# Printing Provenance

by

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# Contents

# Abstract

More often than not, current material practices within Architecture have become ecologically, culturally, and socially inaccessible. This thesis moves away from vast and inaccessible material networks to focus on how local practices and experiences can foster more reciprocal relationships between our making modalities, material, and the landscapes that we extract from and build within. The project centers itself within Medicine Hat, Alberta, a landscape with deep ties to ceramic material processes and extraction. And similarly, the work looks to printing processes as a method for participating more reciprocally with landscape and the materials present within. This thesis works to re-frame printing technologies amidst the fragmented material fabric Medicine Hat offers. And through a lens of "mounding," the work looks to integrate various gestures, modalities, materials, and participants in an effort to ask how printing modalities might offer up opportunities for experiencing and participating in the material landscape.

# Acknowledgements

I would like to acknowledge that the work conducted over my thesis terms was explored and carried out both on the unceded land of the Mi'kmaq peoples, and on Treaty Seven Land - the traditional homelands of the Siksika, Kainai, Piikani, Stoney-Nakoda, and Tsuut'ina nations, as well as the Metis Nation within Region Three and the Cree, Sioux, and the Saulteaux bands of the Ojibwa peoples. These traditional lands provided a material richness that benefitted and bolstered my work and my process.

A special thanks to James Forren and Rory MacDonald for their critique, support, and guidance over the past year.

And to my family, my partner, and my friends, thank you for your support throughout the duration of this work.

# Chapter 1: Introduction

## ‘Things’ Accumulate

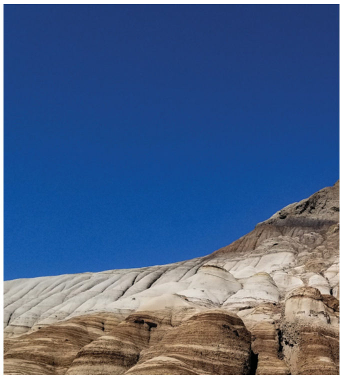

Figure 1: Hoodoo Striations, Drumheller, AB.

Figure 2: Walking in clay pits at Lantz, NS (Saito 1978).

Figure 3: Clay cliffs, Medicine Hat, AB (Fandrich 2017).

This body of work is about matter. How it aggregates and accumulates over time. How it forms our landscapes and entangles our lives. And most importantly, how we as architects, craft persons, tinkerers and makers choose to approach and work with matter.

The material we engage with, craft with, and of course, build with permeates, shapes, and animates our lives. How we deal with and approach our materials through making, producing, designing, and building has longstanding and significant repercussions that resonate throughout our landscapes. Andri Snaer Magnason uses the aphorism “when will someone you love be 90?” (Vaughan-Lee 2018) This simple thought experiment extends an individual’s temporal range through the lives of their loved ones and begs them to question what kind of world each life has and will experience; will our approaches foster reciprocal and resonant experiences? Or will they inform something else entirely? But how can we start to think through our approaches, not only in their immediate effects but also the effects that linger? In moving to address this, this thesis begins with Ingold’s notion of the Mound:

> The mound that confronts us […] is the cumulative by-products of all kinds of activities, carried on over for long periods of time and not only by human beings […]. To observe the mound today is to witness the going on. The mound, we could say exists in its mounding. This is to think of it not as a finished object standing on foundations and set over and against its surroundings, but as a locus of growth and regeneration of materials welling up from the earth, [that] mix and mingle with the fluxes of the weather in the ongoing production of life. (Ingold 2013, 78)

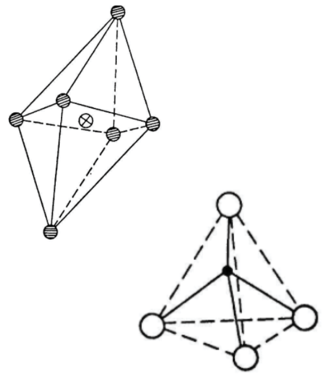

Figure 4: $Al(OH)_6$ Octahedron (Alumina) & $SiO_4$ Tetrahedron (Silica) respectively (Ryan 1978).

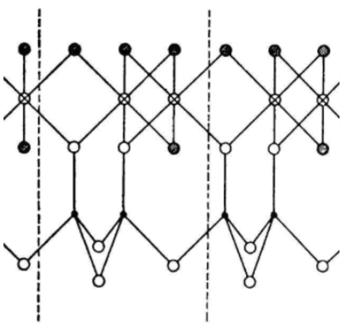

Figure 5: Octahedral and Tetrahedral Bonding forming sheets (Ryan 1978).

While Ingold, in the above excerpt, is referring practically to neolithic mounds and cairns that dot the United Kingdom, he is using them to implicitly convey broader natural processes that cover biological, ecological, cultural, and social systems. Mounding for Ingold is a complex multi-scalar meshwork of reciprocal relations that accrue over time. And in a sense, all the materials that influence the production of life work in this sense of mounding, as they have a unique tendency to accumulate and form relations with the surrounding environments over time. Let's take the life of clay for example, which is a simple choreography of weathering, traveling, bonding, and aggregating. Over epochs and at a constant and continual pace, clay starts as two perfectly matched and abundant particles, silica, and alumina, that are weathered away from stone by wind, water, and glacial pressures. While these particles are carried across territories by the same forces that participated in their making, it is the deposition of these two crystalline minerals that allow for the chemical bonding, hydrogen bonding, layering, and stacking of particles that culminates in the mineral stew that is clay. This accumulation over time, of what Jane Bennet

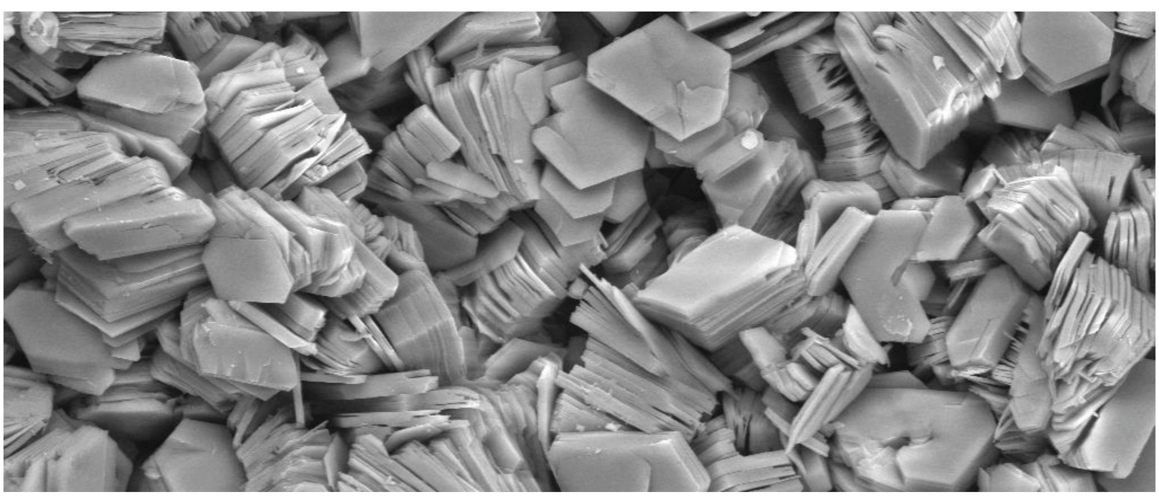

Figure 6: SEM of Clay Platelets - made up of stacked Octahedral Tetrahedral sheets stacked and hydrogen bonded together (Rohstoffe n.d.).

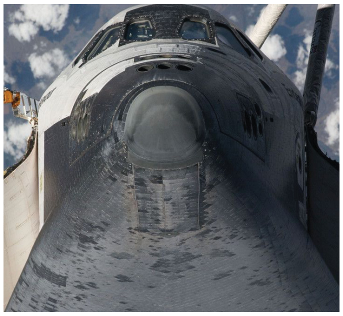

Figure 7: Heat shield tiles on the Shuttle *Endeavor* (Moskowitz 2011).

would call “Small Agencies,” has resulted and continues to result in benevolent alliances that have greatly influenced the course of life (Bennett 2010, 96). From the very start, the accumulation of clay provided the basic microclimates to foster and catalyze early cellular life (Armstrong et al. 2019, 225). It formed the basic building blocks of our agricultural, cultural and urban societies (Rael 2017, 6). And through a continued tradition and lineage of making, more recently, it has taken us past the envelope of our planet to new frontiers (Rodriguez et al. 2011, 185). While this narrative might lean on the anthropomorphizing of the material, clay still “intra-acts within the world, it is inherently agentic, discursive, and an important participant in the making of the world” (Hutton 2020, 8).


Figure 8: Space shuttle heat shield tile. Made of vitrified and packed silicate spun fibers and borosilcate coatings (Pearlman 2012).

Figure 9: Restored ceramic stamp for bricks, 2254BC-2218BC (Dunn et al. 2018, 207).

Now, if we look to the southeast of Alberta, there is a city that has participated industriously in mounding processes. In Medicine Hat, clay that had accumulated in the banks of the South Saskatchewan River over millennia reigned supreme for much of the 20th century. Bricks, crocks, cups, tiles, pipes, and many other products were produced – if it was ceramic, chances are it was made in one of the many brickyards or potteries that popped up over the century-long reign of production (Fandrich 2019). While working with clay existed before western expansion, found in the form of indigenous pottery, the high-quality clay deposits, along with large pockets of natural gas, were approached with wild speculation when the Canadian Pacific Railway arrived at the end of the 19th century. As time progressed, the material production in Medicine Hat further entangled more lives and drove the development of entire communities, all while mobilizing other material, investment, equipment, and individuals within an ever-increasing territory. Something that is critically important to understand is that clay's small, accumulated agencies greatly impacted the production of life. The accumulation of clay and other materials within this landscape was open to human participation, which in turn facilitated industry, livelihood, and cultural participation with the material landscape.

Today, If you walked through the north flats of Medicine Hat, you'll likely come across piles of pottery fragments, and frost shattered bricks. You'll most likely see remnants of potteries and brickyards amidst scars of material extraction. And if you walk down the city's streets, you would be hard-pressed to find someone who did not directly participate in the industry or, at the very least, was related to someone who did (Antonelli and Forbes 1978, 7). Within this social and cultural fabric, there exists a wealth of individuals, each with a set of unique intelligences, experiences, and appreciation for working with clay and the ceramic process that more or less now have limited access to working with the material in their daily lives. The magnitude of production that occurred during the 20th century eventually petered

Figure 10: Ruined smoke stack and test kiln at former Redcliff Pressed Brick Factory Site. Redcliff, Alberta.

out due to natural disaster, the development of cheaper and more extensive territorial and material networks, and declining demand for products. And while the memory of the industry is championed and musealized by the Medalta Society, a historical society that maintains historic sites, provides educational programming, and hosts artists through a variety of residencies, the landscape surrounding the historic clay district still remains relatively ruptured and fragmented. The landscape offers up a specific material provenance, or an embedded cultural origin, meaning, and tie to specific physical materials.

Figure 11: Detritus in Seven Persons Creek.

Figure 12: Detritus in Seven Persons Creek.

Detritus, fragments, shards, scars, and industrial structures were not the only thing accumulated in Medicine Hat over its century-long production period. The need to capitalize on the ‘small accumulated agencies’ that the natural gas and clay provided launched the small prairie town into a voracious production mode that saw an immediate and constant influx of somatic, semi-autonomous, and autonomous tools moving into Medicine Hat. And the need to compete in a market saw successive importations of these tools, each generation improving on the last (Antonelli and Forbes 1978, 30). Working with clay and ceramics, and for the most part with any other material, is inextricably linked with technology, as most likely, one or more of the stages in the formation of artefacts, objects, and architecture rely on some form of technology. Within the ceramic workflow, it can be as simple as applying heat to a vessel or using a mold to form a brick (Keep 2019, 20). The potters and brick makers of Medicine Hat relied on various tools that successively developed and built up over the years - From hand tools and temporary kiln structures to robotics and large-scale tunnel kilns. And just as the potters and brickmakers of Medicine Hat relied

Figure 13: Detritus lined banks of South Saskatchewan River

Figure 14: Assembly of temporary scove kilns (Esplanade n.d.c).

Figure 15: Tunnel kiln being loaded with bricks (Esplanade n.d.c).

on their own accumulated suite of hand tools, machines and robotics, so did the development of cheaper territorial networks that assisted in the decline of the industry in Medicine Hat.

While production has since petered out, the ceramic tradition and its continuum have since continued elsewhere, and new tools, processes, and technologies have emerged. An emerging modality that is increasingly tied to the ceramic tradition and its continuum is additive manufacturing (AM), or 3d printing. AM is a modality that more and more is being incorporated into art, craft, and architectural practice. Just a few years after the I-XL Brick Plant was forced to close due to flooding in 2010, Liquid Deposition Modeling (LDM), a form of 3D printing, increasingly started being adapted to work with clay, adobe, cob, concrete, and other aggregate-based bodies by various creative practices around the globe. Currently, printing in architecture is valorized and criticized for its visions as a ‘world-saving approach’ and its potential subversion of handicrafts. Over the past two years, I have been working with printing modalities that, at first glance, correspond well to Ingold’s notion of mounding. Printing and

Figure 16: Bricks forming strata in face of river escarpment, adjacent to form I-XL complex.

mounding are both operations which deposit materials over time. But printing, rather than being viewed as a fluid and ongoing process, is typically carried out as an operation of absolutes. But printing can, in fact, have imperfections and subtleties; and it can be accessible and flexible when viewed through the right lens.

