, the restructuring of the design process into "product teams" saw people collected through tools rather than disciplines. For example a "wing product team," with members from the appropriate engineering disciplines, was responsible for the design and manufacture for a definable portion of the aircraft, in contrast to the previous organization, where "separate disciplines, such as structures, hydraulics, electrical, or payload stood alone as intimidating departments and almost ends unto themselves."[20]

Despite Boeing's 777 being the first airline to be developed in a 100% solid-modeled environment and Gehry yet to achieve the "paperless" building, Gehry's use of CATIA as a platform to unite players across the construction industry resonates closely to the design process of Boeing's 777. Gehry's process operates as what Glymph more recently called a "continuum," much the same as it does in aeronautical design: software as a site in architecture to bring architects, builders, contractors to the same 3-D model, just as is in aeronautical design (Boeing 777), where different disciplines were brought together through the software. As Michael Schrage of *Fortune* magazine accurately observed, "the issue isn't *Catia*; it's that software can create a seamless continuum between conceiving forms and implementing them. The process of creating an innovative automobile or airplane or building begins to look pretty similar."[21] As Gehry's processes of architecture merge closer to those of aeronautical design, Gehry's contribution can be understood not

only as a re-tooling of the design process through new techniques but also offers an alternative to the ways in which architectural *practice* has traditionally been formulated and understood: architectural practice now emulating and following the practices of design.

While the term "practice" has received numerous definitions in architecture, ranging from sociologist Robert Gutman's definition of architecture as essentially a professional "service," during the late 1980s and early 1990s,[22] to Alejandro Zaera-Polo's "alternative" market models, and OMA/AMO's "collaboration" model during the late 1990s,[23] Gehry's modus operandi fits into a more recent re-interpretation of the term practice, one directly indebted to the particularities of software technologies, and one initiated in 1995 when architecture theorist Michael Speaks called for new forms of practice (rather than simply new forms).[24] While this latter trajectory resonates most closely with the practices of a generalized design field in terms of design production and fabrication, Gehry's use of CATIA is of particular interest because he deploys it *from the center of architecture*.

During Gehry's fifteen-year engagement with CATIA, the embryonic impact of CATIA on architecture has been to reconfigure, through the [re]organization of labor, a less polarized relationship, between builder and architect. The historical split between the two roles, established when architecture acquired an intellectual discipline during the Italian Renaissance,[25] was characterized by a fundamental separation of "conceiving" from "delivering." This separation, achieved through the technique of drawing – *disegno* – enabled architecture to be distinguished from craft or mechanical work. Governed by codes and conventions, architecture – a site for abstract thought – was separated from medieval building, the site of doing. The architect *issued* instructions through 2-D representations – plans, sections, elevations, and details – and the builder *executed* instructions. As architectural historian Robin Evans argued, the architect's drawings first had to be *translated* into buildings.

The recent professionalization of architecture and the increasing irrelevance of the architect in the construction industry have seen builders gain greater autonomy and become less reliant on architectural instructions, i.e., drawing. Gehry's attempt to regain lost ground in the construction industry with CATIA effects a near reversal of the traditional architect-builder divide. Rather than the architect first issuing instructions to the builder through drawings (2-D plans and sections), Gehry's introduction of contractors early on in the design process (to a digital 3-D master model) lies in the hope that their input will evolve Gehry's shapes into more cost effective buildings. In a reversal of the Renaissance model where the 2-D drawing precedes building, a defining characteristic of architecture for at least five hundred years, a digital 3-D model precedes drawing to become a site of operation for both architect *and* builder. Instead of the architect handing over drawings to the builder later in the process, Gehry's CATIA model requires both architect and builder to negotiate design issues early on, and prior to issuing construction drawings, through a "modeling process." This coming together during the "thinking" process not only marks a narrowing of the disciplinary gap between architect and builder and a collapse of Renaissance distinctions between drawing/thinking and construction/doing, but suggests a return of the "Master Builder" principle where architect and builder constitute a single entity. Accountable for both design and construction, the Master Builder – a *pre*-renaissance mode of practice[26] – marks a return to a moment before architecture had acquired its disciplinarity.

