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## Digital Vernacular: Democratising architectural making

### Abstract

Prior to the Industrial Age, most architecture was created by the master craftsman or within the vernacular trades where 'design' and 'making' were aligned. The Industrial Age, and most recently the Information Age, shifted the role of the architect away from that of the 'master craftsman' to the professional 'knowledge worker'. As a result, a divide between design and making in the practice of architecture occurred. This shift impacted an essential part of the architect's process by degrading the symbiotic relationship between mind and hand and limiting the immediate design consequences that only making can provide. But recent technological developments have changed the economic model of design and making in architectural practice and re-established this lost connection. Most importantly, they have provided new opportunities for craft, design, and architectural practice to align.

The purpose of this paper is to examine these new opportunities, define what constitutes the digital vernacular and demonstrate its place in the future of making. The paper will seek to define the digital vernacular by evaluating each of the following variables: materials, knowledge, and tools. Using normative practice as a control, the paper will conduct a comparative analysis of these variables by examining economic viability (cost-to-wage ratios), logistical feasibility (training and facilities), and skillset availability within the domain of architecture (insourced versus outsourced). Using this data, and resulting guidelines, the paper will demonstrate the successes and failures of a practice using the digital vernacular as its primary project delivery methodology and how the digital vernacular enabled new makers.

The focus of this research is not to build an inventory of equipment and methods; rather it is to develop a higher understanding of what constitutes vernacular practice within the digital age. Exploring the digital vernacular is not intended to seek new form-making, but to improve and inform understanding of traditional vernacular methods and to enable a new generation of master craftsmen. This clarity is imperative as to ensure the quality of design and

making with emerging technologies and help to prevent high-volume, low-quality results.

### 1. Defining the digital vernacular

The name digital vernacular is a response to a particular mode of contemporary making that embraces the practical, poetic, and ethical principles of vernacular design while utilising the virtues of both computer-guided tools and hand-guided tools.

Digital, as an adjective modifying vernacular, is defined as always relating to both hand and computer. The origin of the word 'digital' stems from the Latin *digitalis*, or 'of or relating to a finger' (*Oxford English Dictionary*, 2000). The definition of digital as a 'discrete value representing physical quantity' was a natural evolution from working and counting with fingers. In the mid-twentieth century, following rapid advancement of electronic computers, the definition of digital evolved to 'expression in discrete numerical form' and the now common use of the word. Digital vernacular joins the past and present by linking hand sensitivity with computer power.

Vernacular, as it relates to making, is defined as 'belonging to, developed by, and used by, the people of a particular place and time' (*Oxford English Dictionary*, 2000). Vernacular has always referred to that which is native or indigenous. With the advent of digital communication and exchange, the very definition of place and time is changing, and the digital vernacular recognises that place and perceptions of time are no longer bound to specific locations, but are now related to common circumstances, characteristics, or values held in common by a group of people transcendent of traditional place and time. It is important to note that the vernacular does not emerge from an isolated group of intellectuals or specialists but rather from the 'spontaneous and continuing activity of a whole people with a common heritage, acting under a community of experience' (Clausen and Belluschi 1994). The definition of contemporary community and the meaning of heritage are rapidly evolving and the digital vernacular is defined in response to this evolution.

## 1.1. Working principles

The digital vernacular is defined by several working principles; three of the most important are logic, sufficiency, and play.

Logic has long been a hallmark of the vernacular. Logic is a defining human capability and characteristic, perhaps most simply defined as the practice and art of reasoning. Logic is a vernacular trait, used by common people in specific places and times, to organise, evaluate, and process a manifold of conditions and opportunities that are present in community and individual life. Logic could be described as a tool for editing a world seemingly obscure and arbitrary, revealing the legible and meaningful. An example of an editing tool for the digital vernacular might be Ockham's Razor; when faced with several choices, the simplest response is usually the best.