If printing is an emergent practice of making in ceramics and earthen workflows, and Medicine Hat - a city with deep ties to ceramic traditions and technologies - suffers from a ruptured cultural landscape: Might printing modalities be reframed to work with Medicine Hat's unique Material Provenance to develop and offer reparative material practices?

## How to Think about Printing with Provenance?

In thinking through the work, it may be helpful to consider a few different voices – each providing specific and similar attitudes towards approaching and working with materials. For "thing-power materialist" Jane Bennett, "humans are always in composition with nonhumanity, never outside of a [dense] sticky web of connections" where human and non-human bodies can form alliances, self-organize and act in conjunction and in relation with other bodies (Bennett 2004, 365). Bennett argues that in order to stitch the division we see between society and ecology, we need to develop or "cultivate a more enlightened self-interest, one cognizant of our embeddedness in natural-cultural-technological assemblages" (Bennett 2004, 361). Pulling from Bennett, the emphasis on making and working with materials should be placed on agency, and animate forces offered up by our tools, materials, and environs.

While similar to Bennett, Ingold, an anthropologist who emphasizes embodied knowledge and tacit knowing, takes a material-centered perspective, where focusing on the life of materials is to prioritize the processes of production over those of consumption. Holding similar sentiments as Bennett, Ingold suggests that rather than working through deterministic lenses, which render matter “passive and inert,” there needs to be an emphasis on acknowledging, identifying, seeking out, and working with the materials ever-present within our fabrics. (Ingold 2012, 432) Ingold also posits that cognition and knowledge is inseparable from our environments and material experiences, and is developed through routinely spilling out “into the environment, enlisting all manner of extra somatic objects and artifacts in the conduct of […] operations” (Ingold 2012, 438). Put in simpler terms, knowledge is gained through situating ourselves within and experiencing environment and matter - meaning our mind is something that cannot be separated from the material world. In this sense, Ingold would rather see building and making “as a process of growth” where human, material, and environments form intimate relationships and dialogues that create emergent outcomes (Ingold 2012, 431). Thinking of production, whether making or building, as a process of growth allows makers and architects to look at materials beyond their commodity status.

Another individual that explores human-material-environmental relationships is landscape architect Jane Hutton. While similar to Bennett and Ingold, Hutton focuses on the relationships and impacts that humans and non-humans have within the material flows and exchanges we see in our environs.  Hutton posits that “If we could unsee or unlearn the pervasive idea that materials are inert, exist in a single state, and are subservient to human needs alone, we could instead grasp a materials’ agencies and observe more clearly the flows and interdependencies between construction and the more-than-human world" (Hutton 2020, 220). For Hutton, the material we mobilize through production and throughout our built environments and territories are entangling forces that impact and shape people's lives significantly throughout time. Hutton looks at the relationships between things, our approaches, our materials, our landscapes, and the resultant cause and effects that our approaches and materials choices create. Considering how materials affect people's lives and what they mean to them may help frame our approaches to working with materials and the tools and technologies that we use in our material processes. Additionally, similar to Ingold's ideas around making, for Hutton, production should be seen as integral to the project, not external to it. And through focusing on the immanence materials bring to our production processes, we can start to imagine new relationships between making, building, humans, and their surrounding ecologies.

Lastly, Ron Rael and Virginia San Fratello work to center materials in their work by focusing on rendering cultural, social, and ecological issues through material gestures specific to environments. They bring forward the notion of "Material Provenance," which refers explicitly to where a material comes from and what it means to us (Rael and San Fratello 2014). Through centering Material Provenance, we can start to ask questions and investigate how materials not only have shaped and altered life but, through new gestures, can animate life in more reciprocal manners. Through this process, we should start to question a material's provenance,' how it has affected the lives that have been entangled with it? How it has shaped its surrounding environments and ecologies? And through this questioning, look to imagine new trajectories for the materials lineage. Additionally, Rael and San Fratello explicitly explore material technologies in relation to their material-centered approach. The duo has widely explored additive manufacturing and 3D Printing tools, processes, and technologies within their work. For them, “there is a difference between accepting tools as they are and misusing the tool – and in misuse, the tools create new ways to think about materials, the relationships between them and the culture and context” they are situated within (Skavara et al. 2017, 158). In their work, they are constantly exploring this idea of misuse, whether through questioning the materials, the technologies, the fabrication methods, or a composition of these various elements. And in this effort, their work starts to question, interrogate and bring forward culturally specific relationships that we hold with our materials.

In thinking through the various attitudes, concepts, and ideas presented by these allies, we can start to envisage an approach. An approach that:

> Begins to center more reciprocal participation with materials that are situated within a specific context and landscape,
>
> Is routed in the physical and material experiences offered up,
>
> Is open and willing to survey and question materials, participants, technologies, and their implementations.

With this, we can start to assess and survey a context’s material provenance, question a modality’s role, and work to coalesce the two to create meaningfully situated interventions within a landscape.

# Chapter 2: Background

## On Provenance

### Emergence and Decline in Medicine Hat

Before getting into the physical work, it may be of use to provide a more detailed description of what precisely the material itself means to the people of Medicine Hat? A good starting point for this is to describe how exactly Medicine Hat emerged as a prominent center of ceramic production in the 20th century. This emergence was catalyzed three major events. The first was the arrival of the Canadian Pacific Railway in 1883, which resulted in the founding of Medicine hat and its connection to eastern markets (Fandrich 2019). The second was the discovery of clay, found in great variety and quality in the surrounding cliffs and valleys of the South Saskatchewan River. The third was the discovery of natural gas underneath the surrounding landscape. This trifecta, the natural gas, the high-quality clays, and the Canadian Pacific Railway made industry in Medicine hat an appealing venture (Medalta n.d.). The trifecta created what could be defined as an “intertwined flux of material and discursive forces,” mobilizing massive amounts of speculation-driven investment and interest in the town from all across North America (Iovino and Oppermann 2014, 3). Industrialists, capitalists, and technical specialists from Montreal, Chicago, Indianapolis, Texas, and many other places all flocked to Medicine Hat to verify the feasibility, quality, and the potential for ceramic production. It would not be hard to imagine “scouts from companies all over the continent bumping into each other on secret clay-testing missions” (Antonelli and Forbes 1978, 15-18).

Figure 17: Clay mine in southern Alberta (Medalta n.d).

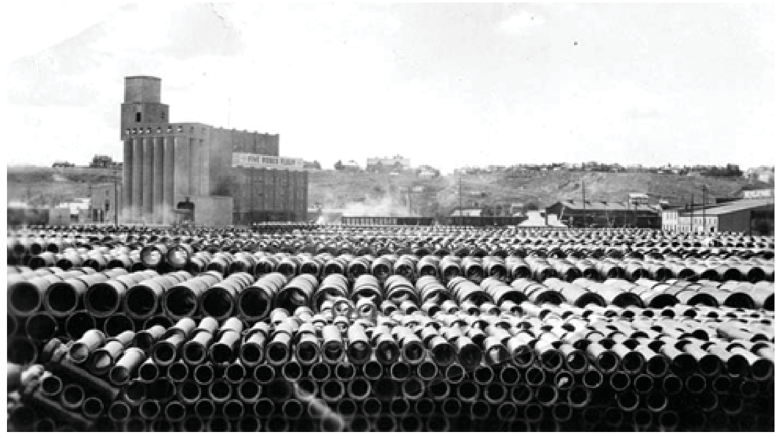

Figure 18: Ceramic sewer pipe stacked in train yards (Esplanade n.dc).

As soon as companies started to settle in, a further influx of labor, materials, and technology continued to flow into the city. And while matter moved into the city, it also moved out – in the form of bricks, pipes, tiles and pottery – in an incredible volume and at a great velocity. The variety of products produced in Medicine Hat, now transportable across North America, was met initially with such demand that the production ran at a speed where “bricks were shuttled hot from the kilns straight into the waiting boxcars,” and at such frequency that the “town’s two-horse fire brigade became accustomed to answering calls to put down fires in loaded boxcars” (Antonelli and Forbes 1978, 18). This exchange and flow of the brick, pipe, tile, and pottery produced in the city’s clay district, engaged a myriad of lives, provided livelihoods, built homes, created infrastructure, and populated domestic and commercial environments throughout North America. This territorial process underscores the agency of materials in the production of life.

Just as these materials generated a great velocity of flowing matter in and out the region, they also helped, directly and indirectly, drive the physical and cultural development of Medicine Hat and the surrounding towns of Redcliff and

Dunmore. An example of this would be when a man named Dr. Stoner, an investor from Minneapolis, came to the area to oversee the construction of a Brickyard in current day Redcliff. Stoner:

> set about building a town around his company – not just a town, but a major industrial centre [one he advertised as] the 'Smokeless Pittsburgh of Western Canada.' Stoner sank gas wells, furnished his townsite with water, and landed several more industries for the town while expanding his own. Stoner's Redcliff was going to be 'the Brick town of Alberta.' (Antonelli and Forbes 1978, 31)

Stoner, like many others, through working to capitalize on the available material, fuel, and infrastructure, physically drove the development of the surrounding fabric. And through the advertisement of work, accommodation, and amenities, an influx of families and individuals migrated into the area. Alberta clay "promised tremendous returns on investment to [those] who had money to invest and a steady livelihood to those [who] had only their muscle, common sense, and a willingness to work (Antonelli and Forbes 1978, 23). Directly, the materials had attracted industry, and by extension, set in motion the development and articulation of built fabrics in the area. The resultant massive migration of investors, technicians, workers, families, and other forms of industry to the Medicine Hat area, had massive consequences for the nature of the city and its landscape. Even from its initial inception in 1883, Medicine Hat started to quickly metamorphize in the early 1900s from "dusty prairie town to major industrial city" (Antonelli and Forbes 1978, 15-18). The clay also didn't just spur on the development of Medicine Hat and its surrounding environment; the raw material was extracted, processed, and transformed from the deposits lining the banks of the South Saskatchewan River into architectural products. Many of these products


Figure 19: Red Cliff Pressed Brick stockpile on loadup platform (Esplanade n.d.c).

were incorporated into many of the facades, structures, and chimneys that slowly started to populate the landscape. Much of the inner town of Medicine Hat and Redcliff is made up of brick buildings. This embedded material is also prominently found in the warehouses, production halls, and kilns that make up much of the historic clay district and surrounding industrial areas. In simpler terms, the proximity of the material agents and a motivation to mobilize it industriously, deeply embedded the material as one of cultural importance. The growth and development of the city would not have occurred at the speed it did if it were not for the material's ability to interact with participants moving into the landscape and vice versa.

Over the course of the century, these factories would develop, grow, change hands, change names, and eventually would have to close down operations in response to natural disasters and a failure to compete in various markets. Harvey Fix, a Ceramic Artist from Medicine Hat, remembers the industry fondly, underscoring the impact that these companies had on the lives of the individuals and families:

> When you lose your past, when you lose what created a viable income and livelihood for so many people, you've lost a major part of your history and your background. My dad came back from the war, he was wounded, and he came back in 44', hence my presence. And he worked building crates to ship the dishes and stuff out. The fact that he got a job here [at Medalta Potteries] and earned enough money to go to school in Calgary to take up his trade…. Medalta did it. (Fandrich 2019)

Even after the industries had gone and went, the potteries and brickyards' impact on the town continued to permeate. Harvey's own experience with some of the potteries continued as the closed down and abandoned yards created "private amusement grounds" for him and other children (Fandrich 2019). Harvey described these yards as "a good place to play, dangerous, but [he] didn't care, [as they] were just kids" (Fandrich 2019). People's distinct relationship to these materials within the Canadian context are ever-present and ever persistent. Working as powerful actors, the material in proximity, catalyzed the development of an intense and intricate meshwork of physical and semiotic relations, alliances, and self-organizing bodies. And while parts of this meshwork are no longer working as they once did, they are still deeply embedded.

