GROUNDING TECHNE

BY

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THESIS

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ABSTRACT

Technê is the ancient Greek word for "both a practical skill and for the systematic knowledge or experience which underlies it" (Aristotle and Tarán, 2000). Landscape architects have delegated the tool-making aspects of the technê of landscape design to others. By not taking full responsibility for the technê of practice, landscape architecture's unique professional identity is jeopardized, landscape architects do not have full control of their craft, and the knowledge required to innovate in response to the ever-changing demands on design is not inherent to the discipline.

This lack of engagement may have been caused by historical rifts between landscape architects and tools at the inception of the discipline. Landscape gardeners, the predecessors of the discipline, worked in a society that viewed nature and technology as fundamentally opposed forces and were commissioned to design idealized versions of nature that intentionally masked the use of technology in their creation. Furthermore, the very division of labor that formed the discipline severed landscape architects from the tools required to realize built landscapes.

Rectifying landscape architecture's separation from the creation of tools provides many opportunities, as tools extend the capabilities of their user. However, tools can also lead the user astray. Understanding and evaluating tools is crucial to be able to exploit their opportunities while avoiding pitfalls. A better understanding of human perception provides a framework for interpreting two sensory tools that had opposing effects on landscape architecture: the Claude Glass, which narrowed and subjectivized the vision of the designer to the point of blinding, and the Earth Observation Satellite, which overwhelmed the designer with raw objective information and encouraged distanced observation of sites.

The ideal sensory tools for the landscape architect's toolkit would combine subjective and objective observation, allowing the user to gather objective information while immersed in the site. These tools are so inherently specific to practice that they must be created within the discipline. As *Maker* culture and wearable technologies have become mainstream phenomena, landscape architects have ready access to the tools and skills they need to tinker their own tools.

I tested this idea by developing a series of tinkering projects or "physical sketches" of new tools for landscape architects: a Small Unmanned Aerial System (sUAS), the *Digital Nerve,* the *Haptic Surveyor,* and the *Baro-Receiver.* I found that tinkering can produce new tools that beget new opportunities and design outcomes for landscape architecture. If approached as a new directive, tinkering new tools for a design technê wholly formed by landscape architects has potential to revolutionize the discipline.

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CHAPTER 1
Technological Innovation in Landscape Architecture: A Directive

Given their interest in interdisciplinary approaches to the built environment, landscape architects are well suited to design and implement a wide range of landscape-based mitigation and adaptation strategies to address environmental crises across the globe. However, increasingly complex cross-dependencies between non-human ecologies and resource economies present landscape architects with ever-changing technical problems requiring new, adaptable technology and formal strategies. As such, landscape architecture has reached a crucial juncture in the development of the discipline. These mounting challenges require unprecedented technical expertise, or *technê*, as landscapes and their architects are expected to perform myriad functions and serve multiple programs.

Technê is the ancient Greek word for "both a practical skill and for the systematic knowledge or experience which underlies it» (Aristotle and Tarán, 2000). Technê relates to another ancient word for knowledge, *episteme,* or pure theoretical knowledge, but technê differs in that it is knowledge of practice earned by making or doing. As James Corner noted, the relationship between craft and motivation is the "forgotten rule of theory" (Corner, 1990). Art and architecture were once considered amalgamations of technê and *poiesis*, the dimension of creative, symbolic representation. Technê did not make a distinction between theoretical and the practical, but with the origin of modern science (technology) and modern aesthetics (art) it became a separate body of instrumental knowledge (Corner, 1990). Technê requires a deep understanding of not only the theory, but also the tools and technology required to make something happen (Parry, 2014). The tools of the landscape architect are the tools to study and design landscapes.

Historically and presently, the discipline of landscape architecture has largely adopted a generalist strategy of borrowing from allied professionals rather than innovating within the discipline itself, in so doing leaving the elements of technê, and by extension technê itself, in the hands of others. Of these elements of technê—tools, technology, and theory—theory has been the focus of the most extensive discourse within the discipline, yet is arguable that even this aspect of technê is adapted from foreign bodies of knowledge. Critic Robert Riley has argued that even some of the most general theories and frameworks of landscape architecture are not legitimate as they were largely "plagiarized" from allied disciplines (Swaffield, 2002). If landscape architects have as a discipline left the theoretical aspect of technê in the hands of others, one could surmise that the strategy of borrowing and adapting, rather than innovating within, has also been applied to tools and technology.

To say that landscape architects have predominantly relegated the creation of tools and technology to other disciplines does not render landscape architecture uncreative; rather than developing and pioneering tools, landscape architects have innovated in the adaptation of these tools to their unique medium. Nor is that approach wholly misguided; it can be opportunistic and efficient. Landscape architecture resulted from the melding of practices, allowing landscape architects to adopt tools and techniques from allied disciplines. Borrowing tools from architects, artists, writers, engineers, horticulturalists, and other disciplines with time-honored technical and theoretical bases enabled efficient use of time and resources and allowed for an upsurge of activity at the onset of the discipline. Today, as generalists, landscape architects must rapidly acquire new skills and ideas and weave seemingly disparate notions into a broader understanding of the built and natural environments, continuing the incentive to borrow and adapt tools. Exclusively acquiring new tools through this strategy, however, puts landscape architecture’s professional identity at risk.

Contemporary environmental complexities mean that landscape architects are less likely to act alone. Now more than ever, projects require the creation of multidisciplinary teams often including the allied disciplines that once contributed to landscape architecture’s founding toolkit. As teams jockey for project scope, allied disciplines attempt to incorporate intelligence from landscape architecture. In some cases, they take concepts back that were once their own, though evolved from the broad-spectrum adaptation to the medium of landscape.

Without an engine of innovation within landscape architecture, allied disciplines can continue to borrow until nothing unique is left to the discipline. A discreet technical directive within the landscape design process is required. Without it, the lines between disciplines are blurred, making it difficult to stake out landscape architecture’s domain.

For example, a client may seek services for landform design from a landscape architect or a civil engineer. While many landscape architects may scoff at a civil engineer’s aesthetically uninspiring grading scheme, the engineer’s means and methods for landform design are more efficient and precise. With a rapid increase in landform design and construction coming from landscape architecture, civil engineers have a litany of inspiration from which to draw similar sensibilities. Are landscape architects learning from civil engineers’ precision and speed, or developing their own methods for tackling problems quickly?

Not keeping pace can be problematic when considering the purpose of a profession as rendering specialized services based on particular knowledge and skill generally beyond the understanding and capability of outside professions. Technology, as it extends the abilities of individuals and collectives is central to the discipline’s ability to provide these services competitively (Rutledge, 2011).

The landscape project is no longer just for landscape architects, yet landscape architecture has the potential to be the most critical of the applied arts today. An opportunity to distinguish the profession lies in the development of a landscape design technê replete with unique technologies and techniques to meet the challenges of the 21st century. Landscape architects are already successful in developing new construction practices, but the extension of this innovation to the tools of design will give landscape architects control over their craft and incorporate innovation into all aspects of the profession. To ensure the strength and longevity of professional identity and practice, this is a crucial endeavor.

Through this thesis, I tested the day-to-day work of creating tools to bolster this unique design technê, focusing on innovation in tools of observation and analysis. There are numerous incentives to develop novel site analysis technologies. As the first step in the conventional landscape design process, site analysis is highly influential on the success of design and an opportune phase during which landscape architects can differentiate themselves.

Furthermore, harnessing the developing marketplace of user-friendly, adaptable tools of observation and analysis can empower landscape architects to validate their work through measurement of landscape metrics both pre- and post-construction. With today’s emphasis on landscape performance, the need for observation and analysis services will continue to grow. Control over the relevant technologies can prevent landscape architects from becoming increasingly reliant on the government agencies and allied disciplines currently providing these services.

As a preliminary step in developing distinctive technologies across the discipline, design and pedagogical researchers must become sufficiently critical of technology. Until recently, very little has been written and disseminated within the discipline in regard to the tools and techniques of a landscape architect; today, this dialogue mostly celebrates the rise of complex software tools for visual representation (Green, n.d.).

Critical analysis of the use of technology in practice would provide instruction for best practices and direction for technical advancement. Without a legacy of discussion on technological aspects of the discipline to build from, the dialogue of the discipline must play catch-up while technical advancement in the field remains stunted and directionless. What are the origins of this lack of engagement?

Clues may be embedded in popular societal views about technology around the origin of the discipline, or in the separation of hand and thought work inherent in the definition of landscape architecture as a professional pursuit separate from gardening.

CHAPTER 2
Break, Borrow, Blend: Landscape Architects and Technology

Both societal views on the opposition of nature and technology and the rift between manual labor and design at the origin of the discipline created barriers between landscape architects and the technologies used to create landscapes. As landscape architecture developed, its relationship with technology evolved from the rupture experienced when the profession was defined; borrowing tools from allied disciplines transitioned into adopting technologies created by industries specializing in tool design. To move the discipline toward a more innovative stance, we ought to understand the initial factors that distanced landscape architects from engagement with technology.

One such factor was societal beliefs about the inherent opposition of technology to the “nature” landscape gardeners were commissioned to emulate on the cusp of professionalization in the mid 1800s. In *The Machine in the Garden* (1964), Leo Marx surveyed mid-19th century literature engaged in the technology versus nature dualism. He described the lush, pastoral Garden of the pre-industrial world and the “sudden entrance” of the Machine, which represented the onset of modernity and the technological forces of the time. The Machine became the symbol of inevitable, sweeping change and progress that intruded upon the Garden, a passive, static domain traditionally viewed as the antithesis of the forces of technology (Marx, 1964).

As the progenitor of the discipline, landscape gardening’s entanglement with this dualism inevitably influenced landscape architecture. Despite the alignment of landscape gardening’s natural philosophies with technophobic beliefs, the gardens and landscapes of the time were very much the products of technology. The idealized bucolic landscape was, then as today, the product of the Machine and accessed through the passage it created (Marx, 1964).

The architects of these landscapes wholly embraced the efficiency of the Machine while ensuring its process was never seen, further obscuring the falsehood of this dualism to society at large (Hoyles, 2002). This misconception thwarts a more affirmative human goal of fitting into the natural world, arguably an essential goal of landscape architecture. As Lewis Mumford suggested, going beyond the conception of technology as “the Machine” to a more richly organic, more profoundly human condition relies on our power to assimilate the Machine (Mumford, 1934). Therefore, a more thoughtful and transparent integration of technology was necessary, not a seeming separation from it.