Principles of sufficiency have guided the vernacular for thousands of years, where long-term ecological and social sustainability was not merely a concept but a way of life. Sufficiency is characterised by the fundamental idea that people can determine what is enough and what is too much, striving for a balance between needs and desires. Prior to the Industrial Revolution, communities practised principles of sufficiency not by choice but by circumstance. With limited resources and simple technologies visible to all, a natural check and balance was in place. Sufficiency always balances means and ends in an extended time frame and provides a sober evaluation of what is need and what is desire.

It is also important to describe what sufficiency is not, lest it be confused with parsimony or the assumption that past civilisations were any less intelligent, sensitive, or creative than society today. Sufficiency is not the suppression of dreams or desires. It is not the inhibition of intellect, ambition, or creativity. It is not a call to eliminate specialisation or discovery. Rather, it is the greater and more challenging exercise of these thoughts and actions, in a context with tangible limits and boundaries that guide more robust, appropriate and meaningful outcomes for the present and the future.

Thomas Princen (2005) writes in *The Logic of Sufficiency* that the paradigm of efficiency and the logic of empire, defined as the 'efficient extraction, technological mastery, and accumulation of private wealth', has delivered much to contemporary life. Princen expands, saying:

Now that the planet is ecologically full it must give way to alternative logics, ones that twist and fall, that have mystery and surprise, that do not maximize anything. They must be at once economic and ecological, rational and self-limiting, innovative and humble. (2005: xi)

These are foundational ideas to guide the digital vernacular and an antidote to much of the nihilistic design operating in the world today. 'The expectation that every new discovery or refinement of existing means must contain the promise of higher values or greater happiness is an extremely naïve thought. It is not in the least paradoxical to say that a culture may founder on real and tangible progress' (Huizinga 1970).

Another fundamental principle of the digital vernacular is related to perhaps the most common action undertaken by all people through all ages: play. Johan Huizinga (1970), writing in *Homo Ludens*, states that 'Play is older than culture, for culture, however inadequately defined, always presupposes human society, and animals have not waited for man to teach them their playing.' Play predates culture and is fundamental to the animal nature of being human. These characteristics of play are especially important in defining the digital vernacular.

Play as a voluntary and free activity is important if the democratisation of design and the voice of the vernacular is embraced. Play guided by specific limits of time is important if the design work undertaken is to be framed around the conditions of the present rather than some conditions of future fantasy. If one can say that great works of design reflect their time, then playing within the present, being in the present, is a critical boundary, opportunity, and limit. The clarity, appropriateness, and historical nature of vernacular design are due in part to its powerful expression of a specific time.

Play guided by bounded place is another integral principle relevant to the vernacular, as there are unique qualities and characteristics associated with a specific place. This relates back to the recognition of play as 'freedom itself' (Huizinga 1970), and fosters the ability of people to express their uniqueness and the particulars of the place in which they live and thrive. Bounded place is also another way of describing the essential playground of the digital vernacular: the studio. Within the studio, surrounded by materials and tools, the deepest intensity of design is realised under the principles of play.

That play ‘creates order and is order’ is both relevant to the design process and the vernacular (Huizinga 1970). It is through order that the meaning of design and community can be conveyed and understood. Central to the understanding of the order-making condition of play is the guidance of play by rules and principles. The best of design is guided by rules and principles and, like play, does not exist without them. There is no way to cheat at good design, and to cheat undermines the fundamental integrity of play. The rules are only the means to the end, the conditions a player must accept and work within in order to participate, as ‘limited means beget new forms, invite creation, make the style. Progress in art does not lie in extending its limits, but in knowing them better’ (Braque 1994).

## 2. Makers

Architecture is not simply imagined; it is real. In order to move imaginings into architectural reality, one must make. The digital vernacular has enabled a new generation of makers to move ideas from virtual simulation to physical fabrication. The term ‘maker’, as it relates to this paper, is defined as those designers and architects that provide full-scale outcomes as their instruments of service. Makers have a prominent place in the legacy of the crafts and trades and are the epitome of the persistence of the craftsman.