For Medalta Potteries, Redcliff Pressed Brick, Hycroft China, Medicine Hat Brick and Tile, Alberta Clay Products, and many other potteries and brickyards, it was an unfortunate decline. Competition with new materials, like plastics and concrete, along with ceramic productions found in territories further afield, meant it was simply cheaper to supply products from elsewhere around the world (I-XL n.d. and Antonelli and Forbes 1978, 161). Pottery production continued until the late 1960s and transitioned into porcelain ware and toilet production under Hycroft as a last-ditch effort to stay afloat, which lasted until the 1980s. Brick and tile production continued into the early 2000s until its consolidation under I-XL, which later transitioned from a manufacturer to solely a distributor of masonry products in 2010. While I-XL is still in operation today and still holds land titles for many of the historic brickyards in Medicine Hat, all of their ceramic masonry products come from outside of Alberta, either from across the country or from south of the border. A once local approach to making, which was initially limited by the physical qualities of the material, was now unburdened by distance. The only remainder of the clay industry now (aside from the highly musealized remnants of the ceramic industry and the brick-dominated fabric of Medicine Hat) is Plainsmen Clay,

Figure 20: Workers loading kilns (Medalta n.d.).

a clay supplier extracting and suppling clay from mines located across North America. Nevertheless, “If you walk down the streets of Medicine Hat, just about every second person you meet will tell you he or she worked in the clay products industry or has a relative who did” (Antonelli and Forbes 1978, 7). Because of this memory, the silver lining that is the non-profit Medalta Society currently operates within the historic center. The society presently offers artist residencies, pottery lessons, and tourism-oriented program centered around a by-gone industry that is still very much present in the minds of’ Hatters.’

Figure 21: Mrs. Hoffman carting hollow tile, circa 1940 (Esplanade n.d.c).

Figure 22: Collage of brick buildings and industrial sites (Esplande n.d.a., n.d.b., n.d.c., and Fandrich 2015).

## Boundaries and Allies

Much of the production previously described occurred in Medicine Hat’s north flats. As a result, the flats now are brimming with a wealth of mineral materials, ranging from a wide variety of clays, aggregates, and other particulates. The area is bounded by the South Saskatchewan River to the North and the clay-caked river cliffs to the east. Today the area is home to a wealth of natural areas and parklands that intermesh and intermingle with the now musealized Medalta Potteries site to the West, and the I-XL Pipe Plant, and Alberta Brick and Tile Factory site to the south. Walking through the flats today, there exists a baffling amount of

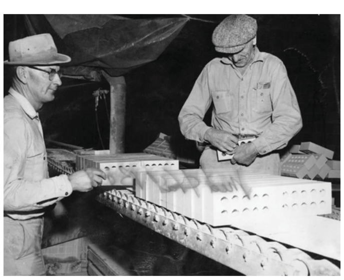

Figure 23: Worker picking brick (Esplanade n.d.c).

Figure 24: View of Alberta Brick and Tile Kilns (Medalta 2020).

Figure 25: Old rail cart line between Alberta Brick and Tile and Medalta Potteries sites.

ceramic detritus now intermingled and intertwined with the area's various natural areas, parklands, and industrial sites. These artefacts were, of course, formed from an incalculable amount of extracted material taken from clay pits adjacent to the Alberta Brick and Tile Site and other sites of clay extraction within the area. The raw material was processed, formed, and fired in the once-bustling industrial structures that still populate the landscape. What is leftover and thrown about in the North Flats only represents a fraction of the volume produced but represents an accumulation of skill, knowledge, and an appreciation for working with a material and its processes. As alluded to previously, the cultural embeddedness of the material and its processes becomes apparent as you would be hard-pressed to find someone who did not directly participate in the industry (Antonelli and Forbes 1978, 7). Things, materials, knowledge, and cultural artefacts have mounded here over the past 100 years. The area has accumulated a wealth of material, human, and non-human opportunities, hosts a wide variety of unique topologies and contexts, and is a host to a plethora of seasonal and natural processes. As such, the north flats bounded by the cliffs, the remaining potteries and brickyards, and the North Saskatchewan River will serve as an area of focus for the studies and interventions of this thesis to play out in – see Figure 27.

Additionally, the boundary is host to a wealth of allies invested in the material provenance, the material narrative, and the ceramic tradition – a network made up of community members, artists, craftspeople, a historical society, and industry partners. As mentioned previously, the Medalta Society, a historical society offers up programming related to the musealization of ceramic tradition within the area and

Figure 26: A variety of brick, tile, pipe, and pottery fragments recovered from Medicine Hat's north flats.


Figure 27: Site Map of the North Flats. Base layers from: (GIS Medicine Hat 2010, 2012a, & 2012b).

programming focused on developing innovation, learning, and continuation of the ceramic tradition for those looking to be involved with the material and its processes. Medalta has spent a lot of time organizing and providing workshops, classes, demonstrations, and residencies to community members and artists within the area and further afield. While the area was a host to a variety of functional, architectural, and infrastructural ceramic production outfits, the focus of the Medalta Society, for the most part, remains on the craft side. With the closure of the Alberta Brick and Tile Factory in 2013, I-XL Industries donated the site to the Medalta Society and have since expanded their programming, offering tours of the once-thriving brick factory. With Medalta's current programmatic focus, resources, community outreach, and expertise, it would not be a giant leap to suggest that a logical next step for the society would be to develop and fold in more architecturally focused education and programming. Especially considering adjacencies to academic institutions within the province that provide architectural and technology-based educational programs, such as the Southern Alberta Institute of Technology, University of Calgary, and Medicine Hat College. Whether through design-build opportunities, architectural workshops, and demonstrations, the Medalta Society is a potential ally for this work.

Overall, the area, its history, its accumulated material provenance centers clay and ceramics as culturally embedded materials. Within the fabric, there is not only the physical remnants of industry made up of scars, detritus, and the still plentiful mineral makeup of the north flats, but there also exists a wealth of knowledge, skill, and willingness to work with materials that are held dearly within the community. And while the work focuses on the potential

Figure 28-31: Various images of ceramic detritus within the landscape

Figure 32: Plateau banks laden with ceramic detritus, north of the old I-XL complex.

Figure 33, 34, and 35: Various panoramic views of the old pipe plant site near the northern-most plateau.

Figure 36: Mud Frontiers (Rael and San Fratello, 2019).

Figure 37: Mud Frontiers Kiln (Rael San Fratello, 2019).

Figure 38: Polymorf Bricks. (Polymorf, n.d.)

for coalescing printing processes, the area hosts a plethora of material, human and non-human participants that could potentially help facilitate, contribute, and drive the work.

## On Printing

### Introductions to Printing with Clay

Additionally, it may also help to provide a more detailed description of printing processes before getting into the physical work. Where traditional manufacturing processes typically skew towards subtractive means, 3D printing works as an additive modality. Most 3d printing technologies and tools typically operate in similar ways, where "material is extruded, while the tool controls the axial directions, building the [artefact] in successive layers" (Stevens and Nelson 2015, 47). While printing technologies originally emerged in resin and plastic based forms, the technology has rapidly been adapted to print with clay, concrete, and other ceramic and biobased materials over the past decade. This adaptation can be categorized as Liquid Deposition Modeling or LDM for short. Printing as a form of making typically involves three distinct aspects: the first being the digital, which relates to the design and translation of digital abstractions and their associated instructions. The second is centered around the material properties and variables. Specifically, how the material acts and how it has to be treated and prepared. And the last aspect typically deals with the mechanical configurations and variables of the printer itself – its physical limitations, potentials, and systems.

On the digital side of things, the typical process for LDM or paste extrusion is relatively linear. First, the designer develops and models geometries in digital space, which can be done with various software utilized in architectural practice (ranging from Solid Works, Blender, Rhino & Grasshopper, 3ds Max, and many others). Once the model is ready for printing, it is exported as an .STL or Stereolithography file, and then brought into a slicing software (Cura, Repetier Host, etc.). The slicing software allows the specific printing settings and requirements to be set and the geometry to be sliced into layers. Finally, the slicing software outputs G-code, a set of digital instructions, flow rates, movement speeds, and coordinates that the printer uses to execute the work. This G-code can then be sent to the printer, where it will be translated layer by layer into a physical object. This is very much the typical process for translating digital designs into physical objects via printing. Still, there are a variety of different paths that can be taken to get to this point. Some artists and architects utilizing printing may opt to utilize programs that are compatible with syntax languages like python or C# – allowing them both to model and export G-code through scripting. Others generate G-code through slicing programs and then alter or augment the code through syntax-based languages. The workflow used within this body of work typically consists of utilizing Grasshopper to generate geometry and associated spatial coordinates sets that could be exported to Microsoft Visual Studio where it could be translated into G-code. Rather than relying on slicing programs, this workflow allows for more control over the code and the resultant material fidelity and topology of the artefacts produced.

The other side of printing involves a fair amount of understanding and control around the printing medium and materials being used. Printing with clay can be a complex affair, as you are not working with just a raw material, but rather a composite material, made up of a variety of clays,

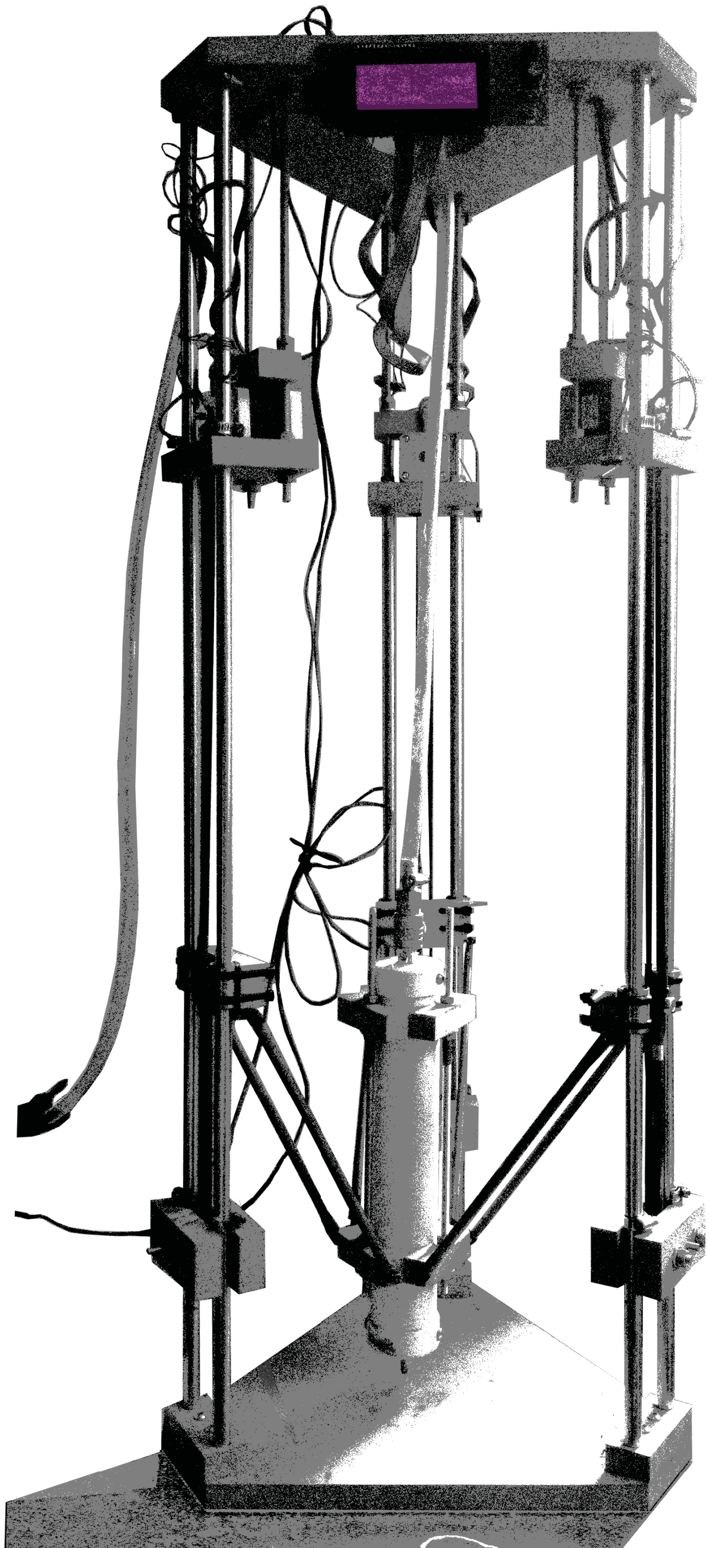

Figure 39: DIY Delta Type Printer.