Indeed, Gehry describes his workings with CATIA as enabling the return of power to the architect by working closely with craftsmen, "the abilities and imagination of contractors and craftspeople" taking his architecture further.[27] Regaining more control of the industry through greater control over the construction process, Gehry sees his practice returning, preferably, to the pre-renaissance model of "master-builder":

> I've always thought that from an architectural standpoint, the era of the master builder that built cathedrals was better. When someone hires an architect, it's for a certain kind of creative input ...[28]

He comments further on the master-builder relationship enabled by software:

> It's the 'master builder' principle. I think it makes the architect more the parent and the contractor more the child--the reverse of the 20th-century system. It's interesting because you wouldn't think that would happen with something as technical as the computer, but in fact it has.[29]

While Gehry's use of the term "master-builder" is no doubt confused (by definition, the master-builder was both designer and builder rolled into one, as opposed to the architect who, only as a conceiver and thereby removed from the building site, could assume the disciplinary authority to be in charge), the re-coupling of architect with builder, simultaneously undoes architecture's disciplinarity, by definition traditionally predicated on the separation of thinking/drawing and construction/doing. This "undoing" evokes a counter hypothesis to either party's aggrandizement: actually, no one is really in control. Instead, it is CATIA that brings together all the parties, by collecting separate responsibilities of each field through the software model, bringing architectural practice closer to design practice (e.g. as in Boeing's 777). Here CATIA re-engineers the architecture of relationships between architect, contractors, and builders. By soliciting the knowledge and experience of contractors and builders to help resolve problems earlier in the design process and in collaboration with the architect, the builder brings technical know-how[30] to the "thinking" process. In so doing, Gehry inserts into the binary thinking/doing divide a new paradigm: thinking-by-doing or, more precisely, *conceiving-by-delivering*. Provisionally distinguished from Michael Speaks' "thinking-as-doing," a form of knowledge that is not disciplinary but rather in line with technical training – a trade skill – and closer to the craftsman's "know-how," conceiving-by-delivering is a form of business savvy.[31]

With the undoing of architecture's traditional notion of disciplinarity through Gehry's re-coupling of architect with builder, Gehry makes way for the *re-disciplining* of architecture through design technologies. Just as Gehry and his partners needed to become literate with the aeronautical industry's CATIA in its facilitation of architectural form, so too did the builders and engineers with whom Gehry collaborated, who, now in addition to understanding traditional 2-D drawings, need to understand buildings as 3-D digital models as well. This technical re-education cuts both ways: as Gehry adjusted his practice to meet the reality of marginalization in the construction industry, the construction industry was required to adjust its skills to meet the new reality of CATIA models. Through a deferral of expertise, Gehry suspends the conclusion of "conceiving" until the moment of CATIA collaboration. And so, rather than the architect, it is CATIA that plays the disciplining role, blurring the lines between architecture, engineering and building as it does so.[32]

Gehry's closing of the gap between architect and builder affects a ninety-degree shift in their disciplinary working relationship. Moving away from a vertical, linear command structure (the renaissance model, namely architect *to* builder) toward a horizontal, multipart collaboration (the CATIA model, namely architect with builder), the role of the architect is re-situated through a deferral of disciplinary authority: "conceiving" acquires a longer life and becomes the obligation of many parties. Echoing the process by which various product teams worked *horizontally* to design and manufacture pieces of Boeing's 777 airline, Gehry's solicitation of trade "know-how," turns the role of the architect-as-individual-genius passing down completed designs and drawings to a builder, into a collaborator in the producer collective that works in concert to calculate, execute and evolve the design into building. This revision in the architect's responsibility is simultaneously an expansion, as the architect emerges as a new kind of design professional. Moving away from a generalist (aka, the renaissance man) or even a specialist (aka, the professional architect who might specialize in, say, hospitals) the architect becomes an integralist*,* a role best characterized as one of amalgamation*,* facilitating the merging of tools and techniques: know-how with thinking and doing.