### 2.1 The importance of the master craftsman

William Morris characterised the craftsman as someone who fluidly connected the energies of the mind, body, and soul. The craftsman made with his own hands that which his mind conceived, until the Industrial Revolution separated the craftsman’s ideas from his actions, leaving him alienated from his trade. In *Shop Class as Soul Craft*, Matthew Crawford (2010) revisits this suppression of craft in his argument for the value of work in the post-industrial era. He asserts that craftsmen and tradesmen have both an ethical and moral obligation to the artifacts they make. Both Morris and Crawford, along with many other contemporaries, are reacting to the importance of the master craftsman, not only to production and output, but also to the health and sustainability of a civilised society.

#### 2.1.1. The suppression of the master craftsman

The meaning of craft and the craftsman’s place in society has evolved over time. Once representing power, strength, or skill, craft has become associated with a specific trade, ‘spawning into the more persistent notion of the craftsman around the 15th century’ (Adamson 2010).

Beginning in the Middle Ages, craft guilds existed as a formal association of skilled craftsmen, otherwise known as masters (Epstein and Prak 2008). These masters trained apprentices and journeymen in specialised fields. The apprenticeship process could last anywhere from two to over seven years and was treated as a ‘series of modules’ which led to more developed expertise (Epstein and Prak 2008). Most processes used by the guilds employed ‘simple technology in small workshops’, obtaining maximum results through minimal means (Epstein and Prak 2008). Innovations within the guilds were not actively pursued, but discovered through ‘small-scale and incremental practical experiments’ during the apprenticeship process (Epstein and Prak 2008).

The vast economic pressures of the Industrial Revolution ultimately marginalised the master craftsman. It was not possible for a carpenter to hand turn a wood spindle and compete with a manufacturer that could produce thousands of spindles more per day. More was lost than simply the ability to create objects by hand. The soul that Morris refers to is expressed through the pleasure of making and the independence delivered through the process of mastering one’s own craft.

With the advent of the assembly line, Henry Ford changed the fundamental economic model for the production of automobiles and other consumer goods. It was no longer necessary for a carriage maker to understand the tools of his craft, nor was it necessary to know the material, its origin or behaviour. It was only important to follow a structured model of assembly. In return, Ford famously paid his employees well for their time. Ironically Ford stated, ‘if money is your hope for independence you will never have it. The only real security that a man will have in this world is a reserve of knowledge, experience, and ability.’ This quote stands in contrast to his actions (well intentioned or not), which led to the eventual consolidation of knowledge, leaving the craftsman to work on the assembly line rather than practise his trade. The removal of knowledge from the craftsman diminished all trades that endeavoured to make what they conceived.

#### 2.1.2. The persistence of the tradesman and craftsman

After the Industrial Revolution, the craftsman became marginalised and the craft guilds dissolved as a result of the new business values of minimalism and economy. Yet while the Industrial Revolution threatened the craftsman’s place in society, it did not render him irrelevant. There was still a need for skilled labour within the context of the new

machine age, 'marking the emergence of the *modern craftsman*' (Adamson 2010). For example, 'hand-finishing of metal was difficult to make absolutely smooth using an automated cutting tool' (Adamson 2010). The craftsman's skill and sensitivity were still essential, but only as a fragment of a larger and holistic mechanised system.

Despite economic factors, the degradation of knowledge, and lack of access to tools and materials, the trades and crafts persisted. This endurance is linked to two basic human needs – the desire for an improved life and the innate part of a person that causes them to actively pursue this improvement, what Morris refers to as 'soul'. As David Pye (1999 [1978]) observes, 'nothing we design or make ever really works' and fundamental design and craft needs constant tending as if it were a 'new born babe'. Pye captures the desire that constantly tugs at designers. The building must be large but light, low cost but made of gold, thus providing content variables that are inherently in conflict, needing to be balanced with compromise. This ultimately creates dissatisfaction as it fights with the desire to improve and resolve matters directly. This is not done out of necessity; in today's society, there is the ability to purchase a way out of most problems. But, this does not extinguish desire, it does not satisfy the soul. It is the act of making, the knowledge of active participation, and the satisfaction of the haptic knowledge of the tools used that feeds the soul. This need cannot be satisfied by industry or economy.

