Digital Shadow

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While architects sometimes lament the turn to digital representation and its affect on the quality of design, it is not clear that digital tools preclude architectural thinking any more than descriptive geometry did a hundred years ago. This paper considers whether digital tools might help activate poetic imaginations in the same way that constructing and rendering shadows did in the past. Just as architects needed to look beyond the allure of mathematical puzzles in descriptive geometry, architects today can use digital simulation of light effects to understand architectural ideas more fully. This paper describes an intentional process of early instruction in architectural representation that can help set this way of thinking in motion.

As recently as a generation ago, architecture students spent long hours learning the fundamentals of descriptive geometry, which was essential for depicting cast shadows. A laborious process for almost any architectural project, it could quickly become mind-bogglingly difficult for complex forms with intersecting angles and curves. (figure 1) It was easy to miss, in the midst of this effort, that the actual goal was to understand something about reality. The classic text on the subject of architectural shades and shadows, written in the first years of the twentieth century by Henry McGoodwin, emphasized how important the designer's artistic mindset was for this work. Its very first paragraph warns, "The shades and shadows of architectural objects are architectural things, not mathematical things."[1] This thinking followed commonly held advice, articulated powerfully by John Ruskin almost fifty years earlier, that "among the first habits that a young architect should learn is that of thinking in shadow."[2] The point was to use the process of drawing, attenuated through the long labor of constructing and rendering shadows, to consider the physical richness of architecture. Students of architecture learned to see past the mechanics of drawing and understand the phenomena of buildings in the world. Our own powerful techniques for architectural representation have changed the process, but digital tools using complex mathematics make it possible to anticipate shadows and the behavior of light with astounding precision, and with far greater acuity and depth than descriptive geometry could ever have provided. But do these tools inhibit or expand architectural thinking?

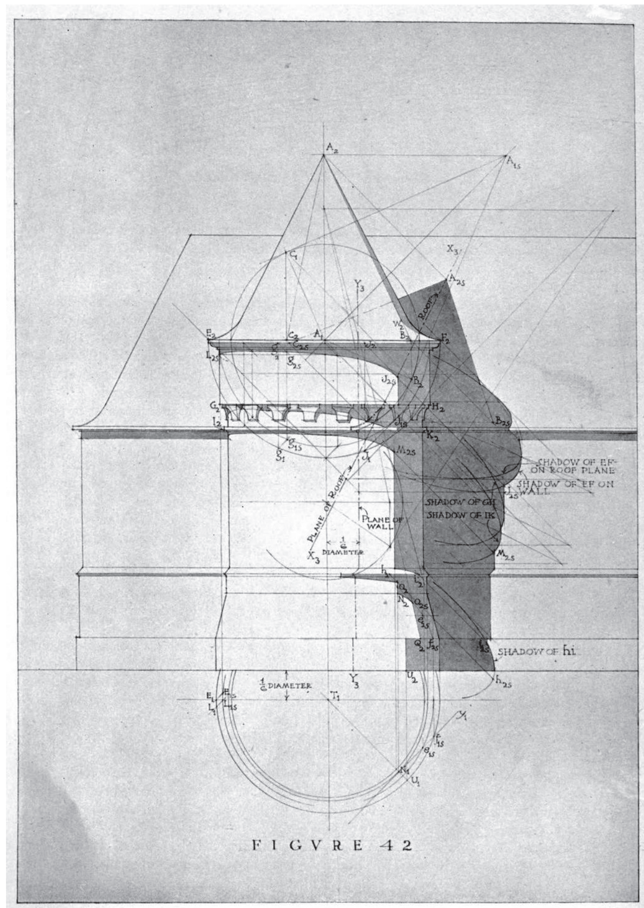

Figure 1: Henry McGoodwin, "Shades and Shadows on the Roof and Wall of a Circular Tower with A Conical Roof" from *Architectural Shades and Shadows.*