As a way for the architect to regain control of the building process, Gehry's integralist practice can be situated into one of two recuperation-attempt trajectories. While the first trajectory is predicated on the architect-developer hyphenate that emerged during the 1980s, John Portman its obvious poster child, the second trajectory, predicated on an architect-builder convergence and to some extent already institutionalized by a "design-build" legacy, Gehry's modus operandi with CATIA can be understood as an updated episode in this latter chapter.[33] Concentrating on the manner of working, as Robin Evans reflected in his essay "Translations from Drawing to Building," these trajectories offer the possibility for writing an alternate architectural history and another speculation. If, as Rem Koolhaas has argued, the architect-developer combination led to a new form of professionalism that defined the essence of historicist post-modernism, Koolhaas thus able to resituate historicist post-modernism not as a style

but rather a new manner of working,[34] then Gehry's architect-builder merge can equally be argued as a new mode of professionalism but on different terms. As a transformation of the "design-build" legacy into the digital, Gehry's practice provides a paradoxical avant-garde for the parallel professionalism of BIM (Building Information Modeling) practices. His call for a return to the "master-builder" principle, arguably constitutes a craft *nouveau:* the combination of a low tech, hands-on method of working with paper models and a high tech method of design development, constituting a new form of technological craftsmanship.

While historicist post-modernism and craft *nouveau* can both be understood as an architect's attempt to recuperate lost territory in the construction industry, they do so by treating the architectural object (building) as an object capable of being divided up and organized into realizable chunks: in the case of post-modernism, as 2D façade elements and colors;[35] in the case of craft *nouveau,* into 3-D components dissected by software. As a new mode of professionalism, craft *nouveau* shifts away from the convention of 2-D drawings communicating all work toward a practice where 3-D master-models negotiate work. Here craft *nouveau* gives rise to a different understanding of the architectural object through practice: a series of realizable components akin to Boeing's 777 plane parts.

With architecture conceived as a series of components, craft *nouveau* – as a mode of professionalism – is further preoccupied by how architecture is optimally delivered to the building site. As Glymph commented, the real lessons for architectural delivery lie not within the building industry per se, but rather in the manufacturing innovations now taking place inside product design:

> Manufacturing industries have completely transformed the way products are designed, built, and delivered […] but the building industry remains entrenched in a paper-based, two-dimensional world. We realized that substantial opportunities existed in bringing advances in practice that we have discovered to the rest of the industry.[36]

As Glymph speculates on the processes of the building industry coming closer to the world of product design (paperless, reliant on component systems, conceived solely in 3-D), it also opens up the possibility for a new definition for architecture: the architect's role shifting away from providing a "service" (as defined in current AIA literature) to providing a "product"[37] where interest is primarily invested in the process of making and delivering the architectural artifact to the building site. By emancipating architecture from its reliance on the service obligation's rulebook, craft *nouveau* allows more experimental work to get realized through the logic of product design.

As a mode of professionalism, craft *nouveau* is simply about efficiency: its purpose is to get the architecture built through a streamlined design and construction process geared toward quality. Gehry's deployment of aeronautical design's software technology – CATIA – to this end has impacted both his architecture and practice, just as Walter Benjamin argued in 1936 that the technological inventions of photography and film transformed the "techniques" of the arts along with the definition of what might actually constitute "art." While Gehry's realignment of builder, architect and engineer through software and 3D models might suggest a return to a pre-renaissance (and thus undisciplined) mode of practice, it actually represents something new: a *re-disciplining* of architectural practice.

