ABSTRACT
What happens when we reduce architecture to the logic of representation? This question is set in perspective by the recent re-emergence of certain discourses in architecture that see the world in terms of style, and that privilege the appearance and form of a design over its performance and the processes that generate it. This in turn is being fed by certain digital platforms that encourage the user to see the world solely in visual terms. The issue comes to a head with the practice of zooming in and out on the computer screen, a practice that helps architects to operate seemingly effortlessly at a range of different scales, from jewelry through to the city, but is not without its problems. This paper looks first at the challenges of operating at different scales by drawing on insights from the world of biology, and considers the performance-based issues being overlooked in this process of zooming in and out. It then goes on to theorize the problem by drawing upon the distinction between extensive and intensive properties as promoted by Manuel DeLanda following the work of Gilles Deleuze and Félix Guattari, and considers the relevance of this distinction for architectural design. The paper concludes that we can never escape representation, but by focusing solely on it at the expense of performance—and vice versa—we are overlooking an important factor that defines architecture.
INTRODUCTION

Recently there has been a renewed interest in representation within architectural culture. Here we might detect two separate—but somehow related—tendencies. On the one hand, we have witnessed a renewed celebration of the concept of “style.” Here we might cite Mario Carpo (2012), who, as an architectural historian, tends to see the world in terms of style, even when addressing algorithmic design. But we might also cite Patrik Schumacher (2009) who famously, or perhaps infamously, has celebrated the notion of what he terms “parametricism” as the singular universal style that, he claims, will dominate all other styles. On the other hand, we have witnessed the development of a range of disparate tendencies within certain architectural circles that come under the umbrella of object-oriented ontology (OOO), culminating in the appointment of the neo-Heideggerian OOO philosopher Graham Harman to a teaching post at SCI-Arc. This is an approach that privileges representation and form over process and performance, and is more concerned with what an object looks like than how it was generated or how it behaves. While both are different in their precise formulation, ultimately they amount to approximately the same phenomenon, a resurgence of interest in representation. It is as though the progressive process-based thinking inspired especially by Gilles Deleuze and Félix Guattari—which became popular in the 90s and could be understood as a reaction to the ocularcentrism and scenographic tendencies promoted in the age of postmodernity—has itself been called into question. In some senses, then, we have seen a return to the representational preoccupations of postmodernism.

What is at stake here? And what are the consequences for architectural design? And how could this preoccupation with representation be seen to be fed by the increasing prevalence of digital technology?

Size Matters

One of the hallmarks of architectural production today is the seemingly effortless way in which certain architectural practices find themselves designing at a range of different scales. Alongside their buildings and urban proposals, for example, Greg Lynn FORM designs silverware and boats, UN Studio designs furniture and 3D-printed shoes, and Zaha Hadid Architects (ZHA) designs jewelry, shoes and handbags. But what exactly allows these architectural practices to shift so easily from small-scale to large-scale designs?

In their documentary movie, Powers of Ten: A Film Dealing with the Powers of Ten and the Relative Size of Things in the Universe, Charles and Ray Eames (1977) explore relative magnitudes. The opening scene depicts a couple having a picnic in a park, viewed first from one meter, then zooms out progressively by powers of ten to a distance 100 million light years away, and then zooms back in again right down to 0.00001 ångstroms, the scale of quarks (the units of which atoms are composed). The original sketch version of movie was produced in 1968, just 1 year before Neil Armstrong and Buzz Aldrin were to become the first human beings to walk on the surface of the Moon, and 4 years after the term “quasar” was coined by Chinese-American astrophysicist Hong-Yee Chu (Schmidt 1963). In microscopic terms the movie was produced 4 years after the quark model was proposed independently by two physicists, Murray Gell-Mann and George Zweig, and 3 years after the first atom probe was introduced by Erwin Wilhelm Müller and J A Panitz (Schmidt 1963; Carithers and Grannis 1995). It was a period in which knowledge of
the universe was expanding rapidly at both ends of the visual spectrum.