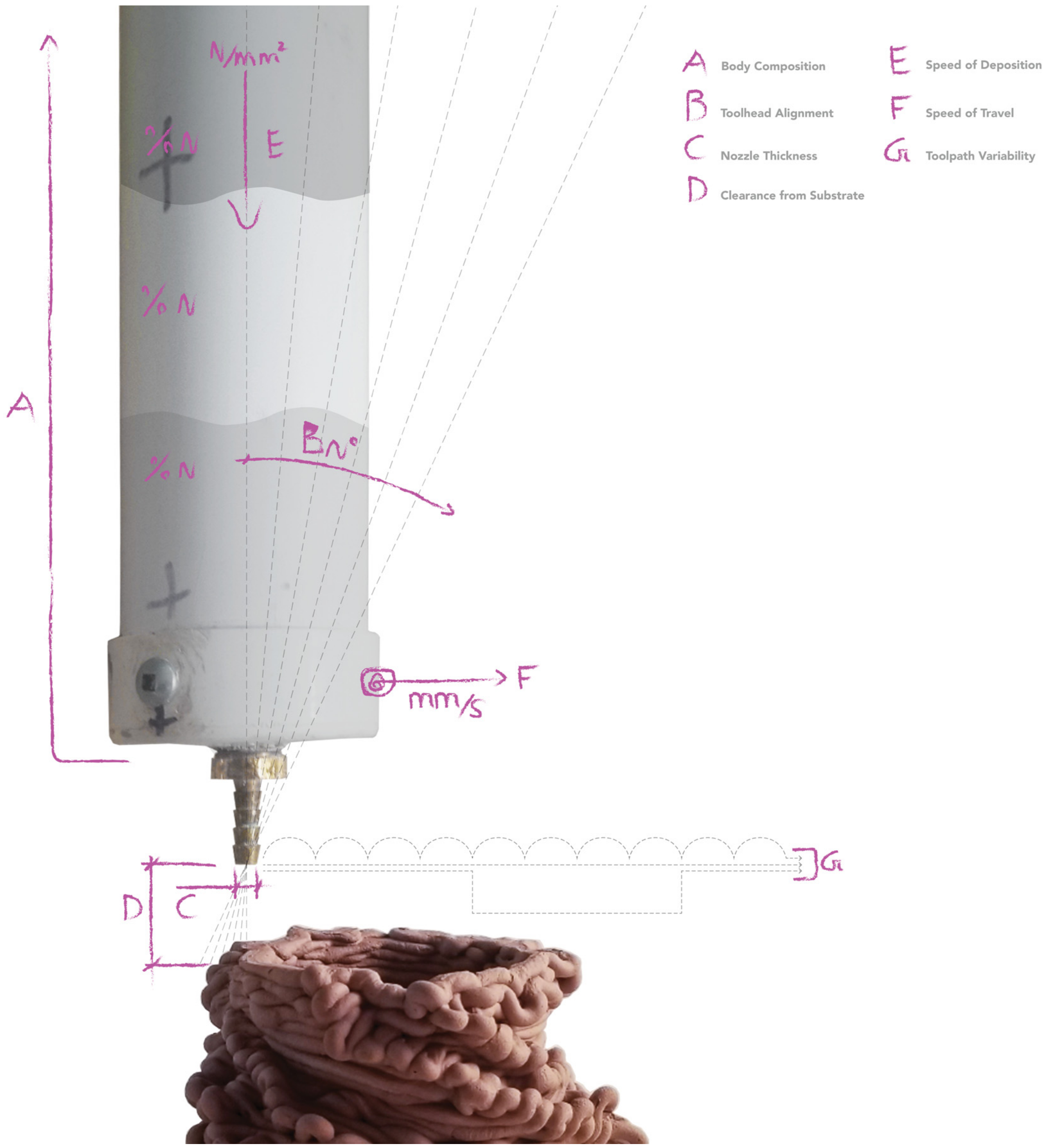


Figure 40: This drawing breaks down key variables that were wrestled and played with in planning out, preparing, and printing the work.

fluxes (additives that control the energy required when firing), tempers (aggregate and particulate that control drying and shrinkage) and any other number of additives. The composition of a clay body has a drastic impact on the rheological properties of the body (i.e., how it flows), the plastic qualities of the body (how well it can be morphed and shaped), and how well the material responds to humidity, drying, and or firing. A clay body with less water content may require a printer to have a feed system and tool head that can deliver and hold up to increased mechanical or pneumatic pressure used in the deposition of the material. Similarly, more water content may require less delivery pressure but may require increased speeds in printer movements. Or a clay body with larger particulate, temper, and or aggregates may require large nozzles to prevent blockage and blowout. Each of the materials variables relates to how things are set up digitally; for example, flow rate, printer speed, and layer height directly correspond to the material's pliability and deposited thickness. These are variables that directly relate to the material's rheological properties. So, the digital variables typically tend to have a one-to-one relationship to the material variables – but there is always room and flexibility for ample adjustments and iteration on either side.

The printer as a tool itself, while they come in many varieties, typically consists of:

> an armature - the structural frame that supports and hosts most of the printers' systems. The size of this armature determines the print volume or the maximum volume in which the tool head can deposit material.

a mechanical system hosted on the armature that is used to move the tool head around. This system typically consists of a variety of bearings, motors, belts, and other mechanical components.

The tool head – Which typically consists of a nozzle used to deliver and deposit material connected to the feed system in one manner or another.

A feed system - In some cases, this can be a mechanical auger-based system that mechanically deposits material. In most cases, especially when dealing with larger printers and projects, a continuous flow or pneumatic system pushes the material through the tool head via air pressure.

And lastly, an electrical system, which conveys and controls the digital instructions, power, and movement of both the mechanical and feed systems. This system consists of various electronic boards, end stops, visual displays, and power converters.

While there are various printer types on the market, coming in all shapes and sizes, it is helpful to understand the printer's component parts as they set and determine the physical limitations of what can be printed and how things can be printed. For example, some system configurations may limit print volume but may optimize controls over the material deposition. In contrast, other printers may be configured vice versa. Regardless, the physical limitations set by the printer, more often than not, impact both the physical preparation of the material (I.e., its rheology, composition, flow rates, etc.) and the digital preparation of the model and its corresponding instruction sets (Layer heights, flow rates, printer speeds). Once the printer's limitations are understood, along with material and the digital workflows, it becomes easier to play, manipulate, test, and hack different elements and variables that exist in the digital, the material, and mechanical (the printer as a system) realms.

Today, artistic, craft and architectural-based practices are increasingly adopting printing into their workflows and processes. Some may utilize fused deposition modeling (FDM) or plastic-based printing to rapidly prototype and test products or design concepts. Others may introduce resin-based printing to create parts and negatives for molding and translating actual designed objects. But more so, over the past few years, there has been an uptake in LDM printing both within architectural, craft, and artistic practices involved with clay, ceramics, and earthen workflows. This specific approach has been adopted at a wide variety of scales and within various projects. From projects like “Mud Frontiers” by Rael San Fratello that utilized printers to articulate full-scale adobe structures and kilns, to “Woven Structures” by Polymorf, which uses printers to explore high fidelity surface articulated bricks and vaults (Rael and San Fratello 2019, and Polymorf n.d.). What is of most interest is that while additive manufacturing methods have typically been explored within highly controlled environments, now there is a growing trend towards in-situ applications. A big proponent of this sort of production workflow would be WASP, a company that centers 3d-printing as a production strategy in hopes of “building ‘zero-mile homes” (WASP n.d.). Creative bodies like WASP, Rael San Fratello, and many others see 3d printing as an opportunity to move towards some sort of material, cultural and environmental attunement. And growing DIY communities have allowed individuals to readily access craft and knowledge, work in place and allow for rapid dialogue with the material, its fidelity, and its corresponding assemblies. The applications of this sort of additive process, whereby physically taking the technology to place, could allow designers and makers alike to directly engage with the material immanence and provenance of a given place. And through these applications, makers can embed highly articulate social and ecological material expressions, develop meaningful programmable composites and assemblies, and circulate and cycle material and technology effectively within a given system.

## Working on a Spectrum

While printing itself requires its own set of skills and knowledge, there need to be clear ways to assess the modality in relation to our own limitations, flexibilities, and our understandings of how we work with them in relation to craft. Printing as a way of making can often be thought of as a polarizing modality. Sennett suggests that culturally we are still struggling to understand our own limits and abilities compared to the mechanical (i.e., machines and robotics) and that “socially we are struggling with anti-technologism” within relation to craft (Sennett 2008, 83-84). Regarding printing, there is some truth to this in that because of significant misconceptions around what 3d printing entails, there is a fear that tradition, skill, and the qualities, subtleties, and imperfections that we associate and value with craft will be lost (Keep 2019, 18). And additionally, there is a Ruskinian-type fear that machines and robotics, like printers, will limit our ability to participate, and direct craft and design. And it does not help that at the other end of the discourse, there is a tendency to frame the technology and the modality in somewhat naive terms. Often the modality is touted as ‘a world-saving way of working, where production hierarchies can be flipped, mass customization can occur, and zero-mile diets can be achieved. Overall, on either side of the discourse, there is a tendency to get caught up in the technology, and often people miss the point that a 3d-printer is simply a tool (Keep 2019, 21). The printer has its own limitations and opportunities similar to most tools, and it is the context and methods in which the printer is used that determines the quality of the artefact, architecture, or intervention. Like most things in life, printing doesn't exist in a good vs. evil dialect between handmade and machine-made artefacts. The modality quite literally exists on a spectrum. In recognizing and thinking through this, there are potentially other ways of understanding ourselves in relation to our tools, approaches, and materials.

While the dichotomy of handmade vs. machine-made is very much prevalent in contemporary craft and printing discourses, it may not be the best way to ascribe value or develop an understanding of our own limitations in relation to craft. As alluded to previously, there is typically an attribution of handicraft 'as a "workmanship of the better sort," while 'machine made' things are given less stock (Pye 1978,15). But how do you qualify what is handmade versus what is not? And does this dichotomy actually tell us anything about the quality, attitude, and intention behind our artefacts and architecture? And more importantly, does this dichotomy tell anything about the relationship between the maker, the material, and the environment? Pye argues that most things, at least within the last thousand years, have had some form of technology, tool, or machine assist in some aspect of the production, with outliers being limited to forms of hand-coiled pottery and hand-woven basketry (Pye 1978, 19). And by only ascribing socio-cultural value to the handmade writes off “every kind of drill, lathe, plane” saw, wheel, and mill that has assisted in these various processes (Pye 1978, 20). Additionally, handmade vs. machine-made does not tell us much about the qualities of the product or the environment it was produced in. A handmade tile or brick could come from a far away context, where the direction and intention for the material outcomes are not held by the craftsperson but by a floor manager who relies on cheap labour and the notion that matter is an inert subservient commodity. Additionally, the brick and tile could just as easily come from a brick plant that utilizes robotics to pump out these artefacts in mass quantities. In a similar respect, the term ‘machine made’ fails to tell us much of anything as well. If we consider printed artefacts, while they can be produced in highly controlled environments and under absolute tolerances, they can also be explored creatively and in relation to specific contexts – more so with focuses on interesting material outcomes, rather than focusing on the consistency, performance, and quantity being produced. This handmade vs. machine-made dichotomy tells us even less about intentions, qualities, and the dynamics of material engagement. So handmade vs. machine-made is not a very good way of ascribing value to a specific operation or series of operations within building and making.

Pye offers his metric for ascribing value which centers around Workmanship of Risk vs. Workmanship of Certainty. The logic behind these two polar ends is that craft can either have a degree of certainty in which the quality of outcomes of a specific operation or an entire set of procedures, is to one degree or another, certain. In contrast, risk stands for the degree to which the material or object within a specific operation or set of operations can either be ruined or altered through undergoing said process. So, in a sense, an "operative, applying workmanship of certainty, cannot spoil the job [whereas an operative] using workmanship of risk assisted by no matter what machine-tools and jigs, can do so at almost any" moment (Pye 1978,17). We could attempt to understand our relationship to craft with Pye's Workmanship of Risk vs. Workmanship of Certainty, rather than focusing on whether things are handmade or machine-made or purely obsessing over the technology. However, this definition only goes so far. Risk does not necessarily ensure quality, nor does Workmanship of Certainty mean that things are produced in mass at poor qualities. Additionally, the terms do not necessarily hint at the level of skill a craftsperson has, the quality the object is meant to take on, nor does it fully render whether things are achieved through somatic or extra-somatic means. For example, depending on the setup of the process, there is inherently a lot more risk involved in 3d-printing a brick over simply moulding a brick with wood moulds, as each successive addition of printed material bears down and could ruin preceding layers. In contrast, the shape and quality of the mould ensures a more certain outcome. The previous statement could easily be flipped depending on the context and relationships between maker, material, and environment.

Additionally, in trying to understand ourselves in relation to craft, material, and technology, it may also help to understand the conditions and relationships held between the maker, the material, the tools, and the environment. Is the printing of an architectural structure conducted within an environment that centers systems of skilled constraint? Where the quality and output of the artefact is reflexively determined by the makers on volitions, actions, and responsiveness? Or is it a system of deterministic control? Where the intention, responses, and actions are pre-determined and controlled. Ingold builds on Pye's notions of Risk and Certainty by considering exactly where the primary drivers, decisions, actions, and responses come from. What is the intention and volition driving the making processes? How is the work being applied? and what forms of constraint and skill are being utilized throughout the operation? (Ingold 2000, 301-303) Is the motivation and volition behind the specifications and requirements of, let's say, a brick, pre-determined hierarchically and unchangeable throughout production; or are the specifications malleable and responsive to both the craftsperson, their environment and their material? Is the brick made with absolute tolerances through mechanically driven presses or pugmills? Or are they formed by the skilled constraint of the brickmaker?