Certainly, many architects have lamented the loss of traditional drawing techniques and fear the consequences of that loss. In The *Death of Drawing: Architecture in the Age of Simulation*, David Ross Scheer contends that digital simulation seeks to replace reality. In fact it "demands to be taken for reality."[3] When they yield to this demand and accept simulation in place of representation, he argues, architects lose an important means for considering the nuances of experience. Simulation orients toward "performance;" it predicts what is measurable, whereas representation contends with "how human perception relates to reality."[4] In other words, representation makes room for some unpredictability, which is valuable in conveying a feeling for how the world actually operates. This sensibility oriented the nineteenth century idea of 'thinking in shadow,' which was about anticipating the complex behavior of light. McGoodwin's warning makes it clear that it was possible to get carried away with the precise mathematics; descriptive geometry on its own could not cause someone to conceive architecture as Ruskin thought about it: "as it will be when the dawn lights and the dusk leaves it; when its stones will be hot, and its crannies cool;

Figure 2: A digital rendering produced in the early 1990s by the author.

when the lizards will bask on the one and the birds will build in the other."[5] Even though present-day rendering engines like V-Ray or Maxwell might yield nearly perfect depictions of shadows and reflections—and possibly even lizards and birds in the joints between stones—it is hard to imagine that these tools would be any more effective than descriptive geometry in helping someone see the world as Ruskin did. The poetic mindset of an architect revels in the incidental, the unpredictable and the invisible, because these are usually what make buildings most interesting and satisfying.

We often hear architects lament the turn to digital representation, or simulation, because it seems to dispense with what Edward Robbins calls the architect's "creative and conceptual musings about design."[6] Drawing has long been the primary vehicle for that kind of thinking. The important question, though, is whether digital tools preclude this kind of musing, or 'thinking in shadow,' any more than descriptive geometry did. Or, is there some possibility that we might use computers to help activate our poetic imaginations in the same way that constructing and rendering shadows did in the past? Just as architects needed to look past the allure of mathematical puzzles in descriptive geometry, can we look past simulation to understand reality more fully?

Early digital tools used for architectural representation were laborious and slow, particularly when producing ray-traced renderings. (figure 2) However, they emulated some surprising aspects of reality and shifted attention, especially for architects trained in the conservative tradition of descriptive geometry and India ink washes (which was also laborious and slow). While these drawing techniques offered ways to construct shadows and intuit the behavior of materials in light, early digital modeling offered new insights. Terms like "index of refraction," "specular reflection," and "distance falloff," which were foreign to traditional shade and shadow casting, became essential in describing materials and light in digital models. Most fascinating about this new vocabulary was that it added depth (and automation) to what was essentially the same process architects had already learned. After all,

Figure 3: Twelve VRay materials applied to the same object, from Chia Fu Chiang, Damien Alomar, Fernando Rentas, *User Manual: V-Ray for Rhino, A Rendering Plug-in for Designers* (ASGVIS), http://help.chaosgroup.com/vray/help/rhino/100/V-RayforRhinoManual_English.pdf, 105.

the simplified version of descriptive geometry McGoodwin used in Architectural Shades and Shadows was ray tracing by another name. The biggest difference, mathematically, was that the traditional method almost always used only one set of parallel "conventional rays" (from over the left shoulder), and it dealt with ambient light, bounced light, and refracted light only speculatively or by convention (such as: small shadows appear darker than large shadows; shade appears lighter than shadow because of reflected light, shadowed areas near floors appear lighter than shadowed areas near ceilings, and so on.) Aside from predicting cast shadows from one distant light source, the traditional method could contend with more subtle effects only very generally. Digital renderings, by contrast, could incorporate multiple sources of light and precisely depict the interactions of light with materials according to their specific characteristics. So, digital modeling involved, in addition to the construction of objects in abstract space, learning how to designate the qualities of light and the material attributes of those objects to improve computer renderings. Just as shadow casting in hand drawing helped