What might the relevance of this movie be for architects? *Powers of Ten* is a visual representation of the Universe, perceived at different scales and premised on a notion of “zooming in” and “zooming out” that echoes the way in which many architects perceive the world in our computational era. Whereas in the old days of parallel motion drawing boards, a fixed scale would be selected in advance—1:10, 1:50, 1:100, 1:200 and so on—and the drawing drafted according to that scale, in our contemporary age of computational drafting, scale is not fixed. Rather, computational drafting relies on the same logic of zooming in and out. It is only when a 2D drawing or a 3D model is to be printed out that the size needs to be specified. As such, it could be argued that scale is no longer the fixed constraint that it used to be, and this capacity to zoom in and zoom out is a contributory factor in allowing architects today to design at a range of different scales. But what is being overlooked as they zoom in and out so effortlessly on the computer? Are there material constraints that are being ignored? And, if so, what might be the consequences?

**Learning from Biology**

Size matters. Ask any biologist. Let us make a comparison between an ant and an elephant. Why does an ant have proportionately long, spindly legs, and an elephant broad, sturdy legs? In order to answer this question, we might start, perhaps, with the simple mathematical principle that if we double the dimensions of an object, we do not double the volume. Rather, the volume increases by a factor of eight. Take, for example, a cube measuring 10 x 10 x 10 cm. Its overall volume would be 1000 cm³. If the dimensions of the cube were to be doubled so that it now measures 20 x 20 x 20 cm, some might expect the volume of the new, larger cube to be 2000 cm³, double that of the original cube. But in fact the volume of the new enlarged cube will be 8000 cm³, eight times the volume of the original cube. In other words as dimensions increase, so volume increases exponentially.

In terms of the ant, this factor has a number of significant implications, not least for its respiratory system (Schud-Nielsen 1984). From the perspective of architects, however, the most important consideration is perhaps structural performance. According to the logic outlined above, if the dimensions of an ant were to be doubled, its volume would increase by a factor of eight. Likewise its weight would also increase by a factor of eight. If scaled up, however, that weight becomes exponentially greater, while the intrinsic strength of its exoskeleton remains the same. As a result its structural strength-to-weight ratio would be reduced significantly. This principle also applies to bones. As Michael Fowler notes: “The intrinsic strength of the material bone is made from in animals of all sizes (Calcium apatite embedded in a matrix of collagen) is about the same. The strength of a bone is proportional to its cross sectional area. Compressive failure occurs for a stress of about 2*10⁸ N/m² (29,000 lbs/in²)” (Fowler n.d.). This has serious consequences in terms of structural performance, and explains why we do not see ants the size of elephants. It also explains why the elephant—a much larger creature—has such sturdy legs. Interestingly, research has also shown that the metabolic rate of insects is much more rapid than that of humans, so that time appears much slower to them (Press Association 2013). Hence a fly often has little difficulty avoiding a human being trying to swat it. Put simply, to a fly, a human being would appear as lumbering and slow, as an elephant appears to a human being.

Let us take another example, King Kong atop the Empire State Building. If King Kong were 10 times the size of a standard gorilla, then, as argued above, his weight would not be 10 times greater, but 1000 times greater than that of a standard gorilla, while the cross sectional area of his bones would only increase 100 times. This would make King Kong intolerably heavy for his own structural frame. The problem is that most animals are “designed” to carry their own weight—but not much more—in vigorous activity. The result is that, if scaled up, a creature ten times the size would be incapable of moving around. Thus the images of King Kong atop the Empire State Building are a complete fallacy. It is not a question of whether the Empire State Building could support the weight of a super enlarged gorilla. No, King Kong could not
even support his own weight. Put simply, nature simply couldn’t produce such a creature. King Kong is a fiction.

So what of the Empire State Building itself? Clearly the same logic would apply. A crucial factor that allowed the New York skyscraper to be built in the first place was the introduction of steel as a building material. After all, there is a limit to the height of a brick building, even if steel is used for the actual structure. And yet the structural constraints of scaling up the Empire State Building are similar to those of scaling up a gorilla. Both are governed by the same principles. The intrinsic strength of steel remains the same. Thus, if the Empire State Building were to be scaled up proportionately ten times, like King Kong, it would not stand up, unless its materials and structural logic were to be radically reconceived. Either its structural frame would need to be fabricated from material with vastly greater structural properties, or its structural logic would have to be reconfigured. An example of this is the way in which the simple compressive masonry bridge needs to change both its material and structural logic as it grows larger, until it evolves into a large-span steel suspension bridge, as with the Golden Gate Bridge in San Francisco, California. While good structural design can minimize stress, there is nonetheless a limit to the size of any compressive structure. One might surmise, too, that other factors would need to be addressed. For example, if the respiratory system of an insect does not work for larger creatures, how would the ventilation, heating and air conditioning systems of the Empire State Building need to be reconfigured if it were to be scaled up? While the Empire State Building can be scaled down to make popular souvenirs easily enough, it cannot simply be scaled up so easily.