The formation of the discipline itself also served to distance landscape architects from the technê of building landscapes. Similar to many of the technical arts during the industrial revolution, the professionalization of landscape architecture formalized a division of labor that severed ties between the tools of the hand and tools of the mind (Maxwell and Pigram, 2012). The separation of the landscape architect and the gardener, however, had begun before the professionalization of the practice. Wealthy landowners, the client base of landscape gardeners, desired an ideal landscape unmarred by the appearance of men and women at work. The gardens appeared each morning with no tools, workers, or mere vestiges of maintenance in sight, yet were impeccably manicured down to each blade of grass. Labors kept out of sight were undervalued: well-educated journeymen gardeners were often the lowest paid yet hardest working of all estate workers (Hoyles, 2002).

The values of landowners were part of larger societal trends that deemed thought work superior to manual labor. A century later John Ruskin criticized this valuation:

> *All ideas of this kind are founded upon two mistaken suppositions: the first, that one man's thoughts can be, or ought to be, executed by another man's hands; the second, that manual labour is a degradation, when it is governed by intellect… We are always in these days endeavouring to separate the two; we want one man to be always thinking, and another to be always working, and we call one a gentleman, and the other an operative; whereas the workman ought often to be thinking, and the thinker often to be working, and both should be gentlemen, in the best sense. As it is, we make both ungentle, the one envying, the other despising, his brother; and the mass of society is made up of morbid thinkers, and miserable workers* (Popova, 2015).

In a society where laborers were undervalued and a field where workers were kept invisible, landscape gardeners, and perhaps later landscape architects, gradually lost sight of the technologies required to realize their work. Today, thorough knowledge of constructive techniques is a specialty a handful of employees in a large office might fulfill. Intimate knowledge of the tools and techniques used to realize a designed landscape is no longer inherent to the profession, or required of all practitioners. Though not all practitioners need intimately know the technê of landscape construction, all must be invested in the development of the technê of design itself—the technê of landscape architecture—to fortify the identity of the profession, to maintain control of the craft, and to drive innovation. Tools are fundamental to technê. In order to develop technê, we must begin with the understanding of what a tool is and does.

CHAPTER 3
Tooling Reality

> *We must directly see, feel, touch, manipulate, sing, dance, communicate before we can extract from the machine any further sustenance for life. If we are empty to begin with, the machine will only leave us emptier; if we are passive and powerless to begin with, the machine will only leave us more feeble* (Mumford, 1934).

Tools: opportunities and pitfalls

As a preliminary step in developing distinctive technologies as part of landscape design technê, landscape architects must become sufficiently critical of technology currently in use by subjecting it to design and pedagogical research, starting at the beginning, with the definition of a tool. Tools are a direct extension of the organism, performing fundamental functions such as strengthening the hand, expanding the mind, or focusing the view. In use, tools are intimately connected to the user and seemingly without an independent existence when idle; a tool can only expand what we already have within ourselves (Mumford, 1934).

Using tools, we attempt to get closer to something with each action: closer to understanding the world, closer to finding our place within it, and closer to understanding ourselves in the process. The tool reveals and reminds us of the limits of our capacities, but also frees us from our incapacities (Rothenberg, 1993). To summarize Martin Heidegger's theory of *releasement*, a tool can be defined as a channel for human artistic statement, where one possesses an idea or feeling, and the tool *releases* this into the world in physical form, subsequently bringing the world closer through this tangible connection. This relationship constantly redefines the natural world, both in our minds and in physical form, and the more we depend upon a tool, the more we are redefined ourselves (Harman, 2002).

This redefinition of the user can be dangerous: As the user engages with a tool, she must be cognizant that technology possesses the power to lead her astray by urging her forward, but without intention, leaving only an unending search for maximizing efficiency (Rothenberg, 1993). The danger of misguided tool use increases as socioeconomic phenomena create conditions ripe for the production of tools that, cleverly marketed, can seduce us into believing they are helpful when indeed they waste time and resources. As Kevin Kelly states, "Humans are the reproductive organs of technology." Without humans, technology could not exist. But with humans, it can reproduce at a seemingly autonomous and uncontrollable rate, appearing to evolve even without human prompting (Kelly, 2010). With this danger surrounding us, critical evaluation of tools is necessary.

From Plato to Heidegger to Mumford, all understood the tool as a vehicle to achieve greater harmony with the world, in part because we can use the tool to shape it (Rothenberg, 1993). Today, landscape architects represent society's relationship with the natural world, as an expression of culture. Landscape is where culture and the natural world meet. Practitioners would be well served by rigorous critical discussion of the contributions of emerging technologies to the technê of landscape architecture.

This discussion is too often limited to a few voices of dissent lamenting the absence of pencil and paper from the design process, opinions easily dismissed as nostalgia or a lack of desire to re-tool in a quickly changing field. Deeper discussion would reveal that digital methodologies in visual representation can unimaginatively marginalize and diminish the role of manual tools to the detriment of the designer. Virtualization of technique can separate human thought and action, putting up barriers to our most natural forms of expression.

Digital technologies can obfuscate simple and fundamental actions such as describing a graceful curve. Rather than gliding graphite across the page, digital representation requires knowledge of splines and their grips and vertices or polylines constructed of arcs and line segments. Each method has its own limitations and requires a specific skillset, hardly resembling the facility of their analog predecessor. Ideally, tools should not add layers of abstraction between what we intend to do and the action of doing it, but when they do, we must understand and evaluate them.

The characteristics of tools requiring our consideration vary per their function. Tools useful for site analysis, the focus of my work for this thesis, are "sensory tools," or tools that increase and extend the sensitivity of the human senses. In the case of sensory tools, the user must understand both the nuances of human perception and the ability of such tools to frame what it is possible to see and, therefore, to think.

Human Perception

Perception can be defined as the organization, identification, and interpretation of information received from the senses in order to represent and understand the environment (Oxford Dictionaries, 2014). Perceptions are influenced in a variety of ways. Human senses are dependent on interpretation by the mind, which instinctively and sometimes involuntarily fills in gaps when sensory perception falls short. Further complicating matters, each person has a sensory system differing from others', as social norms, conditions, and standards influence individual perception (Boeree, 2002).

Due to these influences, human perception can be thought of as subjective, or reliant on personal opinions and judgment, rather than purely objective, or facts-based and unbiased (Hatfield and Allred, 2012). Both subjective and objective perception can positively inform landscape design, but it is important to identify the subjectivity or objectivity of our perceptions. Sensory tools, by augmenting and extending the human senses, can either bring people closer to shared observational understanding, increasing objectivity, or increase differences in individual perception, increasing subjectivity.

In addition to affecting the quality of perception—that is, its relative subjectivity or objectivity—sensory tools affect the quantity of information it is possible to perceive. Depending on the intention of the observer, either increasing or decreasing the amount of perceivable information can have value or be detrimental. Sensory tools that increase the quantity of perceivable information can expand our capacity or overwhelm one sense at the expense of holistic experience. Other tools provide a focused or curated view of the world that can either direct or mislead.

The qualitative and quantitative effects of sensory tools can help or hinder in the realization of human intention, and as such require judgment in their use. On the part of landscape architects, environmental observation forms the basis for decision-making and performance evaluation, so aptitude and judiciousness in the use of sensory tools is particularly relevant. Critical evaluation of the tools we use is fundamental to this expertise.

CHAPTER 4
Sensory Tools In Landscape Architecture

Landscape architects capitalize on a number of sensory tools that augment processes dedicated to site assessment, or the study of the climatic, cultural and geographical context of a specific site (LaGro, 2008). Two sensory tools have influenced the discipline in particular and provide examples of how tools of opposite qualitative and quantitative value can be used to observe the landscape. The Claude Glass quantitatively narrowed the vision of the landscape, providing a subjectively superior aesthetic view by manipulating color and perspective (Maillet, 2004). Conversely, the Earth Observation Satellite vastly expanded the amount of objective data available for interpretation. In their time, these tools enabled desirable outcomes for the users, yet their eventual detriment to the discipline teaches us the considerations for use of tools at each end of the qualitative and quantitative spectra.

The Claude Glass

Nature and the natural were of great interest to 18th century sensibilities, perhaps best expressed through the notion of the *picturesque*, a category of both painting and landscape. Picturesque landscape paintings represented ideal versions of nature, produced to have the effect of transcending time and space through acute and sublime representation (Bermingham, 1986). The artists creating these works often employed a sensory tool known as the Claude Glass, or black mirror, to distort and simplify landscape views to suit their aesthetic ideals (Maillet, 2004).

Figure 4.1 Claude glass (left), unknown maker, 1775 - 1780. Museum no. P.18-1972. © Victoria and Albert Museum, London. Claude glass created by author (right).

A Claude Glass is a small, dark-tinted, convex mirror that distorts the view it reflects. It reduces and simplifies the color and tonal range to one more easily represented with the limited color palette of the artists at the time. The convex shape folds more scenery into a central focal point, creating a vignetted, *plein air* quality found in most picturesque landscape paintings. The ephemeral, abstract reflections were translated to the canvas through a series of perspectival tricks structured by the Claude Glass (Maillet, 2004). The idealized yet false natural beauty left admirers yearning for this new nature. The ideals of the picturesque led to the aestheticization of the English countryside, which spawned the notion of landscape gardening (Bermingham, 1986).

The nascent discipline of landscape architecture was guided by the views and aesthetic theories engendered by picturesque landscape paintings—views created by the Claude Glass, a tool that curated views by obscuring detail, directing landscape designers toward a focus only on the superficial aesthetic character of landscape (Bermingham, 1986). As an influence on landscape architecture, the Claude Glass was problematic in that its focus on stationary, singular views of the environment provided a distraction from a comprehensive understanding and engagement with the landscape. It did not support the full potential of constructive practice.