## 2.2 The return of the maker

Regardless of Morris's arguments, the resulting conditions of designing and making were primarily driven by economy. Until recently, the cost of labour, equipment, shipping, and raw material dictated the marketability and long-term sustainability of a product. Recent developments in digital technology have contributed to a shift in the economic factors that promote large-scale, centralised manufacturing. It is now economically possible to mass-customise many of the products utilised. This is not to imply that it is easy, or that it will become a widespread phenomenon, but there is an opportunity for new makers.

The digital vernacular is born from a new relationship between designer, maker, material, and tool. For decades, the designer has been divorced from the maker, ceding to the maker final influence on the quality of the product. There will always be some part of the design that the designer has overlooked, and this leaves the maker the task of reconciling the

disparity between idea and reality. Craft is born from an intense relationship between maker, material, and tool, and is executed with judgement, care, and skill (Pye 1995). The quality with which design intentions are carried out resides in the hands of the maker. But the designer and the maker have a fundamental connection; they are both fully vested in the quality of the outcome. It is through this common denominator that the recent collaboration between design and fabrication has re-established more fluid intention-driven projects.

## 3. Digital vernacular tools

In Richard Coyne's (1999) book *Technoromanticism*, he describes what he refers to as a 'Golden Age' where culture existed in a pre-literate state and where the hand was the prehensile tool. Learning and understanding was not done by reading and writing, but by touching, feeling, and doing – this was the basis of all mechanisation (Giedion 1948). In the context of today's digital world, when presented with new digital tools that allow for a designer to reconnect with the haptic nature of architecture, one can easily devolve into a digital utopia. The digital vernacular, rooted in the practical traditions, seeks to avoid this digression through careful selection of tools. This selection is not set to impede progress or creativity but rather to root the basis of work in the present, not in romantic notions of the future.

For tools to be classified as vernacular they must be readily available, repairable by the maker, and affordable. Much like the recent democratisation of information brought on by the internet, the democratisation of manufacturing and mass customisation has brought digital tools within economical reach of builders, makers, and architects. This change in accessibility can be seen in the fluctuations of the wage-to-tool cost ratio over the past hundred years in the United States.

In 1922, a carpenter in the US could expect to make \$1.00 per/hour (Chicago Regional Council 2012), while a circular saw sold by Hibbard Spencer Bartlett & Co. (1922) would cost \$285, making the ratio 0.35 per cent. Comparatively, a carpenter in 2010 earning \$19.00 per/hour can expect to pay around \$10,000 for a new three-axis CNC (ShopBottools.com), resulting in a ratio of 0.19 per cent. With a ratio as low as 0.19 per cent, it is easy to conclude that the wage-to-tool cost ratio puts today's digital fabrication technology within reach of the vernacular trades.

This data is further reinforced considering that, in 1996, an entry level CNC cost approximately \$30,000. As stated above, a new three-axis CNC averages around \$10,000, reflecting a cost reduction of 66 per cent within a twenty-year span. The change in entry-level economics is also occurring with additive fabrication processes. Within the past ten years, the price of additive fabrication tools has entered a realm the average person can afford. For instance, MakerBot is an open source three-dimensional printer being sold for under \$1,000, but less than ten years ago machines with the same capabilities sold for \$125,000.

