I, Andrew T Glass, hereby submit this original work as part of the requirements for the degree of Master of Architecture in Architecture (Master of).

It is entitled:
Revealing a Digital Tectonic Intelligence of Digital Fabrication, a Poetics of Detail

Student's name: Andrew T Glass

This work and its defense approved by:

Committee chair: Michael McInturf, M.Arch.

Committee member: Aarati Kanekar, Ph.D.
revealing a digital tectonic intelligence of digital fabrication a poetics of detail

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Andrew Thomas Glass

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Committee Chairs: Michael McInturf, M. Arch
First Member: Aarati Kanekar, Ph. D
Advisors: Terry Boling, B. Arch
Nick Germann (informal), M. Arch
Abstract

Digital architecture must transcend its current preoccupation with surface, volume, and form and rise to the tectonic; face the reality that construction is an assemblage of parts and components that have joints, intersections, and details. Let it be poetic.

As a reaction against the generic standardization of the architecture-industrial complex, the techniques articulated by Branko Kolarevic, Lisa Iwamoto, and others have done well to explore the spectacle and visual novelty of a digitally fabricated architecture. However, these projects have neglected an underlying tectonic sensibility that understands the reality of 21st century construction and its ability to similarly exploit these contemporary tools and techniques.

By a review of precedents that demonstrate exceptional understanding of material, assembly and construction realities, and through intensive material and assembly investigations, a project will be designed and a sample component fabricated that discovers how these techniques can advance an architecture of engagement.

Assembly investigations begin with thorough analysis of detailing approaches that have received critical acclaim, particularly by architects at the turn of the 20th century experiencing a similar industrial revolution such as Otto Wagner, Peter Behrens, and Carlo Scarpa, and through the notable text of Marco Frascari, Kenneth Frampton, and Ed Ford. A technique will be discovered that will utilize the potentials of digital design and fabrication in realizing an expressive relationship between form, material, and assemblage relative to the forces at work in an architecture.

A structure will be designed, on a small scale in order to focus efforts upon the detail, presented in models, drawings, and a sample full size component to illustrate the built example, and the process described in a critical essay of digital design and fabrication practice. As a result of this thesis, the discourse, digital design and fabrication, will have precedent of tactics to exploit the tectonic potential of their fabrications, making them more engaging and relevant to the client and user.
revealing a digital tectonic
intelligence of digital fabrication
a poetics of detail

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A word of dedication to:

Sonne, may this discussion continue to tumble, between the rock and the cloud.

Michael for the rigor and cohesion of theory and praxis

Terry for illuminating the path

Nick for being my daily mentor and sharing a common intuition.

Amy for love, support, and sanity.
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Introduction

About

This thesis is not a traditional architecture pursuit about designing a building but rather about designing building. It is therefore less concerned with efficiently addressing a use than connecting with users. It investigates a particular topic with supreme architectural implications. For what is architecture if not the sum of a choreographed assembly of parts, or the old axiom, the whole is greater than the sum of its parts.¹

The technology for producing and assembling these disparate parts is ever evolving. This thesis proposes to investigate these contemporary techniques and how they are evolving the design and construction of architecture. Not merely the mechanics of construction but the high architecture art of tectonic, or the poetics of construction.

The investigation begins by describing the contemporary condition. A catalogue of current techniques will be described and illustrated… But it should also become evident how these techniques are both producing ambiguous, inarticulate plastic forms that still rely on tradition construction techniques for structure, falling quite short of a true poetics of construction.

To arrive at this poetic of construction, the landmark text by Kenneth Frampton will intervene. The period precedents Frampton cites are all effects of the industrial revolution. This paradigm shift in the construction of architecture at the turn of the twentieth century is parallel to today’s evolution in fabrication techniques. A summary will follow which identifies and illustrates how those twentieth century precedents advanced production techniques and the art of architecture. Frampton is keen to identify how the techniques described connect to culture, place, time, thus describing a poetics of construction.

Having illustrated the contemporary condition and the desired ideal, a review of Ed Ford will give greater clarity to how these distinct subjects

can be bridged. His five categories of detail describe a qualitative scale of architectural detail and give us a measure of worth. These categories become strategies for design.

Finally, authors and projects will be discussed who are approaching these very issues of technology and tectonics. These precedents will be evaluated given the value claims already stated.

We may see a building as a configuration that resists and balances forces, formed from a distinct arrangement of parts, clearly defined and clearly assembled, a system that is at equilibrium, a piece of equipment that serves our needs and provides shelter in the broadest sense. We might call this feeling the building. We understand it in an empathetic way.