The single-minded pursuit of the picturesque was quickly understood as detrimental to the multi-faceted environments in which these landscapes were inscribed—transforming watersheds, relocating ancient trees to frame views, displacing towns for estates, and drowning productive farmland for aesthetic whim (Macarthur, 2007). English poet William Cowper criticized Capability Brown, a landscape designer practicing contemporaneously, as an "omnipotent magician." In *The Task* (1785), Cowper sardonically described his ploys and the immense affect of his attempts to compose landscapes much like landscape paintings (Hoyles, 2002):

> *He speaks. The lake in front becomes a lawn,*
> *Woods vanish, hills subside, and vallies rise,*
> *And streams as if created for his use,*
> *Pursue the track of his directing wand*
> *Sinuous or strait, now rapid and now slow,*
> *Now murm'ring soft, now roaring in cascades,*
> *Ev'n as he bids.*

These early criticisms may have pushed landscape architects to seek a multifaceted understanding of the world, beyond the singular aesthetic pursuit envisioned by the Claude Glass and popularized by landscape painters. Two centuries later, innovation in aerospace technologies introduced a new challenge to the discipline: how to use a tool that gave landscape architects access to environmental metrics at a scale never before possible. Though these technologies increased the amount of data available to landscape architects rather than limiting it as the Claude Glass did, they too proved problematic for the discipline.

Earth Observation Satellites

For over forty years, *LandSAT* satellites have captured highly detailed digital photographs of the Earth's landmasses. Inspired by images of earth from orbit taken during the Apollo missions, LandSAT satellites were unique in their design specifically to collect terrain data. These satellites made use of a multispectral scanner to capture light outside the visible spectrum and to isolate specific wavelengths, enabling global-scale mapping of land use with specific spectral signatures, such as canopy cover (NASA, 2013).

Figure 4.2 A LandSAT satellite orbiting high above Earth. Image by author.

The LandSAT satellites and other remote sensing platforms were widely celebrated by landscape architect and ecological planner Ian McHarg. His championing of the use of natural sciences in landscape architecture and planning promoted the use of many *prostheses* for understanding the world including sensors, computers, and satellites, allowing designers a systematic and comprehensive view while permitting them to remain physically withdrawn from the external world for which they were designing. McHarg despised the first iteration of computers but grew to recognize them as the primary human prosthetic (McHarg and Steiner, 1998). McHarg's curious definition of prostheses is as follows:

> *The purposes [of prosthetic technologies] are to amplify the performance of a biological function—to see small and far, we have the microscope and the telescope; to speak far, we have the telephone and the microphone; to move far and fast, we have the plane and the rocket. Our major prosthesis is the expansion of muscle to tools, mechanical equipment to atom bomb* (McHarg and Steiner, 1998).

Looking back at McHarg's career, his definition falls somewhere between contradiction and perhaps an unintentional underscore of the pitfalls of prostheses. His professional pursuits appeared to be in the interest of all, but the synoptic view he embraced was incompatible with the most universal and fundamental principles of human experience in the world. In *Taking Measure Across the American Landscape* (2000), James Corner comments on McHarg's otherworldly ideologies:

> *Whereas McHarg, like other environmentalists, occasionally portrays humankind as an enormous "planetary disease" (an image of scarring the earth's surface at a scale that would be unbelievable were it not for evidence provided by the aerial view), it is, ironically, the same humankind and its technology (aerial and otherwise) that he and other planners cite as the heroic arbiter and measure of all things. Paradoxically, the view from above induces both humility and a sense of omnipotent power (*Corner, 2000).

The desire and expectation of "ecological inventory," though it never resulted in a built work for McHarg, did give value to data for use in design and planning-based decision-making. While his techniques undoubtedly offer a "prerequisite for intelligent intervention and adaptation," these techniques put too much weight on the insights of science as opposed to intuition. Furthermore, this synoptic understanding is at best an abstraction of human experience. McHargian techniques are ultimately blind to an intermediate scale, where more subjective relationships between people and place occur—

the space where society develops and communicates meaning and identity in landscape (Spirn, 2000).

Despite their pitfalls, these detached perspectives and technical methodologies are still core to landscape architecture curricula and practice. This is evidenced by the glut of student design project boards filled with sterile “layer cakes,” system diagrams, and matrices that often lack a true cultural lens, their creation perhaps incentivized by advanced computing techniques that make these images easier to generate than ever before. Perspective renderings of a design, if even produced, attempt to fill this cultural void, but inversely tend to illustrate only the student’s preoccupation with synopticism and indolent data mining from geospatial applications under the auspices of achieving greater validity through supposed scientific objectivity. Certainly, these tools and techniques are critical to practice, but the allure of technical omniscience should not wholly replace the social and embodied experience of site.

Eighteenth-century critics realized the limitations of landscape practice influenced by the Claude Glass, a tool that curated a view of the world that directed but misled landscape architects’ predecessors. Today, the field still contends with balancing the vast quantities of data available from earth observation technologies with immersive site experience. Learning from such experiences, we can evaluate sensory tools to ensure that they support our intentions: Do they curate or limit our experience of the landscape? Do they open us up to new information or overwhelm us and distance us from site? Landscape architects need a toolkit for site analysis that optimizes the potential of sensory tools while minimizing the drawbacks exemplified by the Claude Glass and Earth Observation Satellite—one that allows practitioners to perceive better, but while immersed in the landscape.

CHAPTER 5
Perceiving Landscape Through Technology

> *Take field trips. The bandwidth of the world is greater than that of your TV set, or the Internet, or even a totally immersive, interactive, dynamically rendered, object-oriented, real-time, computer graphic-simulated environment (*Mau, 2000).

Sustainable planning and development need to be context-sensitive to protect public health, safety, and welfare. Knowledge of the specificities of a site allows the designer to avoid or address confidently the inherent issues or constraints of that place. Furthermore, a designer aware of inherent site assets can capitalize on opportunities to enhance the sense of place, improve ecological functioning, and provide practical benefits such as reducing maintenance costs. A thorough analysis of sites and their context can lead to more fitting proposals and better landscape designs. Typically, a landscape site assessment is a preliminary phase in architectural and urban design processes that consists of site selection, site inventory, and site analysis (LaGro, 2008).

In many respects, landscape architects still follow the site assessment techniques put forth by planners and designers of the mid to late 20th century, such as Kevin Lynch and Gary Hack. Both espoused thorough site analysis as one of the most important steps in a successful design. Lynch's methods relied heavily on observation through all the sensory faculties in order to identify the most valuable qualities of a place (Lynch and Hack, 1984).

Over time, this thought has often been reduced to a simple visual analysis, understood as the most straightforward and practical sensory analysis for determining attributes of a site, requiring little more than a camera, a notepad, and perhaps a measuring tape. The site analysis checklist provided by Lynch and Hack in *Site Planning* is still relevant, but reading it today raises questions as new technologies leave technique open to interpretation. Remotely sensed data and computer modeling provide alternatives to first-hand observation for data collection. Project managers must be knowledgeable to select the best method for any particular project, balancing the varied inputs of time and resources for each technique with the output of varied accuracy and comprehensiveness of gathered information.

For example, is first-hand observation of soil drainage patterns a worthwhile use of time when one might find a revelatory aerial photo freely available on Google Earth? Or, rather than experiencing microclimates on site, it might be assumed that information on a site’s microclimate can be interpreted through regional weather reports or better understood through advanced environmental modeling software. The information gathered in site analysis forms the foundation of any project, setting the criteria for choosing the best method to get high quality information.

Landscape architects serve multiple roles that require them to perceive the world in as thorough and unbiased a manner as possible. Landscape architects serve not only people as public servants whose insights shape the built environment but also entire non-human ecosystems as environmental designers and advocates. Additionally, with increased demands for landscape performance linked to emerging awareness of the relationship between environmental quality and human health and welfare, the collection of detailed baseline information as part of site analysis is required to draw scientific conclusions on the impact of landscape intervention. As such, collection of objective data is increasingly required as part of site analysis.

Digital tools have the potential to increase objectivity, but their current lack of mobility incentivizes, or even necessitates, “exploration” of the site while one remains stationary and detached from it. The apparent efficiency and increasing ease of access of digital tools are economically attractive as they eliminate travel expenses and man-hours on site. For example, visual analysis can be partially conducted through Google Earth and Streetview; however, such tools are not equal substitutes for immersive experience of the site in question.

Removing designers from firsthand experience eliminates the chance for spontaneous discovery and insight, and, though it offers apparent economy, it may have the unintended consequence of generalized or inaccurate assumptions resulting in costly late-stage redesign, dangerous site conditions, or unappealing landscapes void of a localized human dimension. Moreover, streamlining site assessment runs the risk of reducing design practice to seeing the world only through a computer monitor, undermining professional capacity to enhance human experience of landscape. The computer must be relegated to more specific status as a tool for knowledge amplification, not used as a platform for an impossible model of the world in the digital realm.

Additionally, while an approximation of objective site inventory can be acquired through off-site digital means, the subjective experience of an environment or phenomenon organizes objective perceptions in the logic of the spatial components of landscape, forming a narrative of place, and providing inspiration for the creation of a richly experiential design. The site-specific knowledge of a landscape architect can be described as a type of *situated knowledge*, a term originally coined by Donna Haraway. Haraway's theory addresses her concern about the limitations of human perception and the historical overemphasis on the sense of vision in scientific objectivity, concerns echoing those raised by Anne Spirn in her critique of McHargian omniscient view (Haraway, 1988).

Haraway recognizes vision in scientific objectivity as a kind of disembodied, transcendent means of leaving the body, "a conquering gaze from nowhere." The body is disassociated and set above the object of study. Haraway claims this vantage is "an illusion, a god trick" allowing for the power to see and not be seen, to represent while escaping representation. When the perspective and positioning of the knowledge producer is made more explicit and embodied, the producer becomes more ethically and politically accountable (Haraway, 1988).

Situated knowledge not only benefits the designer's sensorial and intellectual capacities, but can also contribute to landscape designs that are more richly phenomenological, nuanced, resilient, and, most of all, *of that place*. Novel technologies can both enrich and document the experience. Sensory tools can reduce bias in human observation of the environment, enrich human experience, and overcome limitations of human perception. To provide one example, technologically perceived data can provide a benchmark for individuals with differing perception and can be stored digitally to provide a record for reference less mutable than human memory.

Sensory tools are becoming increasingly mobile and are available now for landscape architects to seize and improve their capacity for efficient and accurate site assessment. To obtain situated knowledge of the places we build, we should combine subjective and technologically-enabled objective experiences of the site by empowering human users to record data without distracting from their subjective experiences. Thanks to Maker culture and the rise of wearable technology, personalized technological production and innovation do not require advanced engineering expertise. It is an auspicious time for landscape architects to create these tools for themselves, developing new, landscape architecture-specific tools that allow for objective yet immersive experience.