Further to this, these aspects of making are not rigid dichotomies. The making of a component can potentially exist at various points along a spectrum of skilled constraint and determinate motions (Ingold 2000, 306). Depending on the specific approaches, tools, and gestures adopted in making a brick, or the printing of an architectural component, differing gestures, tools, and modalities can be sequenced, overlapped, or overlayed. An example of this, of course, would be the mould maker who works in tandem in both systems. The table saw the mould maker uses to cut the wood for brick moulds requires little interaction, besides understanding how to turn on the machine, orient the blade, and set the saw in motion (there are, of course, other aspects outside of this specific process related to maintenance and safety). The table saw, with certainty, will otherwise cut straight, but where the skill and constraint come in is where the operator measures, marks, feeds, and cuts the material with the saw, as well as the operator's responsiveness to how the saw meets the material. A similar dynamic occurs when the brickmaker pushes clay into a brick mold, just as it occurs when an operator regulates air pressure that is used to feed clay through a printer. Ingold would describe these as half-chain steps of a process meeting up to form a whole operation (Ingold 2000, 306). These, of course, are just singular hybridized step in the processes of making, and "It is important to recognize such compound systems for what they are, since even the total automation of one part" of a component or process "need not in any way reduce" the animate relationship between human, non-human and the environs that articulate material outcomes (Ingold 2000, 306).

With this, we can start to not only organize modalities in relation to one another along a spectrum of risk v. certainty and control v. constraint, but we can also plot modalities themselves along this spectrum. Printing can be plotted in relation to brickmaking but can also be broken down and subcategorized in a way that allows the modality to exist along a portion of this spectrum rather than at a singular point. Thinking through this spectrum enables us to approach or tools in a less rigid manner, allowing us to focus more on how the tools can be utilized in relation to our goals, ideas, and materials, rather than strictly silo-ing modalities into specific roles. Printers can be used normatively, but this spectrum opens up the modality to the potential to be misused, to be hacked, to be reconfigured and reorganized. The printer can be used solely to translate digital abstraction into physical form, or it can be reconfigured to be performed by hand or in conjunction with somatic processes. This extends the printing modality to consider a wide range of varying skill levels, intelligences, and knowledges. With this, we can start to think through versions of printing that aren't inaccessible; that aren't fully mechanized (even though the processes typically aren't already), and the corresponding outputs aren't necessarily devoid of risk and the subtle imperfections that we cherish in our materials. And if we apply the right lens to approach printing through, we can start to work towards material gestures that coalesce and integrate printing modalities that consider a context's embedded knowledge, material wealth, narrative, and landscape.

# Chapter 3: A Mounding Methodology

## Printing as Mounding?

As discussed in the previous chapter, printing can often be a polarizing modality with respect to craftwork and architecture. But with most things, the modality's relationship to materials and to operators, are not necessarily as rigid as the polarizing voices within the discourse would suggest. Things occur along spectrums, and with the right lens, we can start to approach the work in new and meaningful ways. When initially starting out with printing, the work skewed towards leveraging material characteristics through pre-coded and predetermined moves. But the more I worked with printing, the more I questioned how it could be, not so much as a predetermined and controlled process but more so a performative and embodied task. If we start to think of printing in terms of Mounding, it opens up a new lens to approach the modalities, materials, operators, participants, and contexts. As such, it might be helpful to go through the critical characteristics of Mounding.

Mounds are open to different processes and participants – Ingold would describe the mound as a thing that "welcomes us in, as participants in its mounding, whereas the monument [or the edifice] shuts us out" (Ingold 2013, 83). Mounds are built up by the accretion of many different processes – humans discarding waste or moving earth, particulate accumulating via wind and water, and through the breakdown, decomposition and build-up of organic matter over time. If we think of printing like this, we can start to open up the modality, its approaches, and its associated technology to different ways of working or printing, to different modalities or methods of making, and to different

Figure 41: Ceramic strata deposited in between layers of clay, earth, stone and organic matter.

Figure 42: Ceramic strata deposited in between layers of clay, earth, stone and organic matter. Annotated to highlight layers and differing material processes.

materials, participants, gestures and processes. We can expand the spectrum of what printing is – opening up the process so it can cater to different knowledges, intelligences, skill levels, and participants. Printing can be carried out by machine with digitally transcribed instructions or carried out somatically constrained by hand or any mixture in between. Hand coiling, cob, and bricklaying all can be folded into the printing process, engaging various skill levels and accrued knowledge held by a variety of craftspeople. Wind, water, rain, sleet, and snow can participate as much in the process as does clay being deposited and placed by human hands. Through mounding, printing can become indiscriminately open – holding various points of entry into the work.

Mounds are also not fixed to the landscape but are part of it, as “today’s deposit becomes tomorrow’ substrate, buried under later sediment” (Ingold 2013, 77). All of the varying adjacent, overlapping, and co-planar forces that make the mound continually shuffle and reconfigure material. Clay is buried under plant matter, and plant matter is buried under ceramic detritus, later to be buried under new layers of refuse, particulate, or artefacts. There is a continually folding in on itself, where layers continually build up and bury previous layers – constantly shifting and blurring the intersection between mound and landscape. What can be drawn by this is that if we think of printing through the lens of mounding, we can look to the material, participants, and processes that exist underfoot and at hand as integral to the process. We can use local materials with small energetic diets as the medium through which mounding occurs. We can respond to local conditions, topology, weather, and processes. And lastly, we can look to engage those nearby and willing to participate. All materials, tools, participants, and forces can be leveraged and mobilized to shape and form interventions within the landscape continually over time.

And last but not least, mounds are rooted in context and continuum; they are never complete as “One can always carry on adding new material (Ingold 2013, 76). So, just as mounding can occur over periods of time, forming differing relationships with its adjacent context, so can printing. Additionally, mounds as things, hold “intrinsic connections” to landscape (Ingold 2013, 82). And because mounding is literally land being shaped continually overtime, at the whim of various processes, programs, and events, we can try to think of things we make through printing in this way. While mounds support a broad range of processes and events for both humans and non-humans, a mound’s function can easily shift throughout time. For example, functions may shift from simple mounds that orient people within the landscape to mounds that support programmatic rituals, or mounds that act as simple piles of refuse, that later are transformed into sites of rich archaeological survey. If we think of printing in this lens, it will only be in relation to the things we make within the printing process and what we can additionally and successively add onto or change over time.

If we think in terms of mounding when we print, we can open up the approaches to varying and complex sets of relationships that can guide the work in meaningful ways. Through mounding, printing, if open to other topologies, materials, processes, and modalities, becomes something that facilitates not only other modalities, such as bricklayers or potters, but also becomes a pivot point that links and responds to a variety of different, ordered, and overlapping processes. The operator doesn’t just have to operate the printer and supervise the print anymore, but now has to respond to physical forces and processes carried out by non-humans, and interruptions and interventions created by other makers, craft persons, and participants. A bricklayer may lay a course of bricks over a printed substrate, which the operator of the printer will eventually have to respond to. To sum it up, through mounding, the process becomes an interwoven and intermingling set of relationships, all pushing and pulling, attempting to respond and communicate to the impact that other dynamics create. The work becomes an interwoven meshwork of relationships, with different processes pushing and pulling different fibers and strings into place (Ingold 2012, 435)

## A Mounding Method

When we think of printing in terms of mounding, we are opening up the making process to intra and inter-actions between participants - whether those be landscape, environmental forces, materials, non-humans, or humans. But how do we attempt to incorporate, combine, and coalesce these players? How do we formally organize processes of experiencing and participating with material and its correspondent landscape? In tackling this, we can start off with the notion of the Motor Schema – which "is not a mental image of an end product or a drawing but [is] a series of actions we know by heart" – a series that has both a rhythm as much as an order (Spuybroek 2011, 62). Whether it's writing letters, writing G-code or laying bricks, each operation has a set of fundamental actions that require a participant to undertake as a prerequisite for performance. Fundamentally we utilize motor schemas to carry out broad ranges of tasks and operations when approaching work. With printing, there are schemas for filling canisters, writing

G-code, and moderating air pressure, much the same as there are various operations in making brick from mixing, to forming, to firing. Each action or performance in itself makes up a motor schema, but when chained together with multiple processes, they make up larger schemas or sets. Another critical attribute of Spuybroek's notion of the Motor Schema is that they can vary, mutate, and shift the potential outcome (Spuybroek 2011, 62). Spuybroek attributes the motor schema as something like a code or a script where various inputs and actions are informed by preceding actions and subsequently inform succeeding actions (Spuybroek 2011, 62). So, in the act of writing a word, the motor schema used to form the 'a' may alter to produce 'd's, 'u's, and 'p's throughout the process (Spuybroek 2011, 62). These characteristics, mutations, variations, orders, and rhythms can be applied to the printing process. A multitude of actions can be chained, organized, overlapped, and continually reconfigured to produce a material gesture. Printing over a pile of detritus, or corbelling spans of bricks between mounds, constitutes a series of action sets, where each preceding action informs the outcome of the next.

Something that additionally can be incorporated into the methodology is the idea of prompting, which borrows both from Richard Serra's famous 'Verb List' and Christopher Alexander's, A Pattern Language. For Serra, his verb list gave "subtext" for experimentation with materials – providing an interpretable point for guidance that could facilitate "forms that refer back to [their] own making" (Delehanty n.d.). In the mounding methodology, prompts similarly can provide interpretable and subjective sub-text for carrying out the work. Prompts can also be added to scores to provide rough guidance for performing and executing different operations within the work. Additionally, Alexander offers up ‘A Pattern Language,’ which provides a syntactic language that describes spatial features. The language can be used simply to string together spatial patterns that make up a building. Alexander also proposes a more meaningful application where “it is possible to put patterns together in such a way that many patterns overlap in the same physical space,” making very dense and potentially emergent spaces (Alexander 1977, 42-44). A series of prompts or ‘patterns’ can be utilized as a method within the process to facilitate dense spatial material experiences through providing a set of overlapping, corresponding, and succeeding forms of subtext that guide and inform the various modalities tool paths and operations. This subtext is meant to introduce subjective and interpretable instructions, which intend both to bring forward emergent responses within the work and leverage the ‘small agencies’ that a variety of different materials can bring to the process. Simply prompting the word ‘stone’ brings the material and its agency into the work. But still, it is up to the participant to choose how to implement the material within the work, as well as how to respond to preceding and succeeding layers. Building on these ideas, the methodology utilizes a variety of prompt types that includes:

> Contextual Prompts – This introduces complex topologies and contexts to the making process.

> Programmatic Prompts - These provide programmatic ideas that work to articulate not only ideas around the specific spatial elements of an intervention but also the specific operations and material experiences that are embedded within the spatial elements.

Verb Prompts – These are meant to introduce subjective and interpretable ideas that can be infused into specific activities and processes.

Material Prompts – This Introduce new varieties of materials within the process.

Grammar Prompts – These introduce specific actions and interruptions within differing operations and modalities.

In organizing these actions, prompts, gestures, modalities, and operations, Anna and Lawrence Halprins' work regarding scoring and the RSVP cycle provides a good precedent for developing an organizational method. The Halprins' 'Take Part' or 'RSVP Cycle' process is comprised of four distinct parts. The R of RSVP, in essence, is a resource gathering exercise, that for the Halprins, was meant to determine participants and the environments that would make up the microcosm in which the participatory processes would play out (Hirsch 2014, 187-188). In Mounding processes, this can be borrowed and modified as a stage in which careful surveying, inventory, and selection of participants, making up various materials, forces, tools, topologies processes, humans and non-humans, can be selected to take part in the work. The S of the RSVP makes up the scoring process, where through specific forms of annotations, a framework of experiences is sequenced for participants to undertake (Hirsch 2014, 187-188). While the Halprins would often sequence, stage, and frame the specific routes and environments that participants would move through, this can be modified to order and sequence different modalities, approaches, materials, and other elements available for the articulation and formulation of material architecture and gestures. V stands for valuaction, a session or period of time that the Halprins would use to facilitate communication between the workshop's participants – insights and information gained from these shared experiences and discussions could be used to evaluate not only the scores but address underlying assumptions and inform future scores, workshops, and even architecture (Hirsch 2014, 187-188). With printing, this could be modified into a continual process in which scores are constantly evaluated and adjusted based on the outcomes of preceding layers and the conditions, topologies, and situations that the next score or portion of the score has to negotiate. This could work from layer to layer, from element to element, and from project to project, reflecting a natural back and forth between how the tools and users inform and react to the materials and vice versa. P simply stands for the performance of the work or the score (Hirsch 2014, 187-188). For the Halprins, this would constitute the carrying out of the workshops. In the context of printing and mounding, it is the performance and choreography of people, tools, machines, and materials that both well up from the earth and accumulate in place to provide substrate for succeeding layers. The borrowed elements from the Halprins' RSVP cycle facilitates a specific framework that allows for operations, materials, people, and many other variables to be sequenced, overlapped, and coalesced.