This type of engagement with a work of architecture involves a heightened connection to the world. It reminds us of where we are, what is around us, and how we are situated, through an awareness of connections, forces, assemblies, and materials.²

² Ford. The Architectural Detail. 283.
Prologue

I like making things. My life has always been about exploration and making, dissecting my world to find out how things work and fantasizing new ways to help it work better. Growing up on a farm, my earliest memories are filled with a fascination for the simplicity of how traditional things have worked for centuries, the cold iron latch on a barn door, worn smooth from years of use, to advanced noisy machinery full of intricate, moving parts that grind away to create something new and fresh. This intrigue led me to study architecture and soon enough digital design & fabrication where I found a true synthesis of design and making. The matter of architecture became the teaching object.

Promising to revolutionize the architecture industry, digital design and fabrication involves practitioners from concept to construction. It values collaboration between unfortunately separate disciplines, architecture, construction, engineering, environmental control, interior design. The simultaneous evolution of BIM (Building information modeling) further facilitates this collaboration.

Yet, I have always been suspicious of digital fabrication. Having been fed the fundamental architecture education before tackling digital design and fabrication, I knew the modern axioms, “Form follows function,” “ornament and crime,” and found that digital architecture’s indifference toward the use of superfluous decoration uncomfortable. Probing deeper, we find these elaborate surfaces are merely draped over a traditionally constructed support structure. Where is the revolution in that?
The function of digital fabrication has become to give form. Digital design tools have advanced so far and become so ubiquitous that a flowing plastic design is now easy, common, and expected. Techniques for realizing these forms have also advanced; texts on the subject read like technical manuals: Section, tessellate, fold, contour, form, etc., and afford practitioners little obligation to understand assembly processes, fastening methods, or detailing strategies that have delighted audiences throughout history. This thesis intends to critique this shortcoming and substitute a digital design and fabrication that exploits the sensorial potential of fabrications, making them more engaging and relevant to the client and user.

Techniques for digital fabrication have developed because they take advantage of the computational abilities of computers and the inherent capabilities of the CNC (computer numeric control) machines for their production. Architects have always had the capacity to imagine complex geometry but computation and advanced CNC machines have given the ability to rationalize it into producible parts. These machines have been the laser cutter and the CNC mill, which are well suited to cut two-dimensional parts from stock sheets of material, and more recently 3d printers and five-axis CNC mills and robotic arms, which can create complex geometry beyond the second dimension. You will see that while these techniques do well to highlight these two criteria, computation and digital fabrication, they fail to address a greater architectural agenda of tectonic.
Sectioning

Sectioning is a favorite of digital fabrication, perhaps because architects inherently understand thinking in plan and section. It gives us a technique to translate complex three-dimensional geometries into two-dimensional slices with the profile edges describing the desired form. One technique is simply parallel stacking or laminating these slices one on top of the other, the material thickness creating the third-dimension and the form. Otherwise a waffle section can bring the two-dimensional slices into the third-dimension, reducing the laminations but often only creating a structure onto which a skin is needed to create solid form. “The advantages of using this type of hollow construction are clear: it is a lightweight structure that provides accurate edge profiles for a nonuniform shape on which to align and support surface material.”

Another reason this technique is so popular is the established tools and materials which support it. A sectioned slice can be output through any number of manufactured, readily-available two-dimensional sheets of standard building materials. CNC machinery reinforces this as entry level equipment is readily capable in two-dimensions, material thickness and additional layers providing the third-dimension. Finally, the process of digitally translating a three-dimensional model to two-dimensional geometry, physically outputting that geometry in two-dimensions, then assembly back to three-dimensions is perhaps the most straightforward of all the techniques. Slice, output, stack.

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Tessellating

Tessellating is the technique of triangulating a complex curved surface into a series of flat panels. This is done by populating a form’s surface with a series of points then drawing straight lines to connect each point to those adjacent to form flat triangles or polygons, as the design desires. This strategy approximates the original form and will always involve some compromise, as it translates a fluid curve into flat geometry. Increasing point count will decrease this discrepancy but increase the number of individual parts, sacrificing efficiency. Depending on the designer’s intent, points and panels can be strategically optimized where curves are tighter to achieve better definition, or points can be spaced evenly to achieve similarly sized panels. “The ability to array unique panels across large surfaces to address multiple scales and curvatures is one of the greatest advantages of tessellation.”

Again, this transition from three-dimensions to two-dimensions coordinates well with available materials and fabrication tools. An advantage of tessellation is the resulting flat panels are oriented in-plane with the surface enclosure as opposed to sectioning’s planes which orient at ninety degrees. This makes tessellation a more appropriate skin technique versus sectioning which is more appropriate to structure. A disadvantage is presented as materials become thicker and edge tolerances are considered, for each joint must be mitered, often at inconsistent and complex angles, in order to abut the adjoining panel. This complexity, if not resolved, could quickly move the tessellation beyond simple two-dimensional machining.