As architectural practice become more like that of certain design specializations, its manner of working shifts from the privileging of architectural drawings as the medium to communicate with the builder, to the privileging of software models. Without drawing, a defining mode of disciplinarity, architecture comes closer in definition to other design specializations. Challenging Banham's 1988 claim that what ultimately distinguished architecture from design was not "what" it was, but "how" it was done (for Banham it was drawing), Gehry's deployment of CATIA demonstrates that a revolutionizing of architecture's "how," through the emulation of design's techniques and technologies, can advance the discipline under revised terms.

ENDNOTES

1. James Glymph was a partner with Gehry and Associates from January 1990 – December 2005. I am grateful to Jill Auerbach of Gehry Partners for providing me with this information.

2. For a longer description of why Gehry chose the CATIA software see Frank O. Gehry, "then and now" in Mildred Friedman, ed *Gehry Talks: Architecture + Process* (New York: Rizzoli International Publications, 1999): 50

3. Frank Gehry quoted in Friedman, ed (1999): 46

4. Prior to Gehry's introduction of CATIA, sociologist Robert Gutman made the claim in 1988 that the architect's hold over the building process had more or less permanently been lost to the other building professions: "The reason for this is that the aspects of the building that architects are qualified to design represents *an ever smaller proportion of the total project*." He attributed this loss, in part, due to the greater scale and increased complexity of buildings in general and the need for the involvement of a wider range of new disciplines and professions in design. Gutman also remarked that the major loss for architects had been in the areas of the building process outside design: "In this realm, they have been losing jobs to package dealers, construction managers and contractors. But this loss is critical because so much of the economic and political power over building projects, and therefore over design, is concentrated in these functions." Robert Gutman, *Architectural Practice: A Critical View* (New York: Princeton Architectural Press, 1988): 34-35, 68

5. Quoted in Christopher Palmeri, "A Dream of 'Paperless' Architecture," *Business Week Online* (10/2/2003)

6. Gehry quoted in Friedman, ed (1999): 52

7. Gehry's use of the CATIA software can be positioned within an emergent history of software inside the architecture discipline. From 1980 onwards, a highly differentiated field of software application and theorization has produced a software genealogy. During the 1980s, computer softwares were described metaphorically while primarily being used for drafting construction documents. During the early 1990s and with the arrival of the seminal publication, "Folding in Architecture" *Architectural Design* v. 63, no. 3-4 (Mar 1993), guest edited by Greg Lynn, the debates soon shifted into topics of form, geometry and tectonics. During the mid 1990s, when animation softwares such as Alias Maya were introduced into the discipline, architectural debates shifted into discussion of topology (Cache 1995; Lynn, 1996). By the late 1990s, architectural theorists had shifted their interests into "breeding form" (Kwinter, 1998; Lynn, 1999; and de Landa, 2001). By the early 2000s, the discourse shifted its interest again, this time toward the "non-standard," which was consolidated in the influential *Non-Standard Architectures* exhibition at Centre Pompidou, Paris (2003-2004) and reviewed repeatedly (Carpo, 2004-2005). Within one year, this discussion had quickly turned to the related topics of "fabrication," "rapid prototyping," and more recently, generically "practice" (Allen, 2005; Carpo, 2005, Speaks, 2005). While the most recent iteration of the discourse promotes "process," "code," and the potential of software for "scripting," purposes (see for example, *Architectural Design*: *Programming Cultures* vol. 76, no.4 July/August 2006), the positioning of CATIA in this genealogy lies loosely in the world of "practice." However, in terms of dates, Gehry's application of CATIA (1991) predates discourse on the impact of design softwares in the realm of practice by over a decade.