Putting together scores of prompts, modalities and gestures puts together a flexible and fluid framework that is interpretable, subjective, and reactive to different participants - opening up the process as a performance that has the potential to work with and craft within a specific fabric or landscape. This methodology takes advantage of the idea that while machines can work autonomously, they can also, in fact, work semi-autonomously; they can be interrupted, overlapped, misused, hacked, and re-worked to produce new outcomes. Thus, the work becomes as reliant on the tools and machines as it is on the user and the material. Regarding the tools and machines, understanding their parameters, limitations, and variables allow for iteration and testing of the tool's flexibility and potential. Additionally, This process heavily relies on the material and leverages the clay bodies' intrinsic and rheological properties. Depending on the clay body's composition, it can be incredibly forgiving. Clay will settle, it will push and pull, it can be displaced but also pushed into place. So, whether the printer can run along a course of bricks, or an individual can hand-print along a pile of detritus, regardless, clay will intra and interact within this context in an incredibly forgiving way. Lastly, this process relies on the interpretation, volitions, values, and approaches of the users, participants, and operators. From person to person, the interpretability of the score and the corresponding outcomes relies on how a mason could interpret and react to courses of cob or printed beads. Regardless, this methodology starts to align printing with Mounding as a more embodied, emergent and fluid process.

# Chapter 4: Printing Provenance

## Printing Studies

### The Pre-Study

Initially, when the work started to utilize printing, the focus began with articulating the material gesture through G-code, which of course made any sort of emergent gesture or feedback reliant on the material or malfunction brought on by the machine (i.e., pressure blow-out, or the printer slipping off the tracks). The first two series focused on weaving patterns and articulating zones in the surface of the artefact. This was carried out through simple scripts which pulled and offset coordinate points from their origins on the surface of the digital artefact. With these scripts, there was almost limitless customization and variation in the outcome. And while the scripting took advantage of physical forces and the mechanical properties of the material, specifically gravity and the material's willingness to settle, drop and act in a plastic manner, the variation was almost entirely in response to the pre-determined code. Controlling the pattern, the offset, and the magnitude of the offset allowed the clay to drop, fall off and settle, but the outcomes became more or less predictable.  In terms of risk vs. certainty and control vs. constraint, the material outcomes skewed in the more certain and more controlled direction. They were a direct result of a digital to physical translation brought on by the printer. While the printer I was using relied on certain somatic control such a modulating air pressure, application of drying tools, and the odd physical correction (i.e., pushing and pulling at the sample when or if it moved off course), the studies skewed towards the more absolute. There is also nothing necessarily wrong with these more

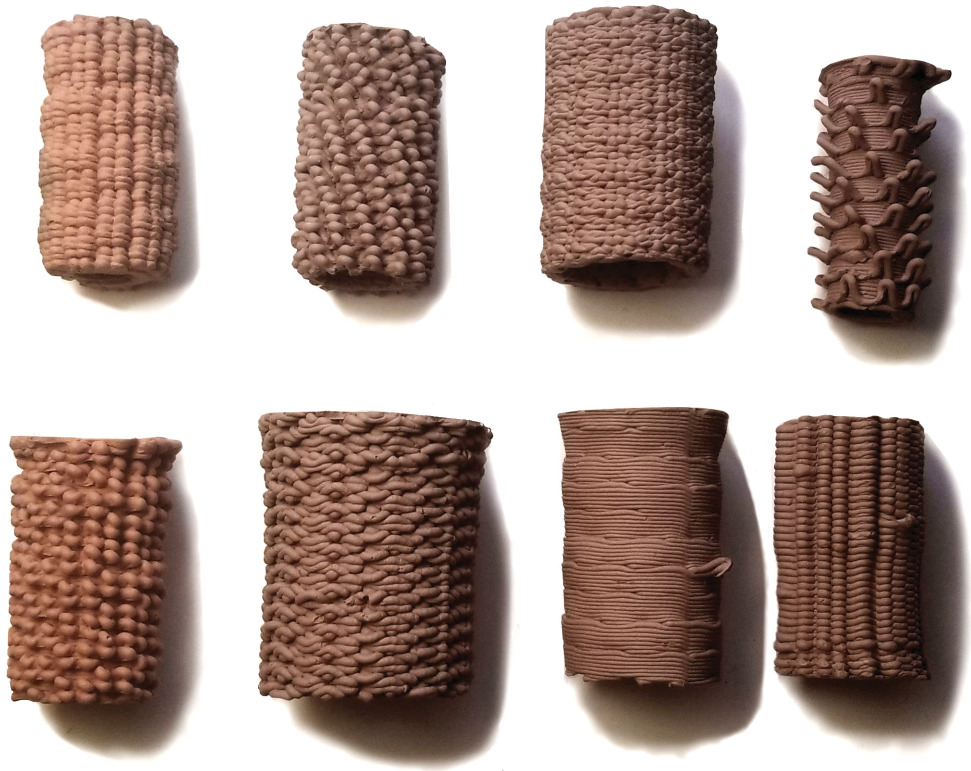

Figure 43: Vessel series exploring surface articulation through manipulation of .gcode.

Figure 44: Collage of surface patterned bricks. Patterning made through manipulating .gcode.

pre-determined and pre-coded samples, as many of them explore and develop material strategies that can fold into the Mounding process. Some artefacts explore strategies such as providing substrate for growth or tactile surfaces. Others explore strategies for increasing mass and structural stability through weaving, and a few artefacts look at strategies for developing porosity and material densities.

Figure 45: Close up of interrupted vessels stacked. Surface articulated through air modulation and physical interruptions.

Regardless, the more printing that was undertaken, the more the question of how printing could be conducted, not so much as a pre-determined event, but more so a performative and embodied process started to pop up. Initially, assessing how more performative gestures could be introduced into the printing process brought forward three distinct types of interruptions: 1) stopping and starting; 2) modulation of air pressure; and 3) placement of different materials. The first interruption was a stopping and starting of air pressure at intervals while the machine was still carrying out its motions.  While preceding layers could be made cleanly and consistently, the pause in air pressure would create a situation where the clay body could self-assemble and settle over preceding layers. Typically, the printer would carry out its motions – moving up from layer to layer, and this would increase the distance between the nozzle and substrate that newly deposited material would have to negotiate. Regardless, over time, the deposited clay tended to self-correct as long as the distance between substrate and nozzle was within a certain degree. The material's nozzle diameter and flow rate also allowed this distance to be made up through faster, higher volume deposition. Depending on the clay body's composition and moisture content, the clay would loop and settle as the crystalline platelets that made up the clay bodies would readjust and repack in response to the pressures being applied to the material. Generally, the greater the distance, the more chaotic and woven the deposition becomes, and similarly, the more settling will have to occur for the clay to eventually self-correct for succeeding layers.

The second interruption was a modulation of air pressure. While the first iteration was a starting and stopping, this interruption involved increasing or decreasing the pressure, which directly affected the deposition rate. Throughout the print, the forces applied could control the thickness of the bead, affect the pliability between layers, and by extension, control the artefact's topology. While the previous patterned studies involved pre-determined coding to create surface patterns, modulation of air pressure was a simple way to control the surface pattern of the artefact somatically. Generally, the first interruption and the second interruption go hand in hand as an increase in air pressure after a pause would decrease the time required for the bead to self-correct. This resulted in more material being deposited. A similar inverse relationship between self-correction and a decrease in air pressure also occurred.

Finally, the last interruption that made up this series involved the physical introduction and placement of differing materials. String, toothpicks, and other burnout material could be placed directly in the path of the print head. Generally, this either involved a pause to allow for placement or involved pushing the material into the artefact during the printing process. In the first scenario, this required the material to settle around the obstruction; in the second scenario, the interruptions resulted in the displacement of material. These interruptions held a direct impact on the surface topology, wall thickness, and variation between artefacts. This

Figure 46: View of interrupted vessels stacked. Surface articulated through air modulation and physical interruptions.

generally also could introduce differing levels of porosity in the walls of the artefacts as obstructions could carefully be removed after drying or could be burned out if the artefact is fired.

With these different types of interruptions, levels of constraint, somatic control, levels of risk, and uncertainty were introduced into the process. The introduction of these different types of outcomes drove increased levels of uncertainty and emergence in the outcomes of the material gestures. At the same time, these gestures also increase the amount of risk required in forming these artefacts, as an increase in air pressure, creating too great a distance between the substrate and the tool head, or introducing other materials generally increases the risk for failure. As a result, this requires far more attentiveness of the operator, as they have to physically read and react to the material throughout the course of the print. Pressure can be increased or decreased as needed, prints can be paused to allow for drying, and many other forms of reactions can be conducted in order to carry out, adjust, fix, or save a print from failure. This is also reflective of one part of the process, and preceding attentiveness to mixing the clay bodies and succeeding attention to drying and firing of the clay bodies require differing degrees of reaction and responsiveness. While these studies are not directly connected to the context in which the thesis takes place, these studies served as a departure point that focused and guided the subsequent studies. They prove that machines can be interrupted, misused, hacked, and worked with. And that printing does not have to exist as a process of absolutes, but more so can work on a spectrum of control, risk, certainty, and constraint.

## Vessel Studies

Figure 47: Machine coiled and hand coiled vessel.

Figure 48: Hand printed and hand coiled vessel.

Figure 49: Pattern encoded vessel made with an interrupted machine.

Following the pattern studies, the work started to question how differing skill levels, types of printing modalities, and materials could be incorporated and coalesced into the printing process. In moving to explore this, the vessel as a component of exploration came into play – as it allowed for consistent and straightforward studies to be conducted at a slightly larger scale than the preceding pattern studies. The first vessels that emerged mainly focused on different intelligences and modes of working. For example, the cup shown in Figure 47, was made with differing printing modalities. The vessel first started with a machine coiled component and then was added onto by slipping scoring hand-coiled beads onto the bottom surface of the machine coiled component. While machine coiled printing requires a fair bit of technical knowledge, skill, and experience with regards to computation and machines, the hand-coiled portion provides an intervening point in which a variety of skill levels can take part in the making of the cup. This is not to say that hand coiling takes less skill than machine coiling, it exists on its spectrum with its complications, limitations, and opportunities, but the act of hand-coiling is a fundamental of pottery. It's one of the first methods taught to beginners and provides a point at which almost any individual of any age or any skill level can come and participate in.

While the layering of different modalities was introduced into these vessels, the study also started to explore and implement various prompts and grammars. These vessels were not only coded and scripted layer by layer prior to making, but additional prompts and grammars like 'shake,' 'turn off,' 'pause,' and many others were added to facilitate improvisational actions. In Figure 49, the prompt 'pause'

Figure 50: Collage of interrupted vessels.


Figure 51: Interrupted machine coiled vessel.

and 'shake' were utilized in the printing process, which resulted in a unique self-settled and assembled stratum. This precisely was created through a momentary pause in air pressure and through the physical shaking of the surface that the vessel was being printed on. Figure 51, similarly uses the 'shake' prompt, but swaps out the 'pause' prompt' for the 'increase' and 'decrease' prompts. Through the physical shaking of the tool head and the decreasing and increasing of air pressure, an entirely new set of strata emerged. An important thing to note within the addition of prompts was that the interpretation of prompts could change between prints (i.e., shaking the print surface vs. shaking the print head). As well, the prompts can also be chained and informed by other prompts (swapping out 'to pause' for 'to increase' and 'to decrease'), resulting in different material topologies and gestures.


Figure 52: Handprinted vessel with detritus.


Figure 53: Handprinted vessel with detritus.

Additionally, after returning from exploring and walking the urban fabric around the historic clay district in Medicine Hat, these vessels similarly started to question how the specific material opportunities and participants that the site held could be incorporated into the printing process. Within the investigation, the following vessels saw an introduction of material prompts that focus on how the detritus and fragments of the originating crafts found within the Medicine Hat landscape can be used to interrupt machine paths and material deposition. While these samples use various somatic and mechanical tool paths, they start to use ceramic detritus in a variety of ways and configurations, each producing unique results in response to the printing modalities. Figure 52, simply shows how the addition of broken pottery fragments can push, pull, and make up part of the layers of a somatically printed vessel. Figures

Figure 54: Handprinted vessel with detritus.

Figure 55: Handprinted and hand coiled vessel made with detritus.

Figure 56: Handprinted vessel made with grass and different clays.

53 and 54, are vessels that take advantage of the plastic qualities of the material and show how the detritus can work to create spanning layers within the face of the vessel. Figure 55, further demonstrates the spanning quality that the interruption provides by utilizing the fragments as a falsework creating a component that can be later combined with other modalities (in this case, hand coiling).

The last few vessels produced in this study focused on ideas of material boundaries and gradation. These vessels started to identify and utilize other material participants that may be found within the prairie landscape, rather than strictly relying on ceramic detritus and newly made artefacts as interrupting participants. Sweetgrass, sage, wild grains, stones, various types of clay, and minerals started to be incorporated into the prompting process. These materials would, in most cases, either decompose out of the vessel or, if fired, would burn out. These vessels also saw the addition of prompts that catered to non-humans. Prompts such as ‘for birds,’ ‘for light,’ ‘for water’ started to alter the outcomes of the vessels by providing a subjective and interpretable guiding subtext. For instance, Figure 56, shows a vessel that utilized the prompts ‘for birds,’ ‘with different clays,’ ‘with sweetgrass,’ and ‘printed somatically. The resultant bird nest-like structure shows a variety of density that reflects on the original guiding prompts sprinkled throughout the making process.