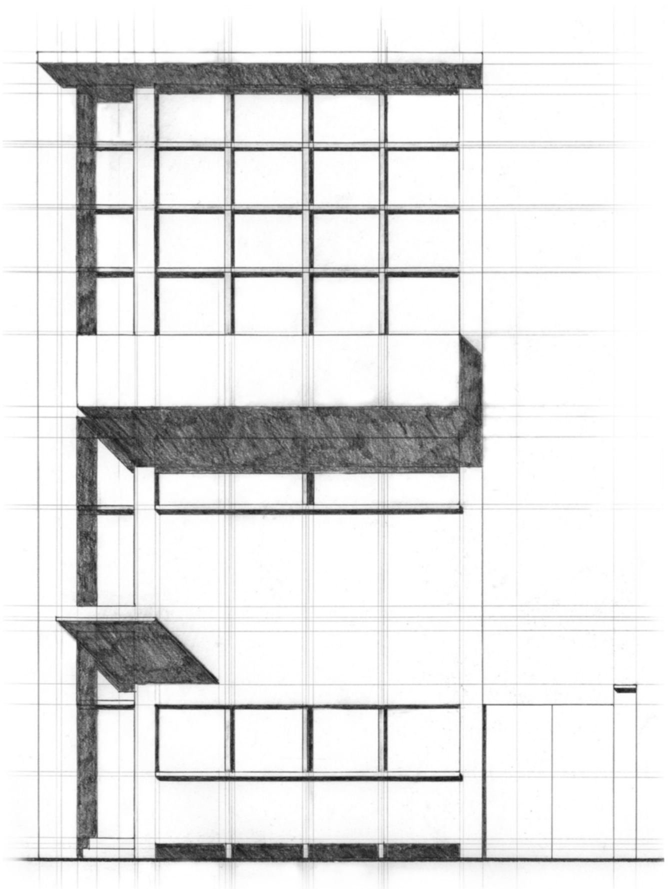

Figure 4: Student project, shadow casting on Le Corbusier's Maison Guiette, Kelsey Pierson, 2016.

designers think more deeply about the fleeting qualities of buildings as people experience them, applying light-interactive attributes to materials in digital models focused attention more closely on how light and materials interact to affect perceptions.

Early digital representation tools provided very limited libraries of materials, so it was important to learn the new vocabulary and to understand, in assigning a material to each object, how light would behave when hitting it. Digital light, too, had attributes and vocabulary to learn and understand, which had to do with color, intensity, direction and source type. Thinking in shadow became much more complex and more technical, but potentially richer. If learning shade and shadow techniques taught students to "study architectural shadows carefully and with his artistic faculties fully awake to their essential value," it seemed natural that digital modeling techniques should add to that.[7] New tools and new techniques awakened thoughtful users to the essential value of materials' reflective and absorptive capacities, which they hadn't considered as deeply before.

Those lessons are still available; however, there are more of them to be learned, and more sophisticated software sometimes hides them more thoroughly. Using V-Ray, for example, requires yet more choices and vocabulary: "fresnel reflection," "sub surface scattering," "refraction glossiness," "caustics," "surface displacement," "angular blending," "atmospheric turbidity," etc. Users can avoid most of this complexity, and the thinking comes with it, by choosing from a huge library of already designated materials and lights that can almost magically clothe any object with realistic-looking material in a couple of mouse clicks. (figure 3) For simulation of architectural effect, these libraries save time and thought, but they are less effective in awakening artistic faculties.

The challenge for architectural expression lies in building up knowledge about phenomena through the use of the best representational techniques available. In this way, 'thinking in shadow', brought forward from the Victorian to the digital era can still work. In Ruskin's time, casting shadows supplied an antidote to "looking at design in its miserable liny skeleton," as he characterized the shallow efforts of the draftsmen-architects of his time.[8] In an age of digital tools, rendering material in light can counteract the shallowness of pure simulation, as Scheer characterizes the work of so many architects now. In both cases it is a matter of mindset more than technique. When students think about architecture wrapped up in natural phenomena and in the context of human habitation, architecture becomes less predictable but richer. Representation evokes possibility, rather than feigning exactitude. Digital tools can fit comfortably in this mindset. They can, of course, be as rigidly mathematical as descriptive geometry, but they can also be as flexible as they need to be for architectural expression.