4 Iwamoto. 36.
Folding

Folding could be misinterpreted as a refinement of tessellation – it formally appears as complex surfaces built from triangular or polygonal planes. But this would be a mistake – tessellation is determined from a form while folding determines form. Folding cannot be applied arbitrarily to a shape, it creates it. In this way it is a more organic, bottom-up design method and must be respected as a generator of form. This constraint has benefits however – when planar materials are folded, they gain stiffness and rigidity, can span distances, and can often be self-supporting.

Unlike sectioning, for example, a technique that is somewhat irrespective of material in that material properties do not inherently change when cut in section, folding relies on the characteristics of the original material as it adds a new visual, spatial, and tectonic dimension.5

This illuminates another distinction – conceptually a three-dimensional folded form is created from a continuous bent surface, while tessellations must be assembled from a series of flat planar polygons.

Folding does carry with it the same baggage as tessellation, it works well as a single-ply surface but when the medium gains thickness or layers, compromises must be made. Lisa Iwamoto briefly acknowledges this, “Critics have rightly argued that the mere physicalization of the fold can in no way approach the complexities embedded in the concept; the fold, like all other theoretical and conceptual constructs, necessarily exceeds the formal domain of architecture.”6 To begin to negotiate these compromises presents an opportunity to address tectonics.

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5 Iwamoto. 65.
6 Iwamoto. 62.
Carving away wood or chiseling stone are the ancient origins of contouring. It has a history as old as architecture herself, only with a fresh name and advanced process. Beginning with an oversized block of raw material, a systematic series of contours removes material until the closest necessary approximation of the original form remains. As with any of the techniques, compromises must be rationalized between efficiency and accuracy. Chasing accurate detail requires exponentially more time. However, an often popular finishing technique is intentionally leaving the tool-marks or contours visible, reducing machine time and revealing the fabrication process.

Contouring is the first truly three-dimension technique discussed. Opposed to previous techniques which become three-dimensional by assembling flat panels, contouring begins with a substantial material investment and carves out the desired three-dimensional form. This true three-dimensional technique readily takes advantage of more advanced machines offering greater degrees of movement, such as extended third-axis, five-axis and robot arms. However, “Architects have tended to develop inventive ways to work within the three-axis constraints,”7 suggesting joints and connection opportunities for tectonic sensibility.

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7 Iwamoto. 90.
Forming

Forming involves the direct manipulation of material into desired forms. This is not additive or subtractive, but the modification of a material shape by digitally controlled equipment. The examples given in Lisa Iwamoto’s book *Digital Fabrications* are not digitally fabricated forming techniques. Iwamoto is honest to admit this, “Though forming processes are never digital in themselves, digital fabrication has created new possibilities for conceiving and designing customizable formwork. It has had this liberating effect mostly because it cost-effectively produces nonstandardized mold making.” While novel in their use of analogue forming techniques, these examples are just an auxiliary use of the contouring technique to produce molds for the forming. Whatever the reason for the exclusion of digital fabrication forming techniques there are examples now available.

Wave Pavilion by MacDowell.Tomova at the University of Michigan Taubman College of Architecture and Urban Planning utilizes a robotic arm in the bending of metal rods. Distances, radii, and angle degrees are output from the digital model to programming software for the robotic arm. The robotic arm is then responsible for the accurate positioning of distance and rotation of the metal rod into a CNC bender which bends the rod to the correct angle.

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It should be evident that these five techniques just described do not take into account the joining of parts or materials. It seems to be their assumption that architecture is the creation of a uniform but variable skin, rather than the assembly of a variety of parts. But yet has been solved the creation of a monolithic skin which solves thermal, acoustic, daylighting, waterproofing, and structural issues in one. Not even considering the routing of services which is typically hidden within the wall cavity.

It is disconcerting that many examples of digital architecture rely on traditional construction practices and techniques to provide their support structure. Behind the veil of many noted digital fabrications are disappointingly stick built studs, nailed and screwed together in clumsy, shoot-from-the-hip solutions rather than the polished, thoughtful, and organized manner we should expect from such highly intelligent surfaces. Most examples are nothing more than intelligent surfaces over dumb structure.

After all, isn't it this peek behind the veil, this revealing of what should or should not be seen, that has invited intrigue and delighting audiences across time? A tension is created between the finish surface and the structure that invites wonder. Consider one of architecture's most basic tricks, the edge reveal. A simple shadow line can hold so much wonder.