Landscape is experienced through the material faculties of the body; accordingly, our tools to analyze and design landscape ought also to engage the senses. Landscape architects have engaged insufficiently with sensory tools in their pursuits of observing and analyzing the natural and built environments. Our technology should not be stationary, isolated, and isolating, but should instead require the designers to be present in the landscapes they are studying.

CHAPTER 6
A New Industrial Revolution: Enabling Invention and Innovation

A new socio-techno-economic paradigm has combined subculture technologists and craftspeople, creating a unique blend of *Makers* driving technical innovation in reaction to real social needs, rather than superfluous economic trends. With roots in traditional arts and crafts and hacking, Makers pursue projects in electronics and 3D rapid prototyping, as well as occasional engagements in more traditional fabrication techniques such as metalsmithing and woodworking (Hatch, 2014).

With origins in the counterculture movements of the 1960s, Makers have quickly evolved from the insubordinate basement hackers and pioneers of the internet to an almost instantaneous but coherent mainstream phenomenon based on sharing and social revolution in technology. As Makers appropriate and innovate technologies that were once proprietary, closed source, and sometimes part of institutional or military-industrial complexes, they have created a marketplace where hardware and software can be purchased, bartered, and used open-sourced. These components can be recombined, often with the help of skill-shares at maker spaces or freely available web-based tutorials, to create unique and highly customized tools (Hatch, 2014).

One such technology released into the Maker marketplace, the Unmanned Aerial System (UAS), is moving beyond its reputation as a sophisticated killing machine to something much more humane and civil. The UAS, commonly known as a *drone,* is operated by preprogrammed autonomous control or by a pilot on the ground. UASs often integrate cameras and other advanced optical systems to create aerial imagery. This observation technology can provide some of the most informative images and data of the world, presenting designers with a means of imaging the earth’s surface with greater immediacy and resolution while maintaining total agency over the tool that enables it (Horgan, 2013).

The capacity of the UAS has yet to be fully realized for aerial observation and analysis in landscape assessments, and it is just one of many examples of open source technologies with the potential to transform the toolkit of landscape architecture. The time is ripe for landscape architects to join the ranks of the Makers and become the creators of tools perfectly suited to the needs of their own discipline, in particular building mobile and wearable technologies that will allow designers to shift from office to field the technology used to inventory landscape.

Wearable Technology

With greater personalization and social agency over technology, wearable technology is becoming increasingly prevalent in many practices and walks of life. The slow embrace of *wearables in* popular culture finds smart devices leaving pockets and strapping to the wrist, hiding behind the ear, or embedding in a pair of glasses. Early prototypes of wearables were often met with either ridicule or fascination and were usually disregarded as highbrow academic antics (Lamkin, 2014).

Figure 6.1 Image copyright (c), Steve Mann, 1996. Image is a self-portrait of Steve (far left) together with other members of the `Safety Net'; Image captured using wireless communications to additional camera located in front of the group.

Researcher and inventor Steve Mann has explored these concepts for the last 30 years, most notably the *EyeTap* device, which Mann wears on a daily basis. EyeTap records the scene available to the eye, superimposes a computer-generated interface, and projects the combination to the wearer. As the creator of this device, Mann is one of the most influential inventors of wearable technology, which he describes as "a device that people attach to their bodies to augment their real, subjective experiences with a virtual experience—but unlike virtual reality, users do not withdraw from the real" (Mann, 2002). Izabella Pederson expands on this notion with her definition of Wearable Augmented Reality:

> The wearer needs to be an autonomous body in control of the computer; it supports a physical challenge to the body in positive terms; it alters the way humans make interactive meaning with their environment and as solitary beings in dialectical terms; challenges ontological expectations of existence—beingness serves as the principle of principles; it functions in ultimate terms (Pederson, 2013).

The similar views shared by Mann and Pederson have particular appeal for the toolkit of landscape architects. As wearables advance, these new technologies designed to augment human experience with an overlay of digitally sensed information will be co-opted by Makers and become available to landscape architects for the creation of discipline-specific tools. Site inventory and assessment will be revolutionized by sensory tools that can record metrics in an environment without distracting the designer’s experience of that place, even enhancing their understanding of their surroundings. To design these tools, landscape architects can engage in a creative process similar that used to design landscapes: *tinkering*.

CHAPTER 7
Tinkering

> *Love your experiments (as you would an ugly child). Joy is the engine of growth. Exploit the liberty in casting your work as beautiful experiments, iterations, attempts, trials, and errors. Take the long view and allow yourself the fun of failure every day* (Mau, 2000).

When setting out to explore the potentials of sensory tool creation in landscape architecture, I was quickly overwhelmed by the vastness of opportunities. By setting aside my preconceived goals of creating determinate results, I was able to stumble upon ideas that would not have occurred to me had I set out to look for them. By necessity, I became a tinkerer.

> *Begin Anywhere. John Cage tells us that not knowing where to begin is a common form of paralysis. His advice: begin anywhere* (Mau, 2000).

Tinkering is inquiry through the hands, fueled by the desire to understand the mechanics of something through its deconstruction. Sometimes this is done in an attempt to improve the item, putting it back together to some useful effect. However, the process also finds value in the fiddling with bits and pieces with no means to end other than stoking curiosity and encouraging further inquiry. It provides a sense of technical freedom and opportunity (Wilkinson and Petrich, 2014). In many respects, tinkering is a creative process similar to design thinking.

> *Process is more important than outcome. When the outcome drives the process we will only ever go to where we've already been. If process drives outcome we may not know where we're going, but we will know we want to be there* (Mau, 2000).

Design thinking is a structured approach to creative resolution of problems intended to deliver an improved future result for a specific end user. It begins with the search for a question that creates a better future rather than setting out to solve a specific problem. The process is dependent on a thorough understanding of said goal, in addition to an active and repetitive mode of creation. Through this testing, the initial ideas are continuously improved and either result in a desired outcome or the process begins again in hopes of improving on past attempts with an even greater end result (Cross, 2011).

Tinkering is largely the same in its approach, except that the focus is on the development of technology. The process is flexible and intuitive. Emphasis is placed on the fluid nature of exploration, leading to cyclical or even chaotic workflows. This sort of technical engagement and development is largely new to landscape architecture. The results of my tinkering demonstrate what a novice can achieve in a short period of exploration.

The first product of my tinkering, a yagi antenna (figure 7.1), enabled eavesdropping on a LandSAT satellite as it passed overhead. Though the sounds produced by the yagi antenna were of no great use, the notion of using simple materials—wood, brass rods, a handheld multiband radio, and miscellaneous hardware—to engage with one of the most sophisticated pieces of technology ever made was an encouraging place to start.

Exploring several open source technology websites, such as Instructables. com as well as forums, magazines, and books, I found a significant number of projects applicable to site assessment in landscape architecture. An online tutorial provided simple instructions for creating my own Claude Glass with a 3.5” overhead projector lens by painting the backside with enamel spray paint (Howe, n.d.). Strangely, looking into a blank smartphone screen has a similar affect as staring into the Claude Glass, though it lacks the convex distortion and invocation of painterly inspiration.

Figure 7.1 A yagi antenna created by the author.

Delving into the Maker marketplace, I encountered microcontrollers and sensors able to measure a wide variety of environmental conditions such as moisture, temperature, light, gas, sound, and vibration. Microcontrollers, such as the open-source Arduino, can interpret the data produced by a sensor and trigger an actuator in accordance with a user-written program (Margolis, 2012). An actuator converts electricity from the microcontroller into an action that changes the physical world, such as flashing a measurement on an LED screen, producing a sequence of vibrations through a shaftless vibration motor, or

Figure 7.2 A claude glass created by the author (right) next to an iPhone.

turning a servo motor 45 degrees counterclockwise (Monk, 2013). This simple sensor to Arduino to actuator sequence can be used to build powerful digital devices and interactive objects that can sense and control the physical world.

By tinkering with these devices, I learned the intricacies of circuitry as well as basic soldering and fabrication techniques. The simple plug-and-play nature of this technology requires only simple programming languages, such as Processing, which includes support for advanced languages such as C, C++ and Java (Monk, 2013). It is designed to introduce programming to individuals unfamiliar with software development, allowing the operation of various sensors and actuators at their most basic level relatively quickly.

The plethora of assemble-it-yourself kits available through web stores provided the foundation for most of my tinkering, with personalization pursued using rapid prototyping to fabricate cases and other accessories, acquired mechanical skills, simple trial and error, and through both intended and unintended use.

As tinkering progressed along with theoretical research, I began to experiment with a series of physical sketches that could evolve into tools to enable a user to gather data from the landscape in manners unobtrusive to the subjective experience of site. These sketches serve as a preliminary feasibility test in the development of wearable and deployable technologies that have the potential to liberate creative work from the confines of the studio and restore a more robust agency to the designer. The body becomes the apparatus for this sophisticated hardware, rather than the plastic shell of a desktop computer.

CHAPTER 8
Physical Sketches

Project 1: The Small Unmanned Aerial System (sUAS)

> *The global landscape is everywhere and for all to see. If landscape architecture once represented a self-conscious act of place making set against an unknowable and untamable wilderness beyond, it has now become a practice of reworking an indexed terrestrial surface about which all is known and managed through the lens of remote aerial representation (*Waldheim, 2006).

Due to the seemingly ubiquitous existence of consumer grade sUAS, it is easy to underestimate the difficulty of constructing and piloting one. Although several out-of-box sUAS are available, most use closed-source technology and cannot be easily modified. There are a handful of reputable DIY sUAS kits that use open source technology. These kits are readily available, cover the basics, and are fully modifiable for easy tinkering (Horgan, 2013).

Constructing the sUAS took nearly eighty hours, with an additional thirty-six hours to learn how to use the software and to pilot the UAS. Wiring errors resulted in costly repair jobs and dangerous confrontations with broken propellers as they violently expelled from the UAS, but the benefits of the sUAS make the trial and tribulations of this tool worthwhile.