Building an outlook that opens students to the possibilities of architectural expression, with 'artistic faculties fully awake' can happen most readily in early architectural representation courses. In an introductory graduate course I teach at University of Washington, students first acquire a fundamental understanding of casting shadows by hand. Using descriptive geometry techniques and conventionally-applied graphite or ink wash in a simple building case study they learn to convey the play of light and shadow on building surfaces (figure 4), and discover, in the words of one student, "new ways of looking and seeing."[9] The benefits of this lie in the technique's limited range of variables, its clear process, and predictive latitude. Simply by following the steps, the student discovers a potent tool for anticipating real-world behavior of light.

The next effort in the course is to undertake what Ruskin called "shadow-hunting," that is, to seek out the interactions of light and material and to consider how to represent them.[10] This happens both inside and outside of the studio. In the design studio that parallels the representation course, students undertake exercises in carving and casting to shape interior spaces. They then photograph and draw the resulting

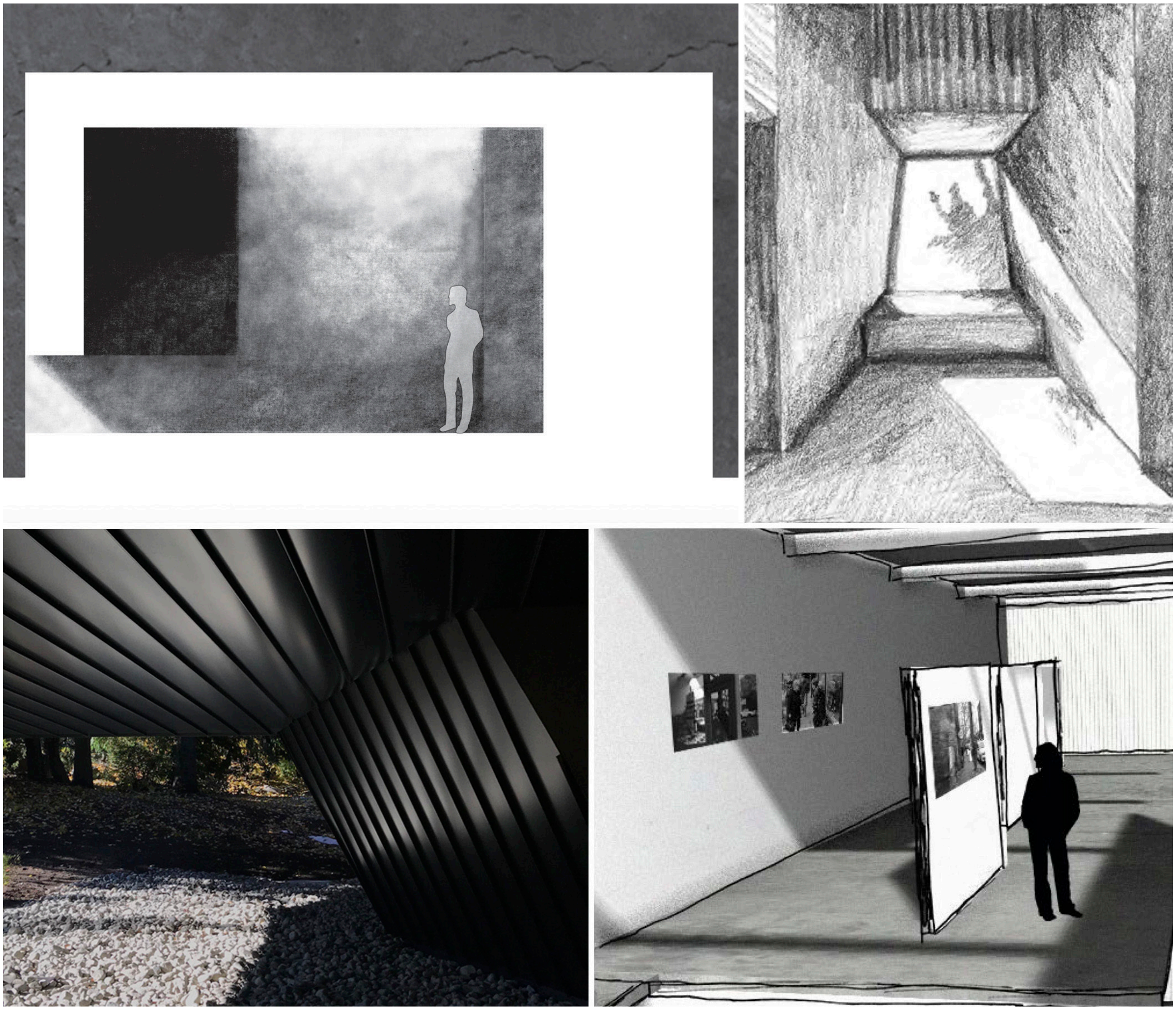

Figure 5. Student projects, shadow casting and shadow hunting. Upper left, Jesse Davis. Upper right, Alissa Tucker. Lower Left, Alissa Tucker. Lower right, Elena Darnell.

physical models to emphasize not clay and plaster but space and light. (figure 5, upper left) Photographs of the models manipulated in Photoshop, and hand drawings supplemented in Illustrator, blend the digital and tactile. Later, outside of studio, particularly on a weekend field trip to Vancouver and Whistler, British Columbia, the students spend some time shadow hunting with their sketchbooks and cameras. (figure 5, upper right and lower left) They look past building form and detail to discover effects of light as it interacts with material. Having already labored over the casting of shadows themselves, students are especially open to this task. Their own photographs or sketches for the assignment frame the phenomena and reinforce the value of experience in orienting their design work.