Common understanding of this phenomenon is represented in Chris Anderson's 2010 *Wired* magazine article that covered a new revolution in the manufacturing process. Anderson asserts that the democratisation of technology has led to a new voice for the individual. Some manufacturing processes, once only available to factories with hundreds of workers, can now be done in a small workshop. In the Industrial Age, products were designed for the masses, and companies focused on mass-market appeal; now, individual makers are finding their niche in what Anderson calls a new 'Atoms Age'. For example, the auto company Local Motors has only ten employees but is a custom car manufacturing company utilising peer production, open source technology, and user-generated content. 'In an age of open source, custom fabricated, DIY product design, all you need to conquer the world is a brilliant idea' (Anderson 2010). The power of the micro-factory over the Fortune 500 Company is in its ability to anticipate change, adapt readily, and operate with low overhead due to globalisation. These small shops focus on the quality of their products, not the size of their market.

### 3.1 Making digital vernacular tools

Throughout the history of craft, the tools of building trades have evolved slowly over time. This is due to the fact that all craftsmen conduct the same task, with the same tool, repeatedly until they can perform it with predictable skill. As Henry Petroski (1992) observes in *The Evolution of Useful Things*, it is the creative and reflective artisan that in the midst of routine pays attention to the details of the tool and devises improvements. It is understood that all tools make other tools and each is connected by the evolutionary development instigated by the craftsman before.

The polygenesis of tools continued uninterrupted until the Industrial Revolution. As with other

products of this time, tools were being developed and conceptualised inside the corporation far from the craftsman's domain. This disconnect continued until the twenty-first century democratisation of digital tools. Now, a craftsman has access to parts, plans, instructions, and assistance to build most any digital vernacular tool. It is this intersection between availability of material and community knowledge that defines a digital vernacular tool. If a tool cannot be built by, maintained, afforded, and evolved by the maker, it is not a vernacular tool.

## 4. Practice

Practising the digital vernacular embraces the inherent opportunities provided by new technology while maintaining the virtues of working manually with hand tools. The combination of designing and making is counter to the organisational structure set forth by many professional and trade organisations. When an architect is directly involved in the making and implementation of a proposal, there is a shift of responsibility that is not currently recognised within the bounds of normative practice. This is not to say that digital vernacular practice is a replacement for the traditional model of practice, but rather an alternative model. As such, the digital vernacular should be acknowledged as a legitimate part of the profession of architecture. The digital vernacular holds within it the attributes common to the profession: lengthy and arduous education, expertise and judgement, registration, and relative autonomy (AIA). The digital vernacular is but a specialisation of practice. The core expectations of an architect are unchanged.

### 4.1 Normative practice

For the purposes of this paper, normative practice will be addressed as the standard project delivery methodologies defined by the American Institute of Architects. Currently, architects working in the US are guided by deontological ethics that demand a clear separation between design and making. Article 3.6.1.2 of AIA's Standard Form of Agreement Between Owner and Architect clearly states:

The Architect shall not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work in accordance with the requirements of the Contract Documents. The Architect shall be responsible for the Architect's

negligent acts or omissions, but shall not have control over or charge of, and shall not be responsible for, acts or omissions of the Contractor or of any other persons or entities performing portions of the Work.

The American Institute of Architects (2009) reinforces this position in *The Architecture Student's Handbook of Professional Practice* when it states: 'professions traffic in ideas and services rather than in goods or products. They have knowledge outside the ken of the layperson.'

The result of these rules is a standard contract model that separates knowledge, discipline, responsibility, and service into client, contractor, and architect (Figure 1). The architect is the guardian of the 'ideas and services' and determines if the work done by the contractor is consistent with the contract documents. The contractor is required to build to the contract documents and is wholly responsible for budget, schedule, safety, and final project delivery. In this sense, the architect's deliverables are the drawings and specifications, while the contractor's deliverable is the actual building. Recently new models have developed around design-build and integrated project delivery with marginal success primarily because they are still based on this division of responsibility. This separation of accountability within normative practice stands in contrast to the fluid decision-making and clear logic provided by the vernacular. Looking at the vernacular's historic ability to succeed within natural limits, it is only reasonable to question the current model of practice.