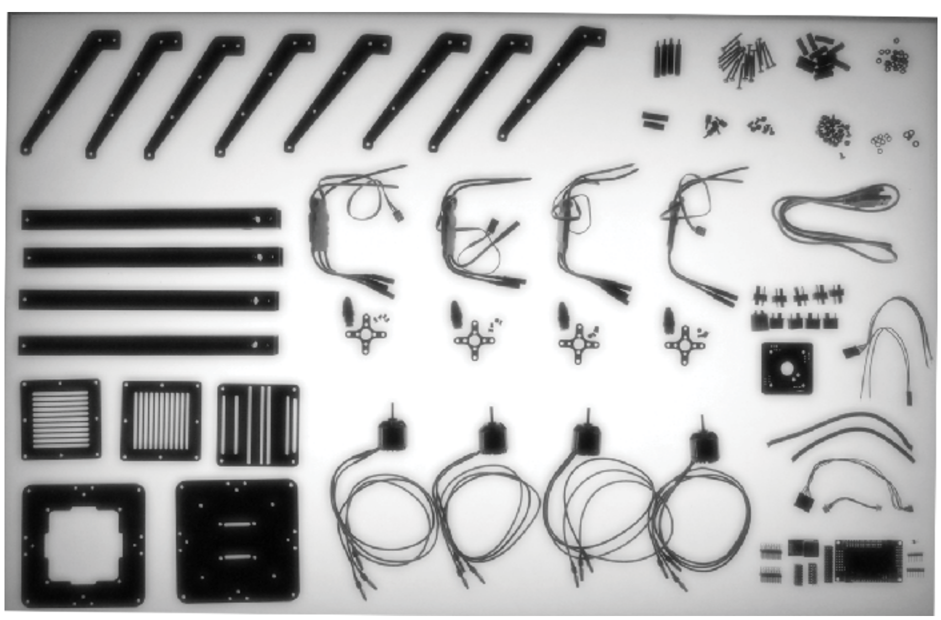

Figure 8.1 Assembly of the sUAS kit. Image by author.

1 : 1x02 Pin Header (H=4mm)
1 of : 2.00 Shunts
1 of : 2x03 Pin Header (H=4mm)
2 of : 3x08 Pin Header
1 of : 3x14 Pin Header
2 of : 3x8 Right Angle Pin Headers
1 of : APM 2.5 -ArduPilot Mega 2.5 Kit
3 of : ArduCopter 3DR Replacement Arm - Black
2 of : ArduCopter 3DR Replacement Arms Blue
4 of : ArduCopter ESC 20 Amp
4 of : Deans Ultra Plug Connector, MALE
4 of : M3 Black Nylon Hex Nut (QTY 1)
16 of : M3 Metal Hex Nut (QTY 1)
8 of : M3 Metal Lock Washers (QTY 1)
4 of : M3 Rubber Washer (QTY 1)
4 of : M3x08mm Black Nylon Spacer (QTY 1)
12 of : M3x18mm Black Nylon Spacer (QTY 1)
12 of : M3x25mm 316 Stainless Steel Metal Screw (QTY 1)
4 of : M3x30mm 316 Stainless Steel Metal Screw (QTY 1)
4 of : M3x30mm Black Nylon Spacer (QTY 1)
24 of : M3x5mm 316 Stainless Steel Metal Screw (QTY 1)
8 of : M3x5mm Black Nylon Screw (QTY 1)
1 of : Micro USB Cable
1 of : Quadcopter Power Distribution Board
1 of : Telemetry adapter cable for APM 2.5 (Radio, OSD)
1 of : Velcro Battery Strap
8 of : Zip Tie (QTY 1)

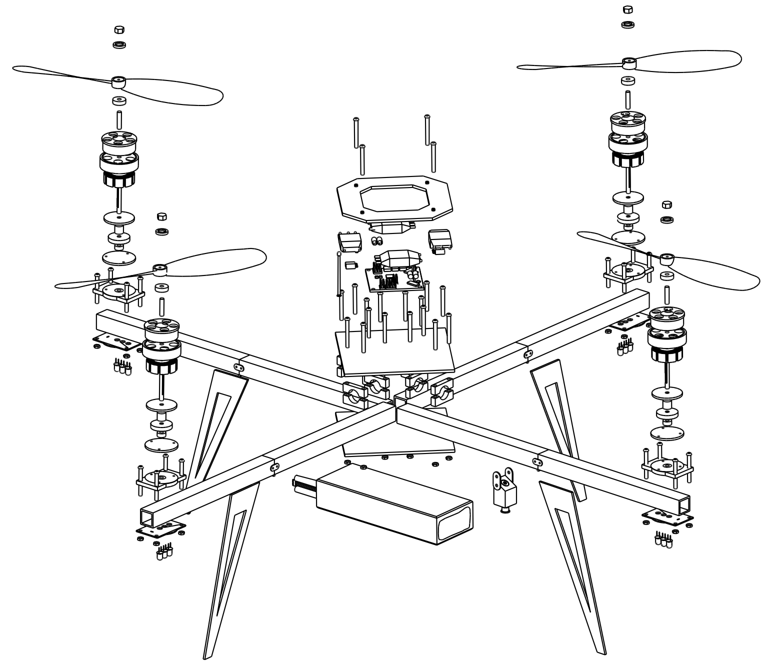

Figure 8.2 Exploded axonometric of sUAS and list of components. Image by author.

At its current stage of development, the sUAS can fly over a predetermined flight path, hover, and self-correct if blown off course by a gust of wind. Its main functionality is taking oblique and plan still images or video, which provides unprecedented control in aerial imagery at a scale and level of immediacy never before achievable by landscape architects. However, it requires pre-planning and quite a bit of attention in the field. The sUAS could be further developed both in expanding the types of information it can record and in its ease of use for the controller.

The sUAS provides several opportunities to revitalize aerial picture making and interpretation in landscape architecture. Beyond high-resolution images, the sUAS can be equipped with a variety of cameras to provide other ways to understand the landscape from above, such as video to observe time-based phenomena or thermographic imagers to understand plant health and distribution. Advanced LIDAR hardware can be integrated to generate high-resolution, detailed point cloud models of three-dimensional topographic data. Pix4D can produce similar, though less resolved, data by deriving it from two-dimensional images (figure 8.4).

Additional work could focus on “tether” tracking, which allows the user to establish a fixed elevation and distance relative to her location, at which the sUAS follows. The movements of the sUAS are wholly controlled by the user’s live movements and preprogrammed settings but do not require her attention in the field and, rather than being pre-programmed, the route can be changed

Figure 8.3 A comparison of two aerial images of a wetland: a satellite image from Google Earth at maximum zoom (left) and an image taken at an elevation of 500 feet by the author with a sUAS (right). Neither image was edited.

spontaneously. There are several nascent iterations of hardware and software for this purpose, but most still require a great deal of guidance from the user or a secondary pilot and typically cannot effectively adjust course to avoid certain obstacles in the landscape. This issue could be corrected with the addition of an obstacle avoidance sensor, an emerging technology that would require significant unique programming for its use in landscape assessment applications (Horgan, 2013).

Figure 8.4 A 3D point cloud model generated with Pix4D Mapper using imagery obtained by a sUAS at an elevation of 100 feet. Imagery and model by author.

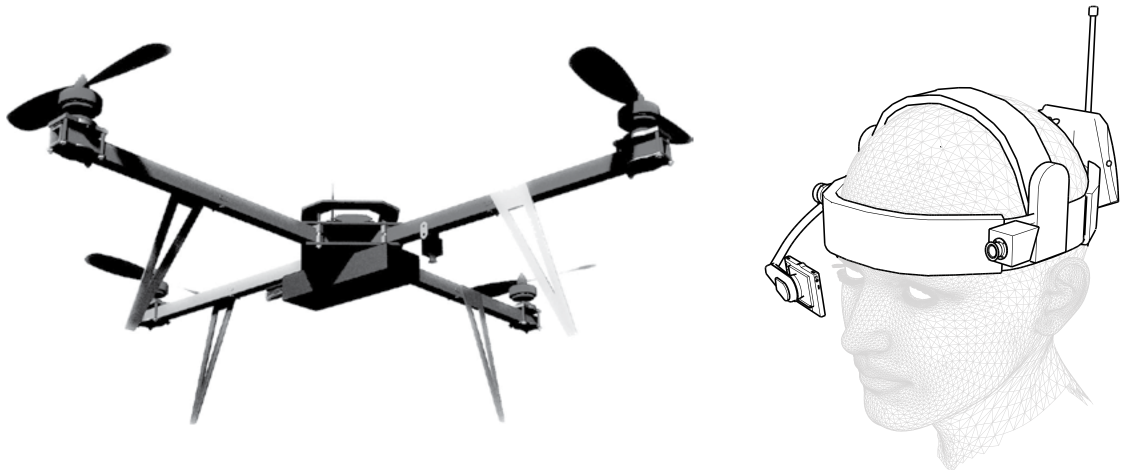

Figure 8.5 The sUAS and sketch of head gear with real-time video display. Images by author.

The development of tether tracking could enable the user to have continuous access to a video feed of a path through a site without distraction from the primary task of experiencing the landscape. By wearing an adjustable video-enabled headset, the user could choose when to engage with the live aerial view. Instead of using a complicated controller requiring an understanding of flight similar to that of a helicopter pilot, the controller is the body itself and piloting becomes as natural as walking. Development of this technology is underway, but current iterations are closed source and require the wearer to don an unwieldy helmet that obstructs first person experience of the landscape.

The sUAS can already deliver plan and oblique photos useful for site analysis or promotion of a completed project. With further development, topographic surveys and plant surveys analyzing health and species diversity are also within reach. While these products can be obtained more conveniently and economically with an sUAS, they can already be produced by other means. The ability of an sUAS and video display to show the designer's location in plan view in real time, however, is a new opportunity.

This enhancement of the site experience can expedite and deepen understanding of the landscape by allowing instant comparison between the user's immediate surroundings and the larger context, with an even further extension of analysis possible through the incorporation of imaging devices able to record information outside the visible spectrum. Additionally, with the addition of geo-located design plan overlays to the video feed, the sUAS can facilitate pre-construction analysis such as mock-ups and layout verifications to catch errors before resources are expended in their construction, improving design and saving significant money, materials, and time.

Project 2: Digital Nerve

While the sUAS allows us to extend our bodies into the air, the *Digital Nerve* encourages exploration of the soil itself by piggybacking onto the basic action of poking one's finger into the soil to estimate soil moisture. By creating a wearable soil moisture meter for the index finger, I hoped to enable more precise readings while maintaining the familiar gesture. As soil moisture sensors are inexpensive, simple to operate, and readily available in the Maker Marketplace, this type of sensor has become a favorite of DIY communities, meaning there were many projects and tutorials available as precedents for the *Digital Nerve* (Gertz and Di Justo, 2012).