8. Paolo Tombesi, "Involving the industry: Gehry's use of 'Request for Proposals' packages" *Arq: architectural research quarterly* vol.6 no.1 (2002): 77

9. Glymph and Jefferson quoted in Alejandro Zaera-Polo, "Information Technology at Frank O. Gehry and Associates" in *El Croquis* 74|75 (1995): 152

10. Glymph and Jefferson quoted in *El Croquis* 74|75 (1995): 152

11. This interpretation resonates with a more recent argument made by Stan Allen in "The Digital Complex" *Log 5* (Spring/Summer 2005): 93-99. Here, Allen theorizes that after almost two decades of complicated "form" relationships – i.e., high tech – with design softwares, architects can finally exercise a more relaxed or lazy attitude toward them – i.e., low tech.

12. Gehry, quoted in Friedman, Ed *(*1999): 52

13. Despite CATIA's invention in 1981 (due to the introduction of wire frame technology), Dassualt Aviation had invented a nascent version of the software in 1967. By 1970, the company was primarily interested in the plane's outside skin, with the plane's interiors only later developed in 3-D in 1975, after Dassault acquired CADCAM for drafting.

14. "Software helps optimize space-suit design," *Design News* (9.12.94): 41

15. Tombesi (2002): 77

16. Gehry quoted in Friedman, Ed (1999): 52

17. André Chasar and James Glymph, "CAD/CAM in the Business of Architecture, Engineering and Construction" *Architectural Design* v73, n6 (Nov-Dec, 2003): 121

18. Christopher Palmeri "A Dream of 'Paperless' Architecture" *Business Week Online* (10/2/2003)

19. Mark A. Gottscalk, "How Boeing Got To 777th Heaven" *Design News* (9.12.94): 54

20. Gottscalk (1994): 54

21. Michael Schrage, "Nice Building, But The Real Innovation is in the Process," *Fortune*, Vol. 142, Issue 2 (07.10.2000)

22. This was the subject of investigation in Gutman's *Architectural Practice: A Critical View* (New York: Princeton Architectural Press, 1988), which examined ten trends that had transformed the subjective experiences of architects and formed the context for their practice. In his "Emerging Problems of Practice" *JAE* 45/4 (July 1992), Gutman identified the subsequent expansion, diversification and stratification of architectural practices into three tiers: the "creative, innovative architects," "administrators" who manage architectural firms, and "employees" who are told what to do.

Also under the umbrella of "professionalism" is Dana Cuff's *Architecture: The Story of Practice* (Cambridge: MIT Press, 1991), a book defining architectural practice as something that *emerges* through social processes (complex interactions between interested parties) and is the "embodiment, indeed the expression, of the practitioner's everyday knowledge."

23. In his "A world full of holes" in *El Croquis* n88-89 (1998), Alejandro Zaera-Polo argued for a "market" model rather than a "bureaucratic" system of practice classification and categorized contemporary practices according to how design was done: namely through process, argument, material, and effect. A year later, Stan Allen proposed "pragmatic realism," or material practice, as an alternative to "dumb practice" and "professional practice" in his "Practice vs Project," *Praxis* vol.1 no.0 (Fall, 1999). Joan Ockman also put pragmatism, as a theory of practice, forward in her "Pragmatism and Architecture" in *AV Monografias* n.91 (September-October, 2001). In 2000, Michael Speaks theorized a new distinction between two forms of architectural practice –entrepreneurial and corporate – to redefine innovative architectural practice as "the techniques, relationships, intelligence, and dispositions that shape design." See his "Tales from the Avant-Garde: How the New Economy is Transforming Theory and Practice," *Architectural Record* Vol. 188, No. 12 (December, 2000). In 2002 Speaks was to re-label innovative architectural practice as "design intelligence" in "Design Intelligence" *hunch* 6/7 (Rotterdam: Episode Publishers, 2002).

Models of collaboration emerged during the late 1990s more specifically out of architectural offices themselves, often appearing as complex bubble diagrams describing various collaborations between architects and consultants in their publications and PowerPoint presentations. See for example UN Studio with their networked practices, and the OMA/AMO alliance with its entourage of managers, institutions, consultants, and engineers. Another version of this collaboration model involves the atomized practice where an architect's office is distributed across the globe, as was the case of Servo with four partners in four cities.