Our most celebrated, notable movements, talents, and structures can all be defined by this articulation of detail, joint, and connection. Consider Mackintosh's arts and craft wood joinery, Wright's abstract organic window mullions, Mies's modern exposed steel structure, the high-tech modern of Richard Rodgers and Renzo Piano's Pompidou Centre, Louis Kahn's exposed concrete tie, and Steven Holl's custom door handles. With these notable architectures the more time you spend with them, the more you find there is to understand.

Karsten Harries describes this phenomenon as re-presentation, whereas an architectural element has an embedded meaning. The element is there, as itself, it represents itself but also has the ability to describe something more, re-present something: Its manufacture, its history, its assembly, its
weight, its luster, its glow.\textsuperscript{10} Many built examples of digital fabrication do a good job of representing, or presencing themselves, that is creating spectacle, but few offer the greater meaning that Harries describes. To remedy this we must go back and understand the theories that influenced the modern architects whom this thesis looks to as precedent.

Since Gottfried Semper proposed his treatise on architecture, building has evolved to become the build-up of discrete layers, each solving a separate condition. The monolithic construction of antiquity is no longer appropriate. Modern buildings demand thermal, acoustic, humidity, structural, seismic, and environmental performance criteria that monolithic construction simply cannot provide. Thus, we have inherited a construction reality that necessitates the layered construction that Semper outlines.

Steel and concrete are superior structural materials but do little for thermal insulation, expanded foams and fiberglass insulation have the opposite qualities – thermal insulation but no structure. Layered together with other materials and products, in a compound wall assembly, all works together to achieve the necessary performance criteria.

There seems to be a typical dichotomy that each author has their own terminology for, but the purposes of this argument it can be generalized. Kenneth Frampton borrows from Semper in differentiating between stereotomic and tectonic; stereotomic of the earthwork and tectonic of the frame. This understanding merges well Ed Ford’s distinction between the organic and mechanic, which he later evolves into abstract and animated. This dichotomy will be useful to clarify digital architecture’s unfortunate fixation with the stereotomic (or organic or abstract) and describe the potential of a digitally fabricated tectonic (or mechanic or animated) construction.
Stereotomic

Digital architecture has been fixated on the abstract detail. This has been illustrated in the earlier review of techniques. All the techniques described were only concerned with realizing an idealized form. None of the techniques described offered any concern for joinery or detail. The contemporary definition of detailing is the act of minimizing the joint.

The first Point of the Detail is omission… instead of being occupied with underlining, emphasizing, paraphrasing, this detail is entirely a matter of excluding.

The second Point of the Detail is that of the imaginary extension… stretching lines caught from the corner of the eye, the unfurling of accidental pockets of leftover space on corners of the site, and the dragging up of parallels with half-hidden substrata.

The third Point of the Detail is that of finding… already there, in the form of stucco rosettes, marble slabs, parquet strips. The architecture followed the findings, wrapped itself around them and opened itself up again to display its found origins.

The last Point of the detail relates to a new ordering to replace classical composition.

These descriptions from Ben van Berkel and Caroline Bos, of the firm UN Studios, illustrate the effort put toward minimizing the detail. The first point is particularly explicit, but the three others are equally non-descript with construction and assembly realities. These exercises in formalism are often foreign to the user, like an alien spacecraft landing next door. Their flowing lines and streamlined surfaces are illegible, they conceal any deeper reading or understanding of construction; often rendered in cold, inanimate materials as they conform easily to the desired shape, they afford residents little serenity or comfort.

Digital computer softwares give architects the ability to quickly generate fluid, streamlined forms. Digital design tools have advanced so far and become so ubiquitous that a flowing plastic design is now easy, common, and expected. Nick Dunn describes the process of digital modeling,
“In freeing the designer from the constraints of Cartesian space, digital modeling programs typically use the topological geometry of continuous curves and surfaces. Also known as ‘rubber sheet’ geometry, topological geometry enables curvilinear surfaces to be described as NURBS.”

Techniques for realizing these forms have also advanced; texts on the subject read like technical manuals: blobs, creases, flows, streams, inflations, spirals, blends. These techniques afford practitioners little obligation to understand assembly processes, fastening methods, or detailing strategies that have delighted audiences throughout history. Hardly any consideration is given to the physical construction technique; these methods rather describe the digital method of generation. These forms must be post-rationalized to become a constructible reality. They are not rationalized as constructed realities.

Vittorio Gregotti realizes the contemporary problem as well, “Often the outcome of this idea in built terms is an unpleasant sense of an enlarged model, a lack of articulation of the parts at different scales: walls that seem to be made of cut-out cardboard, unfinished windows and openings; in sum, a general relaxing of tension from the drawing to the building.”