Soil Moisture sensors don't directly sense moisture. The most common types sense how strongly the soil resists the flow of electricity between two electrodes (Gertz and Di Justo, 2012). The *Digital Nerve* is constructed with one of those sensors, an Arduino mini microcontroller, and a battery. However, unlike most moisture sensors that are handheld, the *Digital Nerve* attaches to the finger of the wearer using a simple molded form and Velcro strap.

The *Digital Nerve* requires the wearer to perform the finger test to penetrate the soil for a reading. While briefly waiting for the reading from the meter, the wearer can make a guess at the soil moisture content from feel only. With repeated use over time, the wearer can improve her ability to judge the soil moisture content unaided by technology.

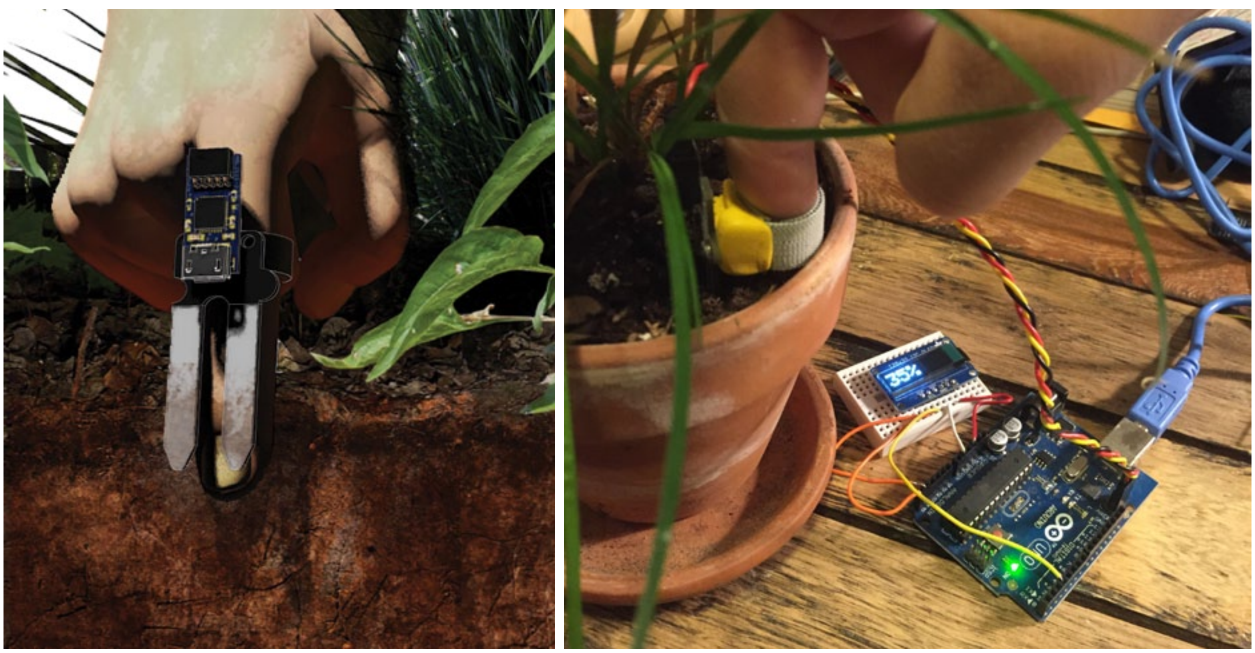

Figure 8.6 Original graphic section depicting concept of Digital Nerve (left). Image showing prototype sketch of Digital Nerve (right). Images by author.

Further developments will work through the ergonomics of this tool, making it less bulky. Additional sensing capabilities could be added, such as PH testing or additional moisture reading via a humidity sensor to improve accuracy in soils with varied salinities. Seamless compatibility with a GPS device could also be developed to enable mapping of soil readings as they are taken.

A wearable soil moisture sensor could be useful in multiple stages of a project. During site analysis, the soil moisture sensor could aid in the understanding of soil resources and drainage patterns on site. However, the Digital Nerve could be of even more use during construction administration, when objective measurements can be compared with specifications to ensure site operations are in conformance with intended means and methods. For example, the Digital Nerve could test bulk soil and compost materials being delivered to the site, verify ground conditions prior to grading operations to ensure soils are at proper moisture content to prevent compaction, determine if tree protection measures are keeping existing trees adequately moist, test irrigation system effectiveness, and monitor plant maintenance.

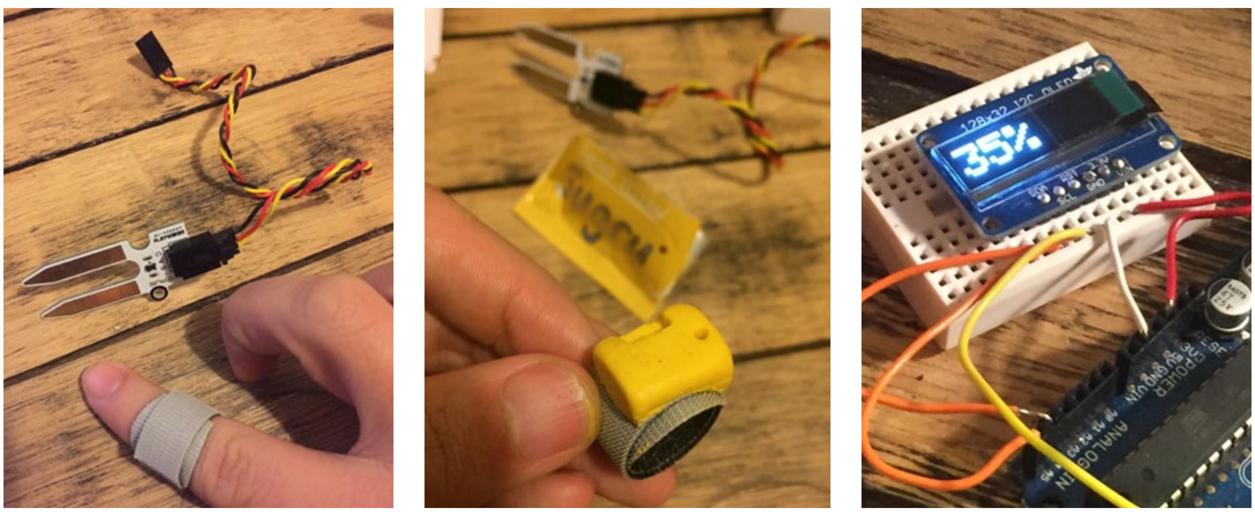

Figure 8.7 Components of the Digital Nerve. Image by author.

Project 3: The Haptic Surveyor

The most basic, human way to explore a landscape is by walking through it. Walking allows intuitive interpretation of space, opens up the plane of perception, and mobilizes all of the human senses. As such, walking the site is a key component of site analysis as a situated, notational method (Shanti, 2011). I began to think about how to pair this most basic human action with devices that could log environmental metrics simultaneously, allowing our complex and embedded understanding of a place to be recorded without distracting from the immersive experience of walking the site.

For this purpose, wearable technology seemed best suited, and the foot seemed an obvious part of the body on which to put it. Our feet are constantly exposed to information about the ground; they are complex sensory organs able to communicate the nature of the surface underfoot in a fraction of a second. Some simple sensors available in the Maker Marketplace replicate the sensory capabilities of the foot in primitive ways: pressure sensors, tilt sensors (3-axis accelerometers), and vibration sensors, to name a few.

Figure 8.8 Original concept diagram of the Haptic Surveyor (left). Author testing a similar aparatus in field with a GPS antenna attached to a hat. Images by author.

I first set out to expand upon the capabilities of the foot with these simple sensors, attempting to use a 3-axis accelerometer to take snapshots of the slope at each step which, when combined with the help of a GPS module, could create an elevational representation of the path walked. However, GPS modules are sophisticated enough to measure locational and elevational data on their own, making the tilt meter unnecessary for a preliminary prototype, though they could be integrated later to improve the accuracy of the tool.

The first iteration of the Haptic Surveyor used a simple GPS module with a built-in antenna from Adafruit industries and an Arduino microcontroller. With this setup I was able to geo-locate my position within ten meters. A more advanced module with an external antenna improved the accuracy to one to three meters for the next iteration. To improve upon existing models that require the use of a small handheld device and make the operation of the GPS controller a natural part of walking, I developed a switch of sorts to give commands to the device with the tap of a foot over a force-sensitive resistor, which also required modifying the GPS’s original source code to make it respond to this input.

The *Haptic Surveyor's* force-sensitive resistor is embedded in a silicone shoe insert, and a strap affixes the GPS antenna to the ankle, or it can be attached to a hat. As the wearer walks, the GPS module records elevation and location data with ten reads per second, storing the data in internal memory. If the wearer encounters a specific point of interest she would like to locate precisely, double-tapping her heel activates the force sensor and tells the device to make a special data point at that location. In addition to these specific spots, the path data can be viewed in its entirety as an elevational profile. By extension, with a systematic approach to the site walk, the *Haptic Surveyor* could be used to create a three-dimensional grid map of the site as demonstrated in figure 8.10.

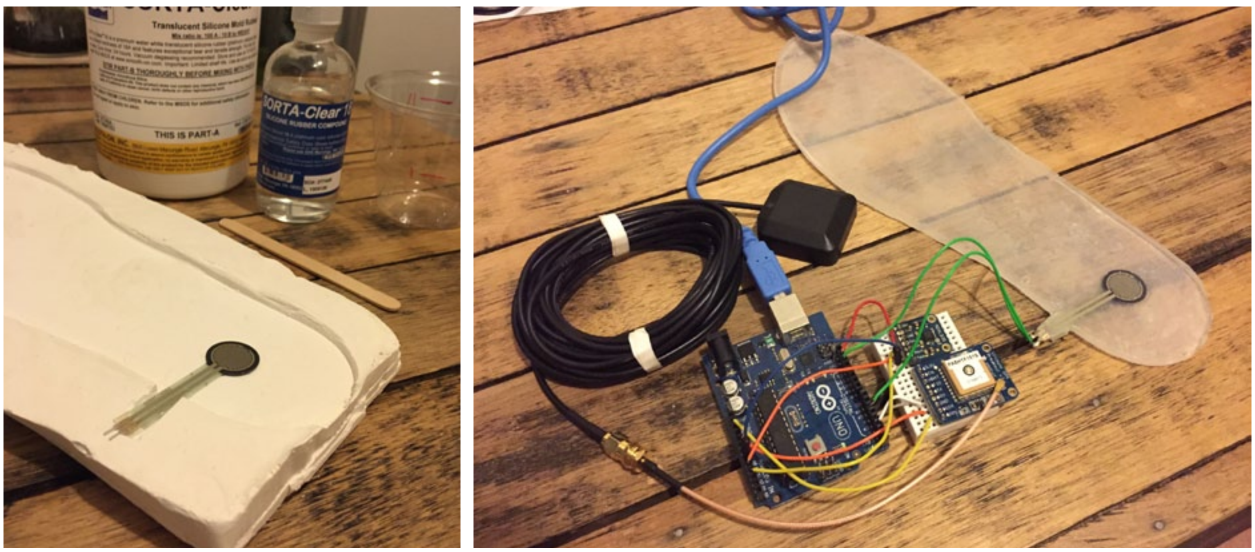

Figure 8.9 Assembly of the Haptic Surveyor. Image by author.