This brings us back to Powers of Ten, and, by extension, the inherent problem of using computational drafting tools that allow architects to zoom in and out effortlessly. While these tools allow architects to operate seamlessly at a range of scales, the problem is that they rely on purely visual criteria. They do not take into account various other non-visual criteria, such as the structural logics of tension and compression.

**Extensive Versus Intensive**

How are we to theorize this question? Here I would like to introduce the distinction that Manuel DeLanda—following Gilles Deleuze and Félix Guattari—makes between “extensive” and “intensive” properties. The notion of “intensity” is central to DeLanda’s thought. It is one of the crucial concepts in *Intensive Science and Virtual Philosophy*, a book that DeLanda (2002) wrote to address the impact of scientific thinking on Deleuze’s thought.

Extensive properties refer to mainly visual properties, such as size, shape and so on, whereas intensive properties refer to often non-visual properties, such as temperature, stress, pressure, speed, gravity, compression, tension and so on (Deleusa 1994, 222). Importantly, extensive properties can be divided, whereas intensive properties cannot be. As Deleuze and Guattari note:

> What is the significance of these indivisible distances that are ceaselessly transformed and cannot be divided or transformed without their elements changing in nature each time? Is it not the intensive character of this type of multiplicity’s elements and the relationship between them? Exactly like a speed or a temperature, but rather it is enveloped in or envelops others, each of which marks a change in nature. (Deleuze and Guattari 1987, 31)
Take a container of boiling water. An example of the “extensive” properties of the water would be its volume, while an example of “intensive” properties would be its temperature. But they do not operate according to the same logic. Hence, for example, if a liter of water with a temperature of 100°C were to be divided in half, it would not produce two half liters of water with a temperature of 50°C, but rather two half liters with a temperature of 100°C.

By extension, in scaling up a gorilla to generate King Kong, as the volume is increased, so the intrinsic strength of its bones remains the same.

Although DeLanda (2005) has yet to explore its implications for architecture, he has pursued its ramifications in the context of space. For DeLanda there are two different types of space: intensive and extensive. We are more familiar with extensive space. This is the space that we inhabit in our everyday lives—the spaces of a house, a city, a country, or indeed any space that is demarcated by a boundary. Extensive space has dimensions. We might also refer to it as a physical space. By contrast, intensive space is characterized not by physical form, but by intensive qualities, such as heat, speed, pressure or density. At an urban scale these differences between extensive and intensive properties are articulated in a typical weather chart, where visual, physical aspects of the chart (such as mountains, rivers and coast lines) operate as extensive features, whereas non-visual aspects (such as high or low pressure systems, and warm or cold fronts) operate as intensive features.

There is a relationship between extensive and intensive properties. Just as the extensive form of a mountain range will influence the intensive properties of a weather front, so intensive properties can influence extensive ones. As such, we could even go so far as to characterize extensive properties as being governed by their form, and intensive properties as those properties that inform that form. Intensive properties therefore play a morphogenetic role in the generation of form.
As DeLanda notes: "Intensive differences are productive. Indeed, it may be argued, wherever one finds an extensive frontier (for example, the skin which defines the extensive boundary of our bodies) there is always a process driven by intensive differences which produced such a boundary (for example, the embryological process which creates our bodies, driven by differences in chemical concentration, among other things)” (DeLanda 2005, 81). And again: "If we characterize the identity of material beings as defined by extensities... then the process that produces those beings will be defined by intensities" (DeLanda 2005, 82).