It is unfortunate and curious that this ‘relaxing of tension’ takes place as increased computation (BIM) has promised to reinforce the link from ‘drawing’ to building. Gregotti is keen to indicate the drawing however, for increased computation ability has also increased architects reliance on the ability to produce ever more realistic renderings.

A disjunction is created between the idealized image on the screen and the physical, layered, reality. The increasing capability to produce photo realistic renderings has further compounded the problem. Photo realistic renderings make these forms look highly desirable and achievable, but the constructional reality often falls disappointingly short. The desire, in fact, is for a stereotomic architecture.

12 Dunn. 40.
Ford calls this the organic or abstract detailing strategy. The intent is to presence the space, volumes, massing of the architecture and eliminate the joints so that they do not interfere with this reading. Just like the first point of the detail, omission, described by van Berkel and Bos.

Frampton describes “the stereotomics of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements.” It is surprising how analogous this is to the technique of sectioning – the slicing of a form into producible planes which are then piled back on top one another. Frampton continues “… suggested by the Greek etymology of stereotomy, from stereos, solid and tomia, to cut.” This is also suggestive of the digital fabrication technique contouring, with its roots in the sculptor’s chisel which removes or cuts material from solid blocks to realize the desired form. Digital architecture is obviously perusing a stereotomic architecture and therefore ignoring tectonics.

To describe tectonic, we must first understand assembly, and thus return to Semper.

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Gottfried Semper connects assembly with the entire history of building when he separates wall from structure. For Semper the purpose of enclosure is to separate space and the roof or mound provides structure. He continues to explain that the enclosure is in fact not the realm of the stone mason or carpenter, as would be previously assumed, but rather the wall fitter (Wandhereiter) or weaver of mats and carpets. “Hanging carpets remained the true walls, the visible boundaries of space. The often solid walls behind them were necessary for reasons that had nothing to do with the creation of space; they were needed for security, for supporting a load, for their permanence, and so on.”

The weaving of these mats and carpets is what created ornament. “The oldest ornaments either derived from entwining or knotting materials or were easily produced on the potter’s wheel with the finger on the soft clay.” The enclosure thus becomes the medium for ornament. Glazed tiles could also be applied to the surface of structure as dressing (Bekleidung), but they still remain enclosure. “This also proves that the glaze was a general covering and its idea was independent of the material to which it was applied.” The variation in the colors of natural fibers used for weaving produced the first pattern. This was soon intentionally emphasized and surpassed with artificial treatment of materials. “The dyeing and knitting of colorful carpets were invented for wall dressings, floor coverings, and canopies.”

This separation of skin and structure showed promise in early modernism, as many architects interpreted Semper’s writings and began applying his principals to the emerging technologies and techniques of mass production. These new technologies and manufacturing techniques

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17 Semper. 103.
18 Semper. 104.
19 Semper. 245.
were creating new structural and material realities with which the early moderns were keen to experiment. The earliest celebrated example being Otto Wagner’s *Postsparkassenamt* in Vienna. Here, Wagner fixes a thin veil of stone panels, as skin, to a underlying structure. The detail is the bolts affixing the panels are left exposed, revealing the reality that there is a skin over structure. This detail reveals, or to use Harries’ term, represents the panels as a manifestation of Semper’s enclosure (*Bekleidung*). The knot as joint in Semper’s woven mats, is interpreted in modern stone and iron. As Frampton explains, “Thus for Semper, the most significant basic tectonic element was the joint or the knot.”

Semper and Frampton maintain that the joint is still integral to the assembly between the separate elements of skin and frame. Digital architecture has unfortunately taken the separation of these elements quite literally. The fluid, streamlined forms previously described are simply treated as clothing, draped over clumsy traditional frames. For all the effort and computation that goes into developing these intelligent skins, the majority of the time practitioners simply return to understood and familiar joinery techniques for their restraint. Again, as van Berkel and Bos described, the desire is to minimize the articulation of detail, therefore minimizing the honesty of a skin over frame construction. The authenticity of revealing construction also speaks to Martin Heidegger’s *unconcealing* as the poetic act. For digital architecture to explore detail and be honest to its material assembly, it must aspire to the tectonic.