Further development could include a small microphone amplifier to be activated concurrently with the force-resisting sensor. This would allow the wearer to record verbal notes at each desired location. By integrating a 3-axis accelerometer/magnetometer, the *Haptic Surveyor* could have improved elevational readings and also the new ability to precisely detect angle of slope of the foot wherever the wearer is standing. With an integrated LCD screen, the device could display elevational data and angle of slope in real time in the field.

Landscape architects could use the *Haptic Surveyor* in many ways. It could be used as a tool in grading classes to facilitate learning about topography in the field and to teach young designers a precise kinetic understanding of slope. For practitioners, the *Haptic Surveyor* can be used as a drawing tool that allows designers to draw with the body through walking. The most obvious application of this is in trail design, where the *Haptic Surveyor* could be used to design a path for walking by walking itself, all while logging slopes to provide a baseline for erosion control measures or accessibility concerns.

The ability of landscape architects to gather elevational data quickly is also of great benefit to site analysis. To provide one small example, a professional survey often only includes one or a few spot elevations for existing trees. The *Haptic Surveyor* allows the designer to understand more fully the existing topography in the entire root zone, informing a less intrusive grading design.

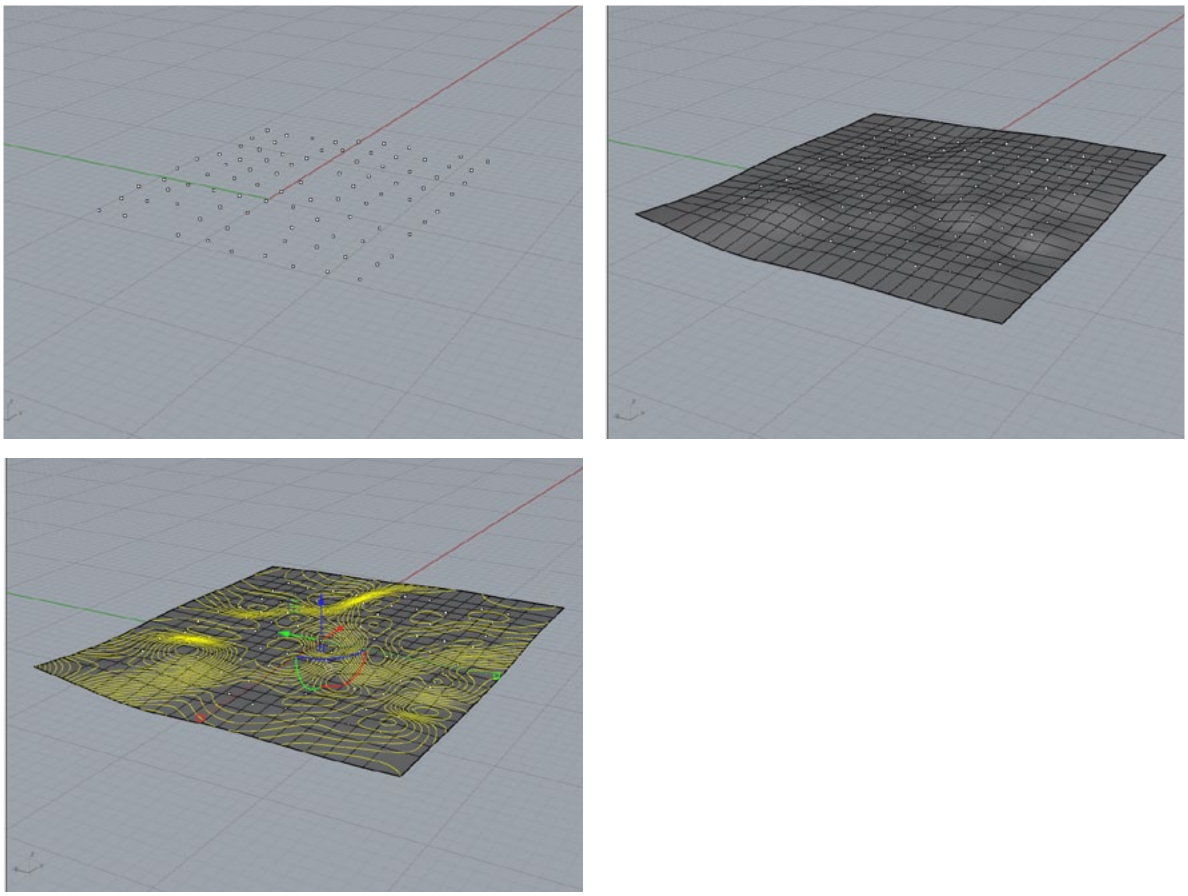

Figure 8.10 GPS points captured at a site with the Haptic Surveyor and used to generate a mesh surface and contours in Rhinoceros 3D. Image by author.

Project 4: The Baro-Receiver

Upon discovering that barometric pressure sensors were readily available, I began to think about potential applications of those devices. Currently, the effects of atmospheric pressure on landscape experience are practically invisible. Despite the inability to sense the effects of pressure in the field, landscape interventions can affect pressure by creating spatially complex microclimates that can in turn influence larger weather patterns, including barometric pressure (Ackerman and Knox, 2003). As design choices affect barometric pressure, understanding the influence of barometric pressure on landscape and vice versa could help inform design decision-making.

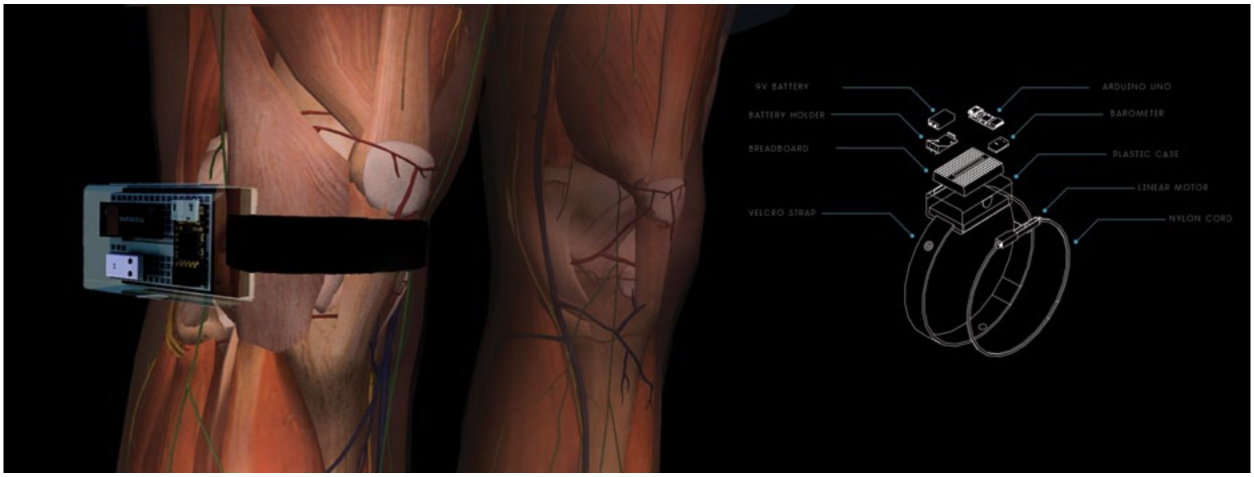

Figure 8.11   Original graphic depiction of Baro-Receiver. Image by author.

Sensing barometric pressure with the body itself is not impossible, but it is a latent sense for most and an unpleasant sense for those who possess it. Aching joints and pressure headaches can indicate a sudden change in pressure, often indicative of an imminent change in weather. Joint discomfort is caused when low barometric pressure induces swelling of nerves called *baro-receptors* and the narrowing of blood vessels to help regulate blood pressure. Even for those who can sense barometric pressure changes, there is limited nuance to the sensation (Thomas Jefferson University Hospital, 2003). Combining research on human sensory capabilities and available sensors, I created the Baro-Receiver.

The Baro-Receiver uses a barometric pressure sensor and a microcontroller to detect and record pressure changes. As the barometric pressure fluctuates, the sensor activates a vibration motor that can be strapped to either the elbow or knee joint. The unit vibrates softly, directing the wearer’s attention to the joints, where she may feel a subtle sensation as her baro-receptors and

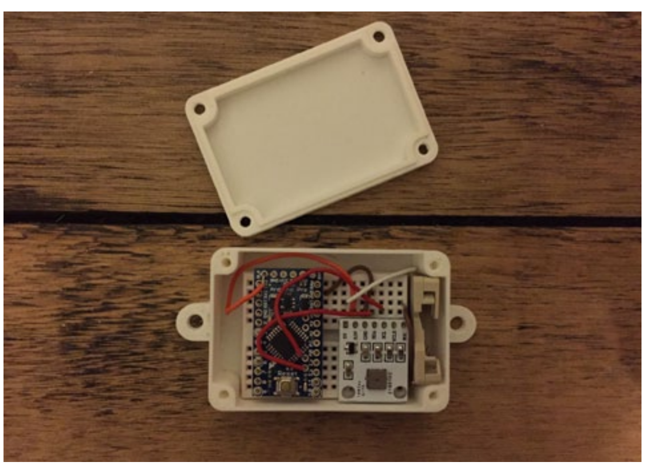

Figure 8.12 Assembly of the Baro-Receiver. Image by author.

blood vessels react to the changing conditions. As wearable technology, this can occur while on site, enabling the wearer to make correlations between the changing pressure and the surrounding landscape. The addition of a motor shield would enable the Baro-Receiver to produce multiple distinct vibration signals. Unique vibration patterns could be used to distinguish between signals for rising and falling barometric pressure.