Architectural culture, by contrast, is dominated by visual—and hence extensive—approaches to design. One example of this visual emphasis would be the issue of “complexity.” This has been in vogue recently in architectural circles, with designers using programs such as Processing to produce visually complex designs, many of them—as in the case of the remarkable work by Roland Snooks—exquisitely beautiful. But are these designs really complex? From an intensive viewpoint, the humble soap bubble, however simple in its form, is far more complex in its material behavior than any visually complex form that could be produced by a Processing script. The material computation at work in generating the form of the bubble—based on internal and external pressures, surface tension and so on—is highly complex. Indeed it could also be argued that a simple bubble, with its relatively straightforward spherical shape, is beyond the capacity of being modeled convincingly with any digital computation available today (Hong, 2003; Ren et al. 2015). However, the issue of complexity in architecture is often only addressed at an extensive level. As such, the actual intensive complexity is often overlooked.

Another example of the predominance of visual thinking in architectural culture is the overriding obsession with form at the expense of anything else. Although neither Deleuze and Guattari nor DeLanda refer to cost as an issue of intensity, clearly there is an opportunity to read cost in this way, whereby the market price can be seen to be driven by the intensity of interest in a product. Relating this logic to urban planning, building forms could be read as extensive features, whereas property prices and intensity of demand could be read as intensive features. Property development is driven by intensive issues such as property values. And yet all too often, architects ignore financial issues, and focus almost exclusively on visual issues. (An inspection of any book on architectural history will reveal that almost the only reference to cost is the price of the book itself.)

The problem with architects, then, is that they are primarily "extensive" thinkers in their approach to design. In other words, they focus mainly on visual aspects of form, often to the exclusion of non-visual behaviors that help to generate that form. The lesson is clear. In scaling up or down, architects need to step beyond their ocularcentric approach that privileges the visual, and take into account other, often invisible, factors, such as stress, tension, compression, gravity and so on.
Gothic architecture is indeed inseparable from a will to build churches longer and taller than the Romanesque churches. Even further, even higher... But this difference is not simply quantitative; it makes a qualitative change: the static relation, form-matter, tends to fade into the background in favor of a dynamic relation, material-forces. It is the cutting of stone that turns it into material capable of holding and coordinating forces of thrust, and of constructing ever higher and longer vaults. The vault is no longer a form but the line of continuous variation of the stones. It is as if Gothic conquered a smooth space, while Romanesque remained partially within a striated space (in which the vault depends on the juxtaposition of parallel pillar). (Deleuze, Guattari 1988, 364)

My point here is not to get lost in the somewhat ambiguous terminology that Deleuze and Guattari use, but rather to focus on how we might understand this distinction within an architectural context. For Deleuze and Guattari, the Romanesque—or perhaps more aptly, the Classical in general—is concerned with the logic of the visual, and with adopting certain top-down templates, such as the rules of proportions. By contrast, the Gothic is concerned with the logic of forces and flows, and

**Intensive Architecture**

How then might we apply these concepts to architecture? Let us turn again to the work of Deleuze and Guattari. As happens with much of their work, concepts often overlap, and a parallel distinction to that between intensive and extensive may be found in their distinction between "Gothic" and "Romanesque."

Here Deleuze and Guattari refer to the distinction not between two different styles of architecture, but between two different modes of thinking or design sensibilities. In fact Deleuze and Guattari use this architectural example as what they would call a "diagram"—or visual example—of a concept, not in order to discuss architecture itself but rather the difference between what they term "smooth" space and "striated" space, a distinction that echoes the difference between what they call "major" and "minor" sciences. Loosely translated this means the difference between following a rule book (major sciences), as opposed to exploring issues in a more experimental way (minor sciences), or—put another way—the difference between being controlled in a top-down fashion (striated) as opposed to being free to pursue ideas in a bottom-up fashion (smooth):

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allowing them to generate a design. It is a distinction, ultimately, between the logic of "form" and the logic of the forces and flows that inform that form.

A similar distinction may be found between their concepts of the "hylomorphic" and "morphogenetic," between "imposing" form on matter and allowing matter to "find" its own form, as we might find for example in the work of Antonio Gaudi and Frei Otto (Menges 2006). Deleuze and Guattari discuss this connection in relation to fibers in wood, which—importantly—they refer to as "intensive affects" (Deleuze and Guattari 1988, 408). To operate morphogenetically is to operate according to the material behavior of the wood; to effectively "surrender" to the wood: "At any rate, it is a question of surrendering to the wood, then following where it leads by connecting operations to a materiality, instead of imposing form on matter" (Deleuze and Guattari 1988, 408).