24. In his introduction to Bernard Cache's *Earth Moves: The Furnishing of Territories*, Speaks argues that architects should not concentrate on designing new forms (a critique of the 1993 *Architectural Design "Folding Toward a New Architecture"* issue guest edited by Greg Lynn) but focus on forms of practices instead: "It is in the shaping of the form of practices (including techniques and logics) rather than the shaping of individual architectural forms, that the concept of the fold becomes important for the development of new architectural form." See Michael Speaks *Earth Moves: The Furnishing of Territories* (MIT Press, 1995): xiii-xix. This attention to techniques and logics (i.e. practices) continues to be developed by Speaks, only to be later labeled in 2002 as "Design Intelligence," a new form of knowledge made possible through feedback, interactive, and non-linear learning and, surprisingly, less traditionally architectural. See for example, Michael Speaks, "Design Intelligence" *hunch* 6/7 (Rotterdam: Episode Publishers, 2002): 418-421. While Speaks theorizes practice in relation to software, theorists and practitioners such as Bill Mitchell and Toshiko Mori write specifically about the new modes of production – design and fabrication – enabled by software technologies. See for example, Toshiko Mori, "Design and Fabrication" *Harvard Design Magazine* (Summer 1998): 51-53. By 2002 "modes of production" have been re-labeled as "versioning" by ShoP/Sharples Holden Pasquarelli – referring to an application of technology that promotes technique rather than image and heralds a move away from generating form toward a specific formal means of production. See for example, ShoP's "Introduction" to *Architectural Design. Versioning: Evolutionary Techniques in Architecture* vol. 72 no 5. (September/ October 2002): 7-9. 2004. Simultaneously, a discourse around the "non standard," "processes of production," " file-to-factory" and "computer-aided manufacturing" (CAM) was theorized by historian Mario Carpo. See for example, "Folding to Non-Standard 1993-2003" in *Architectural Design* Vol.74 n.3 (May/June 2004): 121; "Architectures non standard" in *Journal of the Society of Architectural Historians* vol.64, n2 (June 2005): 234-235 and Carpo leading to a new mode of

mechanical production in Mario Carpo, "Post-Hype Digital Architecture: From Irrational Exuberance to Irrational Despondency" *Grey Room* 14 (Winter 2004): 104. Finally, and perhaps the closest to Gehry's use of CATIA, Stan Allen stated in 2005 that digital softwares enable new modes of practice by reconfiguring the architect-client-builder relationship. See Stan Allen, "The Digital Complex" *Log 5* (Spring/Summer 2005): 93-99. This recent turn away from a discourse that for a decade fetishized the technological repercussions of software, points toward a more *cultural* interpretation of software on architectural practice and it is exactly here that Gehry's interest in CATIA can be provisionally situated.

25. Several historians and critics have recuperated this claim recently, including Stan Allen, Mario Carpo, and William Mitchell.

26. Mario Carpo recently wrote that the rise of CAD-CAM technologies heralds a new division of labor in production of built environment and one that reverses the trend the West has been witnessing since at least the 15th century. He claims that with CAD-CAM "The whole technological system, from screen to manufacturing, or from file to factory, emulates the process of traditional hand-making, from conception to formation, including the various phases of feedback and interaction between ideas and the qualities of the matter to be formed." See Mario Carpo, "Tempest in a Teapot," *Log 6* (Fall 2005): 102

27. Gehry, quoted in Alex Marshall, "How to Make A Frank Gehry Building" *New York Times Magazine* (April 8, 2001)

28. Christopher Palmeri "A Dream of 'Paperless' Architecture" *Business Week Online* (10/2/2003)

29. Gehry quoted in Michael Schrage, "Nice Building, But The Real Innovation is in the Process" *Fortune*, Vol. 142, Issue 2 (07.10.2000)