“*The full tectonic potential of any building stems from its capacity to articulate both the poetic and the cognitive aspects of its substance. This double articulation presupposes that one has to mediate between technology as a productive procedure and craft technique as an anachronistic but renewable capacity to reconcile different productive modes and levels of intentionality. Thus the tectonic stands in opposition to the current tendency to depreciate detailing in favor of the overall image.*”

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20 Frampton. *Tectonic Culture*. 86.
It is the natural evolution that digital architecture and fabrication become more interested in the idea of tectonics. Vittorio Gregotti claims, “It is false to think that culture of industry or building (by now distant cultures from design) could solve the problem of detailing; this might be convenient or economic to the architect, but lead to unprecedented downfall of architecture.” Digital fabrication, contrary to Gregotti’s disdain for the separation of manufacture and detailing, weaves the two back together. Proper execution of digital design and fabrication solves the perceived technological disconnect between maker and object as it allows direct and rapid evaluation. A popular phrase of the discourse is encouraging designers to ‘fail faster,’ or produce physical iterations and perform analysis quickly, remedy the problems found, and output physical prototypes again to continue analysis. This becomes very important and possible with today’s technology at the scale of detail, joints, and assemblies.

To discover the generative ideals latent in this scale of architectural investigation, we look to Marco Frascari. He argues, “the aim... is to indicate the role of detail as generators... and to show that technology, with its double-faces presence as “techne of logos” and “logos of techne,” is the basis for the understanding of the role of details.” The logos of techne that Frascari described being the functional physical properties the detail satisfies, the quantitative. The techne of logos being the qualitative properties, the more metaphysical meanings the detail holds, re-presentation to use the Karsten Harries’ term.

Marco Frascari therefore exposes the significance the detail holds as the nominal element in the expression of meaning in architecture. Details have potential to provide a narrative of their design, fabrication, location, sizing, context, environment, etc. to solve not only practical functions, but also historical, social, and individual ones. He offers an analysis of the

23 Gregotti. 497.
Technology is a strange word. It has always been difficult to define its semantic realm. The changes in meaning, at different times and in different places of the word “technology” into its original components of techne and logos, it is possible to set up a mirror-like relationship between the techne of logos and the logos of techne. At the time if the Enlightenment the rhetorical techne of logos was replaced by the scientific logos of techne. However, in Scarpa’s architecture this replacement did not take place. Technology is present with both the forms in a chiastic quality. Translating this chiastic presence into a language proper to architecture is like saying that there is no construction without a construing, and no construing without a construction.\"[25]

Marco Frascari

architecture of Carlos Scarpa, “The teaching of functionalism is present in Scarpa’s work, but the functionality is mediated by the search for representation and expression through the making. Scarpa’s architecture stands... for the union of representation and function.”

Frascari also proposes that giving careful order to details can establish order on the whole. Through formal and physical joints, space and material can be assembled in a meaningful manner. This provides insight into how detailing provides a logic that can proliferate through the rest of the project. This is important as it gives insight to how digital fabrication processes can become a driver and method for creating details that understand the physicality of materials, construction, and assembly that ground the user within the space, elicit a narrative and encode a logic of legibility.

Through the utilization of the tectonic, detail mediates between skin and structure. Skin no longer becomes symbolically ‘draped’ over structure. Structure is revealed, and becomes intelligent to match the intelligence of skin. Wagner’s Postsparkassenamt is again the clearest example. Structure is revealed on the skin through the iron fastener detail.

However, as Frascari describes, it is through the work of Carlo Scarpa that detail realizes its full potential. With Scarpa’s details nothing is superfluous, yet everything is superfluous. Take the handrail bracket fig. vii, each connection and gesture is carefully articulated. The bracket mounts to vertical circular steel post with the brass semicircular element, wrapping itself around, embracing the post. The bracket must then maneuver the ninety degree corner, it does this with two cylindrical pins, fused together with a spacer. Becoming a singular piece, this element then becomes the vertex for each of the two vectors of the ninety degree transition. To complete the transition to handrail, the bracket abruptly forfeits its chunky mass and becomes simply the horizontal handrail. All these connections and transitions could have been simplified into one singular element, much as the off the shelf items we have easy access to today. But no longer would it tell a story of its conception, its construction, its investigation of the industrial materials and techniques.

Marco Frascari

"Technology is a strange word. It has always been difficult to define its semantic realm. The changes in meaning, at different times and in different places of the word “technology” into its original components of techne and logos, it is possible to set up a mirror-like relationship between the techne of logos and the logos of techne. At the time if the Enlightenment the rhetorical techne of logos was replaced by the scientific logos of techne. However, in Scarpa’s architecture this replacement did not take place. Technology is present with both the forms in a chiastic quality. Translating this chiastic presence into a language proper to architecture is like saying that there is no construction without a construing, and no construing without a construction."