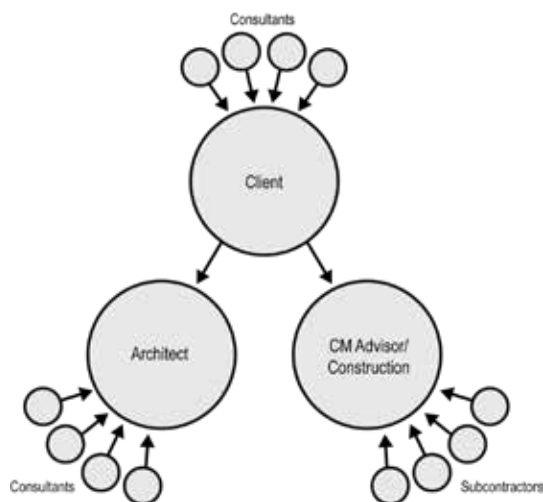


Figure 1. Normative Practice Organisational Diagram (adapted from Holden 2012).

## 4.2 Digital practice

The use of digital modelling to produce architecture has profoundly impacted the profession. The most apparent influence is in the limitless possibilities to generate complex forms. BIM fabrication tools such as Grasshopper and Digital Project are acting in response to the demands of digital practice. What is designed can now be readily fabricated by others. Practising digitally has created a process-based change to the profession. As Branko Kolarevic (2003) asserts in *Architecture in the Digital Age*, 'the digitally based convergence of representation and production processes that represents the most important opportunity for a profound transformation of the profession'.

This opportunity has been leveraged by many firms successfully. For example, SHoP Architects uses a technique they call 'direct fabrication' where the design drawings produce the final fabrication geometry (Holden, Nobel, and SHoP 2012). This method of working presses against normative practice and dated rules that shape the profession by expanding the architect's traditional instruments of service to include direct fabrication files. SHoP has fundamentally changed the organisational diagram produced by normative practice (Figure 2). Further integration is accomplished by consolidating consultants (outsourced become insourced) and further engaging the clients and contractors in the design process. SHoP was able to do this not by limiting their responsibility, as the AIA recommends, but by increasing it, folding the 'responsibility of others' into their design process. Digital practice is a step towards practising the digital vernacular, but it has yet to break from normative practice's separation of design and making.

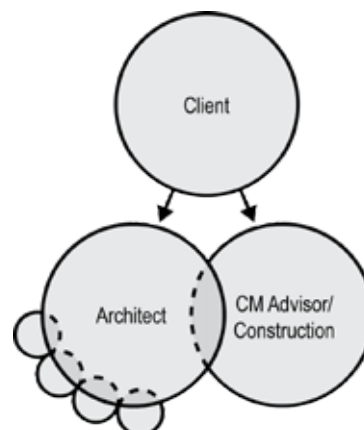


Figure 2. Digital Practice Organisational Diagram (adapted from Holden 2012).

### 4.3 Practising the digital vernacular

To make with the hands provides immediate consequences to design decisions. In a digital vernacular practice, an architect can conceive, design, model, fabricate and realise a design without interruption. A fluid motion of designing, testing, and iteration can be achieved by the architect(s). Understanding the importance of designing and making, David Pye (1999 [1978]) observed:

Design, like war, is an uncertain trade, and we have to make the things we have designed before we can find out whether our assumptions are right or wrong. ... 'Research' is very often a euphemism for trying the wrong ways first, as we all must do.

The digital vernacular allows for designers to edit logically, achieve sufficiency, and play with design variables to seek solutions. Design cannot be faked within the digital vernacular, it is authentic in its successes and failures. It is rooted in the craft guild practices, bounded by the unique context of time and place. The digital vernacular further compresses digital practice's process of design by integrating all aspects of design and construction into one entity (Figure 3). The architect is wholly responsible for design and construction, reaching beyond the limitations of normative practice.