A good example of this distinction within contemporary architectural discourse would be the difference, say, between Gehry and Partners’ design for Disney Concert Hall in Los Angeles, and UN Studio’s design for Arnhem Central in Holland. Both are buildings designed using continuous surfaces, but the Disney Concert Hall is designed purely in terms of visual form, such that the structural logic of supports behind the façade cladding has little in common with the logic of the cladding itself. By contrast, the curvilinear section of the main foyer to Arnhem Central (Figure 10)—which, at first glance, might look like a Gehry form—is in fact a form that has been designed morphogenetically by structural engineer Cecil Balmond.

A further example of operating within the logic of the "Gothic" with a precise understanding of intensive concerns, such as stress, would be the work of Philippe Block, such as his Armadillo Vault at the Venice Biennale. The challenge here is to minimize stress through the geometry of the form, such that the compressive forces flow through to the supports. As Block notes, "In general, 'good structural form,' that is, a geometry that follows the three-dimensional flow of compressive forces to the supports, results in low stresses" (Block, van Mele, and Rippmann 2015, 75).

While we should be cautious of collapsing the distinction between the "Gothic" and the "Romanesque" into the distinction between the "intensive" and the "extensive," in that Deleuze and Guattari do not evoke that connection explicitly, it is clear that there are parallels between the two pairs of concepts. Forces—compression and tension—are effectively intensive qualities, whereas forms are extensive ones. Moreover—as is too often the case with what Deleuze and Guattari call "reciprocal presuppositions"—the one informs the other, such that forces can be understood as a process of formation that "informs" form.

CONCLUSION

What then are the consequences of this for architecture? Clearly there is a danger within the effortless logic of zooming in and out that is afforded by much computational software of being dominated by a visual paradigm and overlooking intensive concerns. It is not that digital technologies are responsible for this in themselves. Rather they simply afford the possibility of being used in a certain way so that architects do not come to address structural concerns. Moreover, there are now plenty of software programs readily available on the market that allow us to test structural behaviors. It is up to us, as architects, to be vigilant.

Likewise, it is up to us to be vigilant in the face of the latest representational turn towards a renewed interest in "style" and the image-based logic of OOO. We can never escape appearances or "affects," in that the extensive appearance of an object is often the result of intensive concerns. A bicycle, after all, looks like a bicycle largely because of how it operates, although there is undoubtedly an element of stylization employed in its design. However, if we do not address intensive concerns, and if we focus purely on representation and form, we will find ourselves slipping back into a design outlook not so dissimilar to postmodernism.

However, there is also a danger in the opposite outlook. By this I do not mean the danger of an overly zealous pursuit of structural concerns merely for the sake of those concerns, but rather the danger of repressing any acknowledgement of beauty or representation. All too often this repression is unleashed in the exquisitely beautiful images chosen to accompany texts about performative or functional approaches to architecture (Hensel, Menges, and Weinstock 2004). Here we risk falling into the same undialectical trap for which Adorno criticized Adolf Loos, with his rejection of purpose-free aesthetic concerns and championing of mercilessly functional or purposeful concerns. As Adorno notes, "There is no chemically pure purposefulness set up as the opposite of the purpose-free aesthetic" (Adorno 1997, 20). Just as there are no functional objects utterly devoid of any sense of design, so too there are many aesthetic gestures, such as dance, that have a social function.

Let us be clear. Architecture is always a combination not only of form and representation, but also performance and process, of not only "Romanesque" concerns, but also "Gothic" ones. It must be dialectical. Inevitably the challenge is how to balance out these two approaches, as we cannot have one without the
other. However, in the context of digital technologies, we must be especially cautious not to allow the visual logic of zooming in and out to reduce architecture primarily to a discourse of representation.

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Figure 4: Eames Office

Figure 5: Andrew Stawarz

Figure 6: Octagon

Figure 7: Roland Snoeks

Figure 8: TheBrockenInaGlory

Figure 9: Carol Highsmith Image source: http://en.wikipedia.org/wiki/Walt_Disney_Concert_Hall

Figure 10: Ronald Tillerman

Figure 11: Iwan Baan

Zoom Space: The Limits of Representation Leach