Marco Frascari
of the day. For this is what Ed Ford categorizes as the autonomous detail; each move, each gesture, is self contained, accepts no influence from a greater motif or metaphor, does not become abstract. Yet taken as a whole collection, the details do create a narrative and describe a logic.
To understand how we might elevate the digitally fabricated detail to evoke the qualities of detail possible, to address a physicality of materials, logic of construction and assembly, and reveal the greater context and place in which they are situated, we look to the categories described by Ed Ford. In his book “The Architectural Detail,” he presents different qualities and qualifications of detail. He begins with the favored detail in contemporary architecture, the abstract detail.
Detail as abstraction

Rem Koolhaas describes the desire for the abstract detail, what he terms the NO-detail, “for years we have concentrated on NO-detail. Sometimes we succeed – it’s gone, abstracted; sometimes we fail – it’s still there. Details should disappear – they are old architecture.”

This represents the general indifference among today’s practitioners to a descriptive detail. Detailing is still an exercise, but rather than putting the effort into designing a descriptive detail, much effort is expended into concealing it, so that the larger ideas, spaces, and massing are not interrupted. The details still remain but they hide information rather than revealing it. The hiding of information denies opportunities for greater understanding.

Given the popularity of this techniques, Ford continues to give it six axioms. These axioms describe concepts behind the selective suppression of detail. The six axioms describe potential strategies for selective omission or inclusion of detail:

Axiom 1
Detailing involves the selective presentation and suppression of information at the service of a larger understanding of the building.

Axiom 2
The inclusion or omission of a positive detail is a result of concepts that are both compositional and ideological.

Axiom 3
Consistency of form in detail is neither possible nor desirable. It inevitably leads to the superficial and the stylized.

Axiom 4
Consistency of concept may lead to an inconsistency of form, but one that is often beneficial.

Axiom 5
Detailing requires the presentation of information in degrees of importance, in hierarchies.

Axiom 6
Good detailing, having created hierarchies, will often violate them.

No money, no details, just concepts.

Rem Koolhaas

Van Berkel and Bos, have written extensively on the omitted detail, are the most appropriate example. Their Burnham Pavilion in Chicago (2009) fig. ix is as monolithic a form possible. All detail is concealed, all that’s left for the audience to interpret is the fluid surface. Consisting of two planes, one floor, one roof, the floor plane lays perfectly flat on the earth, but the roof plane is plastically deformed as though it were a soft clay with three fingers pushed down upon it from the sky. And this interpretation of surface is the intention, but although being highly sculptural and three-dimensional, it suffers to reveal deeper understanding. It becomes rather one-dimensional in this regard, again the form is all we can interpret. Sure these geometries are being influenced by their context, by the pedestrian flows, but wouldn’t it be remarkable if this intelligence could penetrate deeper into further scales of the project.

27 Berkel. 72-76.
Detail as motif

The detail as motif applies the same metaphor regardless of scale, function, or situation. These metaphor can be something as simple as repetitive geometry, Ford has this to say in response to Edward Cullinan’s addition to St. John’s College Library (1994);

> the methodology is, to use circles – in fact, as many circles as possible. The entry plaza, benches, stairs, elevators, lamps, handrails, concrete columns, steel columns, fasteners and access holes to fasteners, lamps and lamp bases, plumbing taps and tap handles, half curves of the balconies and clerestory windows, three-quarter curve of the desks, all are composed of circles – wood or metal, large or small, solid or void.28

The other technique to motific detailing is applying the same metaphor to the detail, as was applied to the entirety of the building, without compromise to the relative scales. In other words, “detail as fragment in which the whole building is represented.”29

Zaha Hadid presents an appropriate example of the motific detail in digital architecture. Her Guangzhou Opera House (2010) figure xi applies the same methodology of continuous linear reliefs to multiple scales and functions. These slits of light become each lighting element, handrail, and transition from horizontal ceiling surface to vertical wall surface. One can only imagine that the handrail design is not especially user friendly or comfortable to the human touch. The panel treatment is equally suspect, an example of the tessellation technique taken to the extreme. Window shapes and mullions, wall treatment panels, and structure all follow the same rational. The detail decision are here made only based on stylistic desires, they are ignorant of scale translations, material differences, even functional requirements.

Detail as construction

The detail as construction became a favorite among the moderns exploring new industrial realities, material possibilities, and construction techniques. This detail has also become known as the expressed detail. Construction and joinery is exposed to heighten visual interest, following modernism’s axiom that *form follows function*, the detail becomes the ornament. Often, these details present the theorem already discussed, modernism’s separation of frame and skin.