The study served as a means for exploring the printing through the lens of mounding and saw the addition, integration, and development of various material and grammatic prompts and strategies that could be utilized in later studies. These vessels also demonstrated how various levels of constraint, control, certainty, and risk could play out through the combining and coalescing of various gestures and prompts. Some of the vessels utilized a variety of hand-printing, others used a combination of prompts, but nonetheless, the study shows an initial demonstration of how different modalities, materials and prompts, that both inform and react to preceding and succeeding layers can play out. This resulted in increasing levels of material density, expression, and gestures in the artefacts produced. In a similar manner to mounding, the vessels have become open to a variety of participants, processes, and forces, and they increasingly start to focus on how printing processes can focus on specific contexts and participants.

### Situated Vessel Studies

Following the vessel investigation, I wanted to speculate on how similarly prompted architecture could be situated and programmed within the landscape. Initially, this involved selecting various reference points throughout the Historic Clay District's Old Pipe Plant just north of Alberta Brick and Tile. As well, sites within the adjacent and overlapping parkland to the west and north were similarly considered. These points of reference acted as prompts to help consider the materiality, topology, and context. 'Along the River' vs. 'In a Meadow' provided uniquely different scenarios, each bringing their own opportunities. For example, a small plateau below the Medicine Hat Cliffs, coined as 'below the cliffs,' offered up a multitude of both river clays and a variety of ceramic detritus. The topology of the plateau presents opportunities for dealing with either the slight slope of the plateau or the drastic slopes of the bounding embankments, and the location of the plateau offers up views of the surrounding north flats. Whereas the point of reference coined as 'in a meadow' Is located in the relatively


Figure 57: Map showing points of reference for situated vessel study. From top to bottom: Site locations for figures 61, 59, 60 and 58. Base layers from: (GIS Medicine Hat 2010, 2012a, & 2012b).

flat and tree line obstructed meadow in the flats of the Seven Persons Creek, offering up an entirely different material palette with other clays, aggregates, and flora, and a unique relationship to the surrounding tree line and topology.

Again, I used simple prompt combinations to speculate on how the cups, the material, and the mounding process's corresponding interruptions could be scaled architecturally. These prompts provided subtext and guidance for working through initial speculations. As explained prior, points of reference within the landscape took the form of a location prompt, but additionally prompts around inhabitants, whether human or non-human, and programmatic prompts borrowed from the algorithmic logic of Christopher Alexander's A Pattern Language were used for flushing out spatial and programmatic experiences (Alexander 1977, 42-44). These set the requirements through which the collages were developed. The prompts themselves set the terms in which dense material experiences could be articulated.

Figure 58: Pavilion in a meadow, made with detritus, for coyotes.

Working through the study, it was found that pavilions ‘Made for Birds,’ ‘With Different types of Clay,’ that were ‘Printed Somatically,’ seen in Figure 60, produced uniquely different results than the speculation made with a different prompt set: ‘A place to wait,’ ‘made with an Interrupted machine,’ ‘in a meadow,’ seen in Figure 59. Similarly, A Hearth made

Figure 59: A place to wait, below the ramps, and made with an interrupted machine.

Figure 60: Pavilions made for birds, along a path, with different types of clay.

with detritus, below the cliff, seen in Figure 61, produced drastically different results than a den made for coyotes, with detritus, in a meadow – seen in Figure 58.

These are simply speculations, and as such, they tend to take artistic and imaginative leaps in relation to the program, the users, and the digital translations. One would require further investigation into what a coyote needs or wants of a den. Furthermore, what would be the context-aware strategies and requirements that a printer and its operator would have to undertake to satisfy this scenario? Regardless, at a surface level, the study served as a way to flush out strategies as to how printed matter, ceramic detritus, and other interrupting materials could coalesce to work programmatically and phenomenologically. In a speculative scenario, the printing over detritus seen in Figure 58, is created from a situation where different materials are negotiating and coalescing to create thresholds, porosity, and openings. Similarly, in Figure 59, the combination of

Figure 61: Hearth made with detritus, below a cliff.

printed vessels and detritus fill creates a situation where mass of materials can articulate seating conditions. These initial studies laid a good foundation in which the material investigations could be developed, and specific architectural ideas and themes could be explored.

## Wall Component Studies

The artefact in Figure 64, emerged from a series that explored the physical performance of interruptions that can be undertaken when printing. Similarly, the study simultaneously examined formal and digital rules relating to the translation of digital geometry into physical form. Initially, the artefact was modeled and then was translated into a series of coordinate points – making up the order and rules for a toolpath. In the scripting of the artefact and the ruleset, the digital rules tend to be linked inextricably to the physical limitations and dynamics of the printer and the material. Figure 63 shows a series of toolpath iterations explored as part of a digital to physical back and forth that occurred through the development of the wall component study seen in Figure 64. One of the significant variables demonstrated in this illustration is the print area. The tool head can only move so much in the x-direction and only so much in the y-direction, and as a result, this becomes a direct limitation within the scripting of wall components. The printer used at the desktop scale for these studies had a print area of 200 x 200mm and a print volume of 200 x 200 x 450mm, quite substantially smaller than a print area of a 6-axis articulated arm or a 4-axis SCARA (Selective Compliant Assembly Robot Arm) machine that could be used for printing structures on site. Nonetheless, the volume and area are important variables that impose limitations on what is printed and how it is printed. For example, the printing at

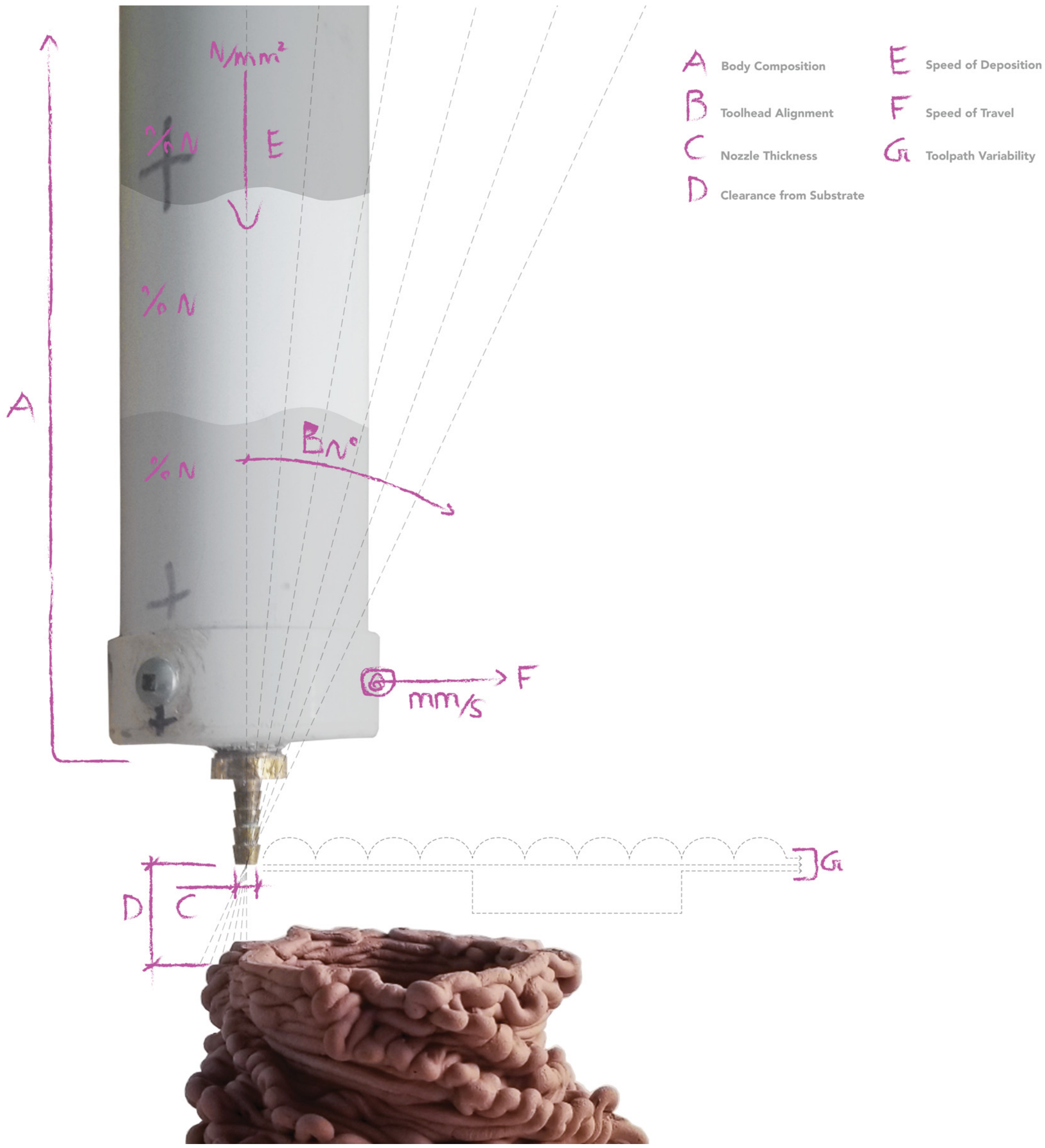


Figure 62: This drawing breaks down key variables that were wrestled and played with in planning out, preparing and printing work.

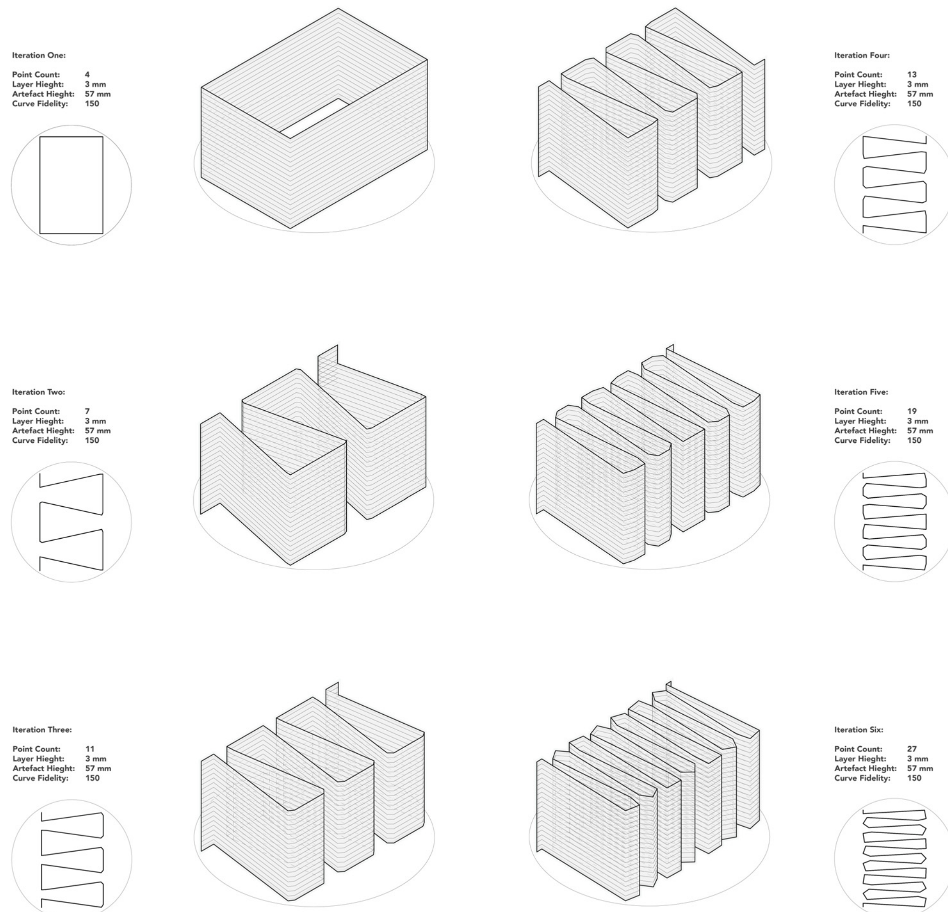


Figure 63: This illustration shows an iterative series of tool paths which investigates the degree of fill in between the boundary of the print. Each iteration is approximately 150mm x 100mm x 50mm.

the desktop scale was more limited in the X and Y directions than in the Z direction. So, the G-code could be edited to allow for taller printed elements, or when gestures, uneven surfaces, and interruptions were introduced, the code and, by extension, the tool head, could be offset in the Z direction to offer just enough clearance to print over previous layers and substrate. In this context-aware workflow, altering and offsetting the G-code, tool head, and printer could be undertaken on-site in order to deal with challenges that specific contexts and topologies bring to the table.