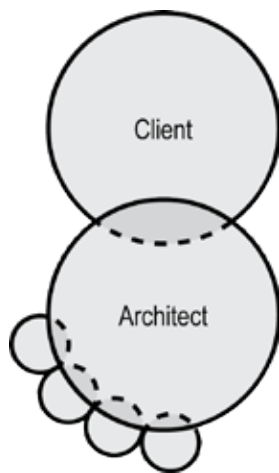


Figure 3. Digital Vernacular Practice Organisational Diagram.

#### 4.3.1 Suitcase CNC

To make evident the virtues of digital vernacular's direction and potential, a brief case study is provided that describes the process of design and fabrication of a suitcase CNC machine undertaken by makeLab, an architecture and digital fabrication studio.

POLIS University, a new architecture and design institution in Tirana, Albania, was created to address the growing needs of a developing, post-communist country. In 2012, makeLab was asked to teach a digital fabrication workshop at POLIS but was faced with the dilemma that the new university had no digital fabrication equipment or tools. The challenge was to design a CNC machine that could be packed in a case, checked as luggage on a commercial flight and cost less than 1,000 USD. The multiple destinations in the Balkans required that the CNC be setup and broken down quickly and that alignment had to occur immediately without calibration. The project was further complicated by the unpredictable availability of replacement parts, inconsistent power voltage and the general rigors of travel. The suitcase CNC successfully enabled makeLab to teach a new skill set to design students who otherwise would have not had the opportunity.

The design process was guided by the limits inherent to designing a machine for travel, weight and budget. These design limitations require hyper attention to be paid to each component. Digital models were created to verify size and weight. Using three-dimensional geometry, a full-scale wood prototype was created to ensure all fittings worked and that disassembly, packing and unpacking could be done quickly and easily (Figure 4). After multiple attempts, the final machine's structure was milled from HDPE plastic, commonly used for kitchen chopping boards. This material allows the joints to be fastener free by using joint taxonomy. Four OD Linear Motion Shafts coupled with 3/8" flanged sleeve bearings carry the load of the gantry. This allows for free movement without the need of gears or tracks that could slip quickly out of alignment while on the road. A small 12-volt, DC motor, much like those found on remote-controlled cars, is mounted to the z-axis. Through a series of couplings and belt pulleys, the motor is connected to a spindle holding a 1/8" endmill tightened by a 0.035" hex key. Each axis is driven by a Nema 17 stepper motor connected to a three-axis hobby CNC control board on the computer side and flexible aluminium coupling on the machine side. This aluminium flexible coupling proved to be essential on the road. When hit hard, the coupling deforms, allowing the 1/4" stainless lead screw to run straight and reduce the possibility of misalignment and unwanted vibration. To eliminate the need for a desktop computer, the control board was served by a smooth-stepper board allowing connection to a laptop USB. Of course, all of this had to be contained in a sturdy case.



Figure 4. Wood prototype – Suitcase CNC.

Although the machine was viewed as ‘complete and operable’, upon leaving for the Balkans the design was continually tended to as travel progressed, which started with an initial trip to Albania. In Albania, the CNC endured ten straight days of cutting and surfacing at POLIS University in Tirana. After a few hiccups, it made it through most of the initial run. Then, an on-the-road-repair to a belt driver allowed it to be demonstrated in Pristina, Kosovo. From there, it travelled to Paris to cut models in the courtyards of apartments, university campuses and basement hacker-spaces. Ultimately, the CNC broke down, was repaired, broke again and, with help from makers around the world, was repaired yet again. What was not expected, but what was ultimately learned, is that the machine was in a constant state of design and repair. As craftsmen have always done, the machine was modified as work progressed, using vernacular tools available in the immediate area. The travel, testing and repairs are as much of the design process as the initial assembly.