30. Manuel de Landa described "know-how" as a form of knowledge not easily verbalized, talked about, or written down. Categorized as a kind of craftsman's hands-on-experience, de Landa argued that "know-how" was an overlooked form of knowledge and largely ignored by philosophers. See Manuel de Landa, "Philosophies of Design: The case of modeling software" *Verb: architecture boogazine*, vol. 1 (Barcelona: ACTAR, 2001): 133-134

31. Michael Speaks's "thinking by doing" is a defining characteristic of his recent "design intelligence," of which Speaks writes: "This is a form of thinking-as-doing that creates design knowledge, or "design intelligence," as I have called it […] through design prototyping." While Speaks is right to claim that thinking-as-doing produces a knowledge of sorts, I would argue that the knowledge is not disciplinary knowledge but closer to the craftsman's "know-how" as described by Manuel de Landa. For the latest mutation of "Design Intelligence" see Michael Speaks "After Theory," *Architectural Record* Vol. 193, No 6 (June 2005): 72-75.

32. André Chasar and James Glymph, "CAD/CAM in the Business of Architecture, Engineering and Construction" *Architectural Design* v73, n6 (Nov-Dec, 2003): 118

33. Design-build describes a set of contractual relationships between architect, builder and contractor that form a single entity to deliver a project.

34. With regard to historicist post-modernism as a new form of professionalism, Rem Koolhaas writes:

> Postmodernism is not a movement; it is a new form of professionalism, of architectural education, not one that creates knowledge or culture, but a technical training that creates a new unquestioning, a new efficacy in applying new, streamlined dogma. Post-inspirational, past erudition, intimately connected with speed, a futurism, postmodernism is a mutation that will be from now on part of architectural practice – an architecture of the flight forward.

Rem Koolhaas, "Atlanta" *SMLXL* (Rotterdam: 010 Publishers, 1995): 847-848. Kenneth Frampton made a similar claim some ten years earlier in his book *Modern Architecture: A Critical History*:

> Post-Modernism reduces architecture to a condition in which the 'package deal' arranged by the builder/developer determines the carcass and the essential substance of the work, while the architect is reduced to contributing a suitably seductive mask.

Kenneth Frampton, *Modern Architecture: A Critical History* 2nd Edition (London: Thames and Hudson Ltd, 1985): 207

35. Robert Gutman suggested that historicist post-modernism could not have been so pervasive had the building industry not been able to reduce style to a series of components:

> If the building industry had not acquired the capacity to produce components in any shape and almost any color cheaply and quickly and if it had not developed organizations to oversee their production and installation, it is unlikely that the recent revolution toward the post-modern architectural style could

> have been realized. The willingness of architects to accept a task limited to esthetic arbitration fits with the preference of many clients for an architect who will confine his or her role to the esthetic or formal aspects of the project […] many architects believe the design impulse flourishes when it is not circumscribed by too close collaboration with consultants and industry specialists who are mostly concerned with technological and pragmatic problems.

Robert Gutman, *Architectural Practice: A Critical View* (New York: Princeton Architectural Press, 1988): 39-40

36. Glymph quoted in Deborah Snoonian, "New Gehry Technologies will enable many to boldly go where only Frank has gone before," *Architectural Record* vol.191, no.10 (October, 2003): 11

37. R. E. Somol makes this distinction in "Yes is More," an introduction to Roger Sherman's, *Under the Influence* (Minneapolis: University of Minnesota, forthcoming 2007). Of the current digital groups' foray into architecture-as-product, Somol writes of the "particular shift to understanding architecture as a product rather than a service. In trying to escape the perceived limitations of a client-based relationship, this group has embraced the anonymity of a consumer market. In this commoditization of architecture, the shift "down" from service to product (or from client to market), architecture imagines itself as ultimately rescuing mere product by personal brand."