The clearest examples come from the work of Mies van der Rohe – take his Alumni Memorial Hall in Chicago (1946) fig. xii. Here the purpose of detail is to reveal the use of a steel frame construction and curtain wall system. Frame and wall are distanced to emphasize the new construction possibilities. What is curious is the dis-honesty at play. The steel column that re-presents the steel frame is only a representation of the actual structure. The true structure needs to be encased in the concrete column for reasons of fire proofing. Perhaps this was an acceptable workaround for Mies, the best way to be able to express the structure of the building. Or perhaps Mies appreciated the sleight of hand, the irony that what he was expressing was not the real structure but to truly understand the function of the building you have to dig deeper into understanding.

“This is a practice seen in many contemporary buildings, the application of superfluous constructional features in combination with the suppression of real ones, to the end of achieving a “modern” image... This is not non-detailing; it is selective detailing. Its intent is to be the paradigm of the construction of the building as a whole, and it is a highly legitimate form of detail, but also deceptive one.”

A contemporary example comes from Nader Tehrani and his MOMA fabrications (1998) fig. xiii. Here the laser cut stitch functionally acts as a perforation allowing the bends to be made easier and more accurately. But this detail also presences the fabrication technique, it re-presents the accuracy of the laser cut that is only possible with the new technology.

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Detail as joint

The detail as joint is perhaps the oldest. This detail created ornament for classical architecture. For example the Ionic capital becomes joint between the pediment and the column; the pediment collects loads from above and directs them to the column, and the column, provides vertical support and bringing those forces to the ground. The base of the column provides a similar joint, negotiating loads with the ground. Louis Kahn acknowledges this joint, “A capital had to hold its volutes out to invite the span. It had to reach out, receive it, and the receiving of it had to be bigger than what the column was.”

Ed Ford illustrates the re-presentation potential of this type of joint with an example from Arne Jacobsen’s Aarhus Town Hall in Denmark (1941):

“...the series of cruciform columns that support the floor of the main council chamber do not connect with the remainder of the building. At the base and top of the columns, brass connectors form a kind of “ornament”...Although Jacobson never commented on this, there is an obvious political metaphor in the structural semi-independence of the council chamber from the rest of the building. This is a detail at odds with the building that contains it. It is a moveable joint in the static building, animating what is otherwise a fixed building, implying a larger relationship, social and political order as disparate parts in the midst of a monolith.”

A contemporary example of a digitally fabricated detail as joint comes from Wes McGee’s Matter design and his Helix stairs (2013). The joint between stair components is represented with a shallow reveal. This complex shape of this joint also re-presents the digital production of the stair along with its appropriate material, considering concrete’s malleability and also its customized nature, accommodated by the digital workflow.

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32 Ford. The Architectural Detail. 196.
Ed Ford reaches his conclusion with the autonomous detail – it is most desirable detail because it offers the most understanding. These details ignore any influence or metaphor from the larger building, they “follow their own logic and order and not that of the building that contains them.” They re-present the most information. They are performance (as a function) and performing (as an act) without compromise. The best examples Ford describes as subversive – they ‘change our awareness’ about the function of the detail.

Actively subversive – the detail that not only follows different rules, but also contradicts the concepts of the totality of the building.
Construction – a change in our awareness of parts and whole
Structure – a change in our awareness of the forces acting within a building
Program – a change in our awareness of our own engagement with in a building
Performance – a change in our awareness of the environmental forces acting on a building

An analysis of this detail has already been introduced through the work of Carlo Scarpa. With Scarpa, and his autonomous detail, every move, every connection is described, they are performance and performing. This illustrates how the detail becomes intelligent, it is tectonic, the poetry of construction, it offers knowledge to the audience. “An architecture of matter and tactility aims for a ‘poetics of revealing’ (Martin Heidegger), which requires an inspiration of joinery. Detail, this poetics of revealing, interplays intimate scale dissonance with large scale consonance.”

In digital architecture the skin typically is the only element with a voice. The overall form must then contain all meaning. This thesis proposes to disseminate that agency, specifically bringing it into the detail, as it is the element that mediates between the skin and frame. For, if the skin becomes less dominant, the detail can become presenter. It is allowed to

heighten our awareness, increasing the intelligence of all parts, skin, joint, frame, and user.

There is a strong tension between skin and frame. This becomes explicit in the tectonic, but an autonomous detail can also provide welcome interruption of the stereotomic. The detail must aspire to mediate this tension.

*We may perceive a single building as abstract or animated, but rarely in equal quantities. The autonomous detail is the manifestation of one of these sensibilities in the context of another – the vital in the inert, the naturalistic in the abstract... It is the role of a detail not to resolve this contradiction, but to articulate it.*

The following is the proposition of this thesis:

Architecture is the assemblage of layers.

- Leveraging today's technology and techniques.
- Let it be poetic.
- Honest. To reveal truth (a world).
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Credits