A third step happens as students learn basic digital modeling techniques. A crucial task in this is to configure materials in their digital models without recourse to pre-built libraries. This helps students familiarize themselves with new concepts and vocabulary related to light and material, and it emphasizes that even a basic digital model is about more than construction and arrangement of forms. Another task is to use their own perceptions and intuitions to adjust the modeling software's calculations by layering its output with photographs from physical models and hand-drawn lines to create a hybrid drawing in Photoshop. (figure 5, lower right) In other words, for presentation output the students must rely on the calculations of the modeling software, but they must also adjust its depiction of space and light to convey a more complex and nuanced understanding of the design using other techniques.

This sequence of exercises in a ten-week introduction to architectural representation helps build a habit of thinking about phenomena, especially about material and light, in the production of graphics for architectural design. It makes extensive use of digital tools without relinquishing creative intuition. By emphasizing the concept of 'thinking in shadow' through a series of interrelated exercises it challenges students to envision their designs as 'architectural things not mechanical things' and to incorporate 'creative and critical musings' in a rigorous process of design and representation.

Henry McGoodwin claimed that student work undertaken in pursuit of a mathematical method was bound to be "spiritless, disinterested, and perfunctory," because it did not concern the substance or art of architecture.[11] For the architects of his generation drawing supplied the means for the expression of architectural ideas, and shadow casting was meant to serve that end. Our vastly more complex systems of digital representation can provide access to even deeper insight, but only if we use them to facilitate understanding about phenomena in the built environment and then use this knowledge to cultivate architectural thinking.

ENDNOTES

1 Henry McGoodwin, *Architectural Shades and Shadows* (Boston: Bates & Guild Company, 1904) 11.

2 John Ruskin, *The Seven Lamps of Architecture* (1849) (New York: Dover Publications Inc., 1989) 85.

3 David Ross Scheer, *The Death of Drawing: Architecture in the Age of Simulation* (New York: Routledge, 2014) 31.

4 Scheer 20.

5 Ruskin, *Seven Lamps* 85.

6 Edward Robbins, *Why Architects Draw* (Boston: MIT Press, 1994) 27

7 McGoodwin 12.

8 Ruskin, *Seven Lamps* 85.

9 Comment from Arch 310 student course evaluations, University of Washington, December, 2017.

10 John Ruskin, *The Works of John Ruskin: Modern Painters, Vols. III and IV* (New York: John B. Alden, Publisher, 1885) 86.

11 McGoodwin 11.