For those who cannot identify the sensations in their joints when barometric pressure changes, the Baro-Receiver can be used as a training aid. Those who do experience identifiable discomfort can use the Baro-Receiver to calibrate their sense with real measurements. Through repeated use, the wearer may discover how these atmospheric nuances relate to the landscape and human experience in a much more resolved manner. Certainly, many designers know they can affect wind, or the equilibration of unevenly distributed air pressure, with a strategically placed tree hedge or landform, but what opportunities, such as in microclimate creation, reforestation, and climate change resilience, perhaps, would a greater understanding of landscape’s affect on air pressure reveal?

CHAPTER 9
Conclusion: A Typology of Future Tools

> *Make your own tools. Hybridize your tools in order to build unique things. Even simple tools that are your own can yield entirely new avenues of exploration. Remember, tools amplify our capacities, so even a small tool can make a big difference* (Mau, 2000).

The current and imagined capabilities of the sUAS, Digital Nerve, Haptic Surveyor, and Baro-Receiver can be categorized into three types:

> *Logger*s (*Haptic Surveyor, Digital Nerve)* passively collect data while "piggybacking" a human sense and externalizing metrics into digital memory.
>
> *Extenders (Baro-Receiver, sUAS)* expand, filter, and/or alter the user's experience of reality in order to heighten awareness of environmental conditions.
>
> *Trainers (Digital Nerve, Baro-Receiver, Haptic Surveyor)* expand on the capability of Loggers by improving an existing sense or revealing a latent sense through repeated use.

These typologies allow one to imagine tools that could enable the generation of environmental metrics at a scale and immediacy not currently attainable to landscape architects. They emphasize the importance of embodiment and materiality in the world and seek to demonstrate an understanding of how technology can be used to enhance the fullness and generative experience of being-in-the-world, not detract from it (Rothenberg, 1993). Loggers offer an unencumbered channel for human artistic statement in the environment. Extenders enhance human experience of the world, rather than supplanting it. Trainers change the human body itself to sharpen the senses.

In the discipline's future, there could be tools such as these that enable creative work in the landscape itself, rather than in the studio. Such tools would allow landscape architects to use the body and its senses to reimagine and create as they explore sites on foot, open to full immersive experience in the landscape. Such bespoke tools would open up new insights and opportunities, offering a sense of freedom and creativity that current working methods stifle.

These opportunities could be part of a more defined yet constantly evolving design technê brought about by proactive and entrepreneurial tinkering in the discipline itself. The discipline of tinkering should be promoted in curricula through coding and technical fabrication courses. Practitioners should find time and allot resources to develop their own technologies to increase efficiency and create capabilities to set themselves apart, both in their own self-interest and in the interest of the discipline.

As Iain Maxwell and Dave Pigram note, "Tools invariably begin as generic, but cycles of improvement, adaptation, spin-off, remodeling, or deliberate misuse gradually resolve them into specificity" (Maxwell and Pigram, 2012). Tools created through tinkering often carry the intention of continuous improvement or easy adaptation for new criteria; they are flexible and instill a technological dynamism that is greatly needed in landscape architecture.

The tools we use should constantly evolve along with our medium, which is in itself an ever-changing phenomenon. This notion evokes Beatrix Farrand's understanding of the living landscape, affected by time and season, always in flux and requiring constant attention from the designer (Farrand and Pearson, 2009). If we were to design technology as impressionable as the landscapes we design, we—like Farrand—would know to get our hands dirty on occasion, taking measure of our tools, refining their form and application as needed.

A design technê evolving incrementally through the mass tinkering of landscape architects is the change the profession desperately needs to reestablish the discipline as a leader amongst its allied professions. Mastery and manipulation of landscape design technê will ultimately produce new opportunities in landscape architecture: What as yet unimagined outcomes can we gain from creating and using our own tools, extending and amplifying our capacities to change the world?

REFERENCES

Ackerman, S., & Knox, J. (2003). *Meteorology: Understanding the atmosphere.* Australia: Brooks/Cole Publishing.

Bermingham, A. (1986). *Landscape and ideology: The English rustic tradition, 1740-1860*. Berkeley: University of California Press.

Boeree, G. (2009). Perception and Interaction. Retrieved January 9, 2016, from http://webspace.ship.edu/cgboer/genpsyperception.html

Conan, M. (2000). *Environmentalism in landscape architecture*. Washington, D.C.: Dumbarton Oaks Research Library and Collection.

Corner, J. (1990) Origins of theory. In Swaffield, S. (Ed.), *Theory in landscape architecture*: *A reader*. Philadelphia: University of Pennsylvania Press.

Corner, J., & MacLean, A. (1996). *Taking measures across the American landscape*. New Haven: Yale University Press.

Cross, N. (2011). *Design thinking: Understanding how designers think and work*. Oxford: Berg.

Farrand, B., & Pearson, C. M. (2009). *The collected writings of Beatrix Farrand: American landscape gardener* (1872-1959). Lebanon, NH: University Press of New England.

Gertz, E., & Di Justo, P. (2012). *Environmental monitoring with Arduino: Building simple devices to collect data about the world around us*. Farnham: O'Reilly.

Green, J. (2009, June 18). Interview with Daniel Tal, RNL Design, on technology for landscape architects. Retrieved January 9, 2016, from https://www.asla.org/ContentDetail.aspx?id=20096

Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies, 14.3*, 575-599.

Harman, G. (2002). *Tool-being: Heidegger and the metaphyics of objects*. Chicago: Open Court.

Hatch, M. (2014). *The maker movement manifesto: Rules for innovation in the new world of crafters, hackers, and tinkerers*.

Hatfield, G., & Allred, S. (2012). *Visual experience: Sensation, cognition, and constancy*. Oxford: Oxford University Press.

Horgan, J. (2013, March). Unmanned Flight: The Drones Come Home. Retrieved April 5, 2013, from http://ngm.nationalgeographic.com/2013/03/unmanned-flight/horgan-text

Howe, G. (n.d.). Make your own Claude Glass or Black Mirror. Retrieved October 24, 2012, from http://www.instructables.com/id/Make-your-own-Claude-Glass-or-Black-Mirror/

Hoyles, M. (2002). English Gardens and the Division of Labor. *Cabinet*, Issue 6, 35-38.

Kelly, K. (2010). *What technology wants*. New York: Viking.

Kruft, H. (1994). *A history of architectural theory: From Vitruvius to the present*. London: Zwemmer.

LaGro, J. (2008). *Site analysis: A contextual approach to sustainable land planning and site design* (2nd ed.). Hoboken, N.J.: John Wiley & Sons.

Lamkin, P. (2014, September 25). The history of wearable technology. Retrieved September 27, 2014, from http://raconteur.net/technology/history-of-wearable-technology

Levy, S. (2011, October 9). Grounding Landscape Urbanism. Retrieved July 7, 2012, from http://scenariojournal.com/article/shanti-levy/

Lynch, K., & Hack, G. (1984). *Site planning* (3rd ed.). Cambridge, Mass.: MIT Press.

Macarthur, J. (2007). *The picturesque: Architecture, disgust and other irregularities*. London: Routledge.

Maillet, A. (2004). *The Claude glass: Use and meaning of the black mirror in western art*. New York: Zone Books.

Maker Culture. (n.d.). In Wikipedia. Retrieved August 11, 2013, from http://en.wikipedia.org/wiki/Maker_culture

Mann, S. (2002). *Intelligent image processing*. New York: IEEE.

Margolis, M. (2012). *Arduino cookbook*. Sebastopol, CA: O'Reilly.

Marx, L. (1964). *The machine in the garden: Technology and the pastoral ideal in America*. New York: Oxford University Press.

Mau, B., & Testa, B. (2000). *Life style*. London: Phaidon.

Maxwell, I., & Pigram, D. (2012). In the Cause of Architecture: Traversing Design and Making. *Log, 25* (Summer 2012), 31-40.

McHarg, I., & Steiner, F. (1998). *To heal the earth: Selected writings of Ian L. McHarg*. Washington, D.C.: Island Press.

Monk, S. (2013). *Hacking electronics: An illustrated DIY guide for makers and hobbyists*.

Mumford, L. (1934). *Technics and civilization*. New York: Harcourt, Harcourt, Brace and Co.

NASA: Landsat Then and Now. (n.d.). Retrieved August 9, 2013, from http://landsat.gsfc.nasa.gov/?page_id=2

Parry, R. (2003, April 11). Episteme and Techne. Retrieved September 9, 2012, from http://plato.stanford.edu/entries/episteme-techne/

Pedersen, I. (2013). *Ready to Wear: A Rhetoric of Wearable Computers and Reality-Shifting Media*. Anderson SC: Parlor Press.

Perception. (n.d.). In *Oxford Dictionaries*. Oxford University Press.

Popova, M. (2015, July 1). Legendary Victorian Art Critic John Ruskin on the Value of Imperfection and How Manual Labor Confers Dignity Upon Creative Work. Retrieved July 11, 2015, from https://www.brainpickings.org/2015/07/01/john-ruskin-imperfection-creativity-labor/

Rothenberg, D. (1993). *Hand's end: Technology and the limits of nature*. Berkeley: University of California Press.

Rutledge, A. (n.d.). Definition of Design Professionalism. Retrieved August 16, 2013, from http://designprofessionalism.com/defining-design-professionalism-1.php

Spirn, A. (2000) Ian McHarg, Landscape Architecture, and Environmentalism: Ideas and Methods in Context. In Conan, M. (Ed.), *Environmentalism in landscape architecture* (pp. 97-114). Washington, D.C.: Dumbarton Oaks Research Library and Collection.

Swaffield, S. (2002). *Theory in landscape architecture*: *A reader*. Philadelphia: University of Pennsylvania Press.

Tarán, L., & Gutas, D. (2012). *Aristotle Poetics editio maior of the Greek text with historical introductions and philological commentaries*. Leiden: Brill.

Thomas Jefferson University Hospital. (2008, June 3). People With Joint Pain Can Really Forecast Thunderstorms. ScienceDaily. Retrieved January 9, 2016 from www.sciencedaily.com/releases/2008/05/080530174619.htm

Waldheim, C. (2006). *The landscape urbanism reader*. New York: Princeton Architectural Press.

Wilkinson, K., & Petrich, M. (2014). *The art of tinkering: Meet 150 makers working at the intersection of art, science & technology*.