To align with the perspective of vernacular tools being accessible, repairable and affordable, the suitcase CNC was designed and built without the use of experts and built with low-cost non-proprietary components. Digital vernacular skills are thereby increased through the machine’s portability and its ability to ‘act’ and ‘teach’ in a vernacular way. Using vernacular tools also ensured that the Suitcase CNC was fully mobile, as it could travel independently

of any specialised tools. Therefore, following completion of the design and construction, the Suitcase CNC can be packed, tagged and rolled away (Figure 5).



Figure 5. Travelling – Suitcase CNC.

The design challenge from the client was simple: they desired to teach digital fabrication but had no tools. The response was direct: to bring the tools to the client. The response seems simple but it was not without research and an understanding of the origin of the issues. The philosophy, and ultimately the design response, was directly shaped by the history and context of tools themselves. From history, it is understood that, traditionally, tools were made by the tradesman who used them and were modified to suit their specific needs. This resulted in tools evolving within the boundaries of the user. The industrial age and, more recently, the digital age has accelerated the evolution of tools outside the hands of the end user. The Suitcase CNC sought to realign this evolution by creating its own machine, modifying tools to suit the maker’s needs, and passing this knowledge on as it travelled (Figure 6).

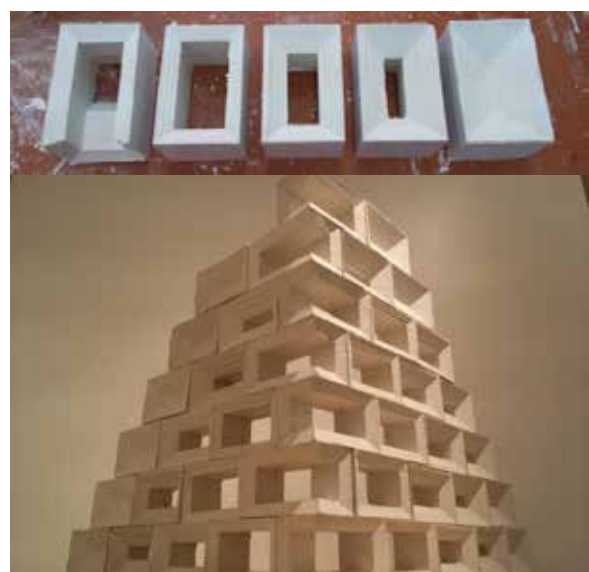


Figure 6. POLIS workshop, digital forming and casting of parametric bricks.

## 5. Conclusion

Given that logic, sufficiency, and play are the guiding principles of the digital vernacular, the design, fabrication and repairs of the Suitcase CNC is a manifestation of these principles. The Suitcase CNC was born out of the given conditions of time and place, making the solution logical and constructible. The construction of the machine was not guided by a desire to revolutionise making; it only sought to accomplish its task – be a portable and durable method of making.

The working principles – logic, sufficiency and play – are fully utilised in the final product and further evidenced by the tools used in completion of the Suitcase CNC. These vernacular tools, readily accessible and affordable, directly contributed to makers meeting the principles of logic, sufficiency and play. The seamless integration of the tools allows for fluidity from design to creation to repair, which is essential to the digital vernacular.

The Suitcase CNC functions, but only because makeLab used vernacular tools, materials and, ultimately, physical testing. The convergence of designing and making allowed makeLab to operate at its highest and best use, culminating in the principles, processes and tools that exemplify the foundation of the digital vernacular. In turn, the Suitcase CNC enabled the university to teach a curriculum in digital fabrication that was previously not available, directly contributing to the future of making. The enthusiasm the suitcase evoked from the students and faculty has spurred internal changes leading to new funding for tools which will remain onsite for students to use. More importantly, the knowledge the students took away from the experience led to numerous grants to fund independent design projects.

The fruition of this endeavour demonstrates the home the digital vernacular has found in the future of making. This home is not defined solely by the act of making, but also by the democratisation of making it provides. By supplying designers with fundamental tools and knowledge, new makers have been enabled and are participating in the future of making.

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