Other variables are more flexible – providing opportunities rather than limitations. The point count of the baseline that makes up the toolpath controls not only the fidelity of the print path but also the density of the weaving fill lines. While this variable is more explicitly determined in digital space – the point count and, more so, the fill density directly impacts the structural integrity of a print, especially a print that is being interrupted and manipulated during the act of printing. The more fill lines (the diagonal lines weaving in between the bounding edges), the more structurally resilient the print will be, and the greater the volume of material will be required for printing. The study shown in Figure 63, focuses on this point count variable and identifies what values for this variable would lead to sound substrate and what values would more so lead to entropic opportunities. A print with a point count of 4, with no resulting fill lines, is much more likely to collapse in on itself or develop dips or bends when exposed to interruptions or external forces than a print with a higher point count. While the focus of the study leaned towards the physical augmentations and opportunities, a variety of these varying digital toolpaths produce a

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M107M107
M104 S190
G28
G1 Z5 F5000
M109 S190
G21
G90
M82
G92 E0
G1 Z1 F7200
G1 E-2 F2400
G92 E0
G1 X-1.415 Y26.868 F7200
G1 E2 F2400
G1 F1080
G1 F 1800 X-5.508243 Y-62.959505 Z0 E0
G1 F 1800 X-6.1484e-7 Y-63.2 Z0 E5.51349
G1 F 1800 X5.508241 Y-62.959505 Z0 E11.026979
G1 F 1800 X10.974565 Y-62.23985 Z0 E16.540472
G1 F 1800 X16.357363 Y-61.046512 Z0 E22.053962
G1 F 1800 X21.615672 Y-59.388574 Z0 E27.567452
G1 F 1800 X26.709474 Y-57.278652 Z0 E33.080944
G1 F 1800 X31.6 Y-54.732806 Z0 E38.594434
G1 F 1800 X36.250028 Y-51.770411 Z0 E44.107922
G1 F 1800 X40.624174 Y-48.414011 Z0 E49.621412
G1 F 1800 X44.689149 Y-44.689148 Z0 E55.134907
G1 F 1800 X48.414009 Y-40.624177 Z0 E60.648397
G1 F 1800 X51.770409 Y-36.250031 Z0 E66.161887
G1 F 1800 X54.732806 Y-31.6 Z0 E71.675378
G1 F 1800 X57.278653 Y-26.709473 Z0 E77.18887
G1 F 1800 X59.388574 Y-21.615671 Z0 E82.702361
G1 F 1800 X61.046513 Y-16.357362 Z0 E88.215851
G1 F 1800 X62.23985 Y-10.974563 Z0 E93.729342
G1 F 1800 X62.959505 Y-5.508243 Z0 E99.242831
G1 F 1800 X63.2 Y-6.1484e-7 Z0 E104.756321
G1 F 1800 X62.959505 Y5.508241 Z0 E110.26981
G1 F 1800 X62.23985 Y10.974565 Z0 E115.783303
G1 F 1800 X61.046512 Y16.357363 Z0 E121.296793
G1 F 1800 X59.388574 Y21.615672 Z0 E126.810283
G1 F 1800 X57.278652 Y26.709474 Z0 E132.323775
G1 F 1800 X54.732806 Y31.6 Z0 E137.837265
G1 F 1800 X51.770411 Y36.250028 Z0 E143.350753
G1 F 1800 X48.414011 Y40.624174 Z0 E148.864243
G1 F 1800 X44.689148 Y44.689149 Z0 E154.377738
G1 F 1800 X40.624177 Y48.414009 Z0 E159.891228
G1 F 1800 X36.250031 Y51.770409 Z0 E165.404718
G1 F 1800 X31.6 Y54.732806 Z0 E170.918209
G1 F 1800 X26.709473 Y57.278653 Z0 E176.431701
G1 F 1800 X21.615671 Y59.388574 Z0 E181.945192
G1 F 1800 X16.357362 Y61.046513 Z0 E187.458682
G1 F 1800 X10.974563 Y62.23985 Z0 E192.972173
G1 F 1800 X5.508243 Y62.959505 Z0 E198.485662
G1 F 1800 X6.1484e-7 Y63.2 Z0 E203.999152
G1 F 1800 X-5.508241 Y62.959505 Z0 E209.512641
G1 F 1800 X-10.974565 Y62.23985 Z0 E215.026134
G1 F 1800 X-16.357363 Y61.046512 Z0 E220.539624
G1 F 1800 X-21.615672 Y59.388574 Z0 E226.053114
G1 F 1800 X-26.709474 Y57.278652 Z0 E231.566606
G1 F 1800 X-31.6 Y54.732806 Z0 E237.080096
G1 F 1800 X-36.250028 Y51.770411 Z0 E242.593584
G1 F 1800 X-40.624174 Y48.414011 Z0 E248.107074
G1 F 1800 X-44.689149 Y44.689148 Z0 E253.620569
G1 F 1800 X-48.414009 Y40.624177 Z0 E259.134059
G1 F 1800 X-51.770409 Y36.250031 Z0 E264.647549
G1 F 1800 X-54.732806 Y31.6 Z0 E270.16104
G1 F 1800 X-57.278653 Y26.709473 Z0 E275.674532
G1 F 1800 X-59.388574 Y21.615671 Z0 E281.188023
G1 F 1800 X-61.046513 Y16.357362 Z0 E286.701513
G1 F 1800 X-62.23985 Y10.974563 Z0 E292.215004
G1 F 1800 X-62.959505 Y5.508243 Z0 E297.728493
G1 F 1800 X-63.2 Y6.1484e-7 Z0 E303.241983
G1 F 1800 X-62.959505 Y-5.508241 Z0 E308.755472
G1 F 1800 X-62.23985 Y-10.974565 Z0 E314.268965
G1 F 1800 X-61.046512 Y-16.357363 Z0 E319.782455
G1 F 1800 X-59.388574 Y-21.615672 Z0 E325.295945
G1 F 1800 X-57.278652 Y-26.709474 Z0 E330.809437
G1 F 1800 X-54.732806 Y-31.6 Z0 E336.322927
G1 F 1800 X-51.770411 Y-36.250028 Z0 E341.836415
G1 F 1800 X-48.414011 Y-40.624174 Z0 E347.349905
G1 F 1800 X-44.689148 Y-44.689149 Z0 E352.8634
G1 F 1800 X-40.624177 Y-48.414009 Z0 E358.37689
G1 F 1800 X-36.250031 Y-51.770409 Z0 E363.89038
G1 F 1800 X-31.6 Y-54.732806 Z0 E369.403871
G1 F 1800 X-26.709473 Y-57.278653 Z0 E374.917363
G1 F 1800 X-21.615671 Y-59.388574 Z0 E380.430854
G1 F 1800 X-16.357362 Y-61.046513 Z0 E385.944344
```

Figure 64: Wall component/fragment next to corresponding .gcode.

wide variety of unique opportunities and could be used in combination or in series.

For example, a wall that specifically requires rigidity and consistency in one area may use a toolpath that has more fill lines, and where structure becomes less important, and there is more of an opportunity for the material to self-assemble a toolpath with fewer fill lines could be utilized. Similarly, layer height is another flexible variable within the scripting process but more so heavily relates to the physical and material variables involved in printing. As a rule of thumb, the layer height typically needs to be half the value of the diameter of the tool head nozzle to ensure proper pliability and cohesion of layers. But this is, of course, related to different variables seen in Figure 62, which hold proportional relationships that can be altered, changed, tested, and played with. For example, if the flow or feed rate of the material is greater, this will have a proportional impact on the wall thickness. Similarly, the wall thickness variable also proportionally changes in relation to the materials rheology, flow rate, layer height, and various other variables. The material's rheological properties and composition significantly impact how the material flows, the rate it flows at in relation to pneumatic pressure, how it plies together, and by extension, what the corresponding layer heights should and could be. The key variables seen in Figure 62, relate specifically to digital variables, limitations, and frameworks, embedded within the scripting process. Many of these elements can be played with and altered digitally and physically to suit specific challenges and contexts – and many are flexible enough that a variety of different material performances can be pursued, whether they be inherently entropic or be structurally consistent.

The making of the artefact in Figure 64, really started to formalize the mounding and scoring methodologies. From the vessel studies, I found that working with printing modalities, the tools I was using, of course, could work mechanically and autonomously, but I could also use them semi-autonomously. The tools could be hacked, reconfigured, interrupted, simplified, and used in different ways – printing became something that was, rather than a process carried out solely by a machine, could be something performed on a spectrum that engaged a variety of differing levels of constraint, control, risk, and certainty. From this, simple interruptions, modalities, materials, and gestures could be introduced and ordered in differing ways. Initially, the artefact in Figure 64 started as a simple toolpath, similar to those seen in Figure 63. The toolpath was generated in Grasshopper and then exported through Visual Studio into a format that the printer could use to translate the object from digital abstraction into a physical object. Similar to the cups, I applied prompt sets to utilize during these printing sessions, but more so, the work started to be organized around small scores and annotations, that specifically ordered when a gesture or action might be performed, when an interruption might be introduced, or when one modality, might be swapped for another.

So formally, a toolpath can be produced, made into G-code, and then sent to the printer so that the abstraction can be printed. But someone can introduce other material to the print, such as laying a brick in the way of the toolpath, or a pottery fragment, stone, cup, etc. The print can be halted, allowed to dry, and then receive succeeding stratum made up of brick courses or other courses made up of cob, or cups, or a variety of other materials and modalities. And while the printer operates, following the rules and logic embedded within the G-code, someone may choose to introduce new gestures, from shaking the tool head, pausing the printer motions while the air compressor remains on, or choosing to increase or decrease the air pressure that is moving the clay body through the tool head. And lastly, while printing can occur on clean and level surfaces, someone may choose to print over uneven topologies – ranging from intricate brick patterns or navigating the material topology of a specific site when printing in-situ. With this, the making of artefacts and interventions transitions from a process following absolute logics to a process that follows rules of thumb that relies on situational and contextual decision making. I started working in notations that looked at scoring different sets of a motor schema – a set of operations made up of different, corresponding, overlapping, and or succeeding toolpaths, modalities, materials, gestures, and prompts.

The key variables outlined in Figure 62, hold a variety of relationships not only between the printer, the material, and what is digitally being scripted but also in relation to the operators, participants, and materials involved in the physical performance. Greater nozzle diameters, flow rates, and appropriate layer heights can provide an increasingly stable substrate for other modalities and additionally facilitate quick and sturdy restabling of print substrate when interruptions are incorporated. Additionally, where pre-set and pre-coded conditions struggle to settle properly in the face of specific topological conditions, handwork and gestures can be utilized to correct and restabilize prints for future substrate. All three portions, the printing variables, the digital logics, and the performative material frameworks, are interrelated, and while each holds its own specificity, thresholds, and domain, the variables in each portion can be altered, ordered, manipulated, and negotiated in relation to other intertwined and related variables. With this, the boundary between physical to digital can be blurred slightly, as different actions, choices, and variables used in formulating site-specific printing strategies can be ordered, negotiated, and coalesced in any number of combinations. Along this blurred spectrum, any number of choices can be made, any number of variables can be altered, and any number of actions can be performed, running in either direction, back and forth, to accomplish a specific goal. And while much of this work was conducted in 'lab' conditions, it holds similar variables and produces a similar toolkit of strategies that could be utilized and scaled up on site.

## Scoring Development and Cairn Studies

The motor schemas or scores took the form of a simple graph that allowed for varying datums to be plotted on the y axis and the duration of work and overlapping modalities to be plotted on the X-axis. While these notations, or 'scores,' went through a variety of iterations, this current iteration allowed for a more or less one-to-one translation between what was scored and what prompts, gestures, and modalities were physically used to carry out the work - seen in Figures 65 and 66. The scores act as a projection for where the mound could go, acting as an almost time-driven section that allows the work to be plotted and coursed. But the scores in their making also had to be continually addressed and readdressed while the work was being executed. The operators, craftspersons, and makers working with the tools, the materials, and interruptions must respond to what is currently happening within the print, as well as how it may affect succeeding layers. The process becomes an animate dance between the tools, the materials, and the operator / maker. For example, an operator may choose to print on uneven ground, and while the clay settles against the ground, it may take more passes and more air pressure regulation than initially predicted within the score. Similarly, increasing airflow, decreasing airflow, adding interruptions, pausing prints, and various other moves create opportunities, each requiring its own set of reactions and adaptations. So, while score can work as a projection, it is similarly flexible enough to allow for the work to adjust to the ongoing material dialogue as needed – whether that dialogue occurs in a small element printed over a few days or larger assemblies and structures printed over several weeks or even multiple seasons.

As a result, the artefacts that emerge from the scoring process tend to take on emergent qualities, forms, and opportunities. While the same logics and structures that make up the digital abstractions, geometry, and code, ring through and provide the underlying rules for the material to build up physically, it is really the decisions and negotiations made in-situ that determine the material outcomes, topology, and, to a certain extent the form. Rather than just dealing with tolerances of tools and their coordination, there are a plethora of variables that must be negotiated in-situ, and not only in a single instance, but continually at various points over time – whether hour-to-hour, day-to-day, week-to-week, season-to-season, or year-to-year. In this dialogue, you may follow a score and execute it perfectly, or you may follow it to a certain point until you must address certain material conditions or opportunities. For example, scored pottery fragments may provide more exciting opportunities for building the material over rather than building it up as intended originally. Or, if the artefact is left to sit in the elements, the forces and fluxes of the environment


Figure 65: View of cairn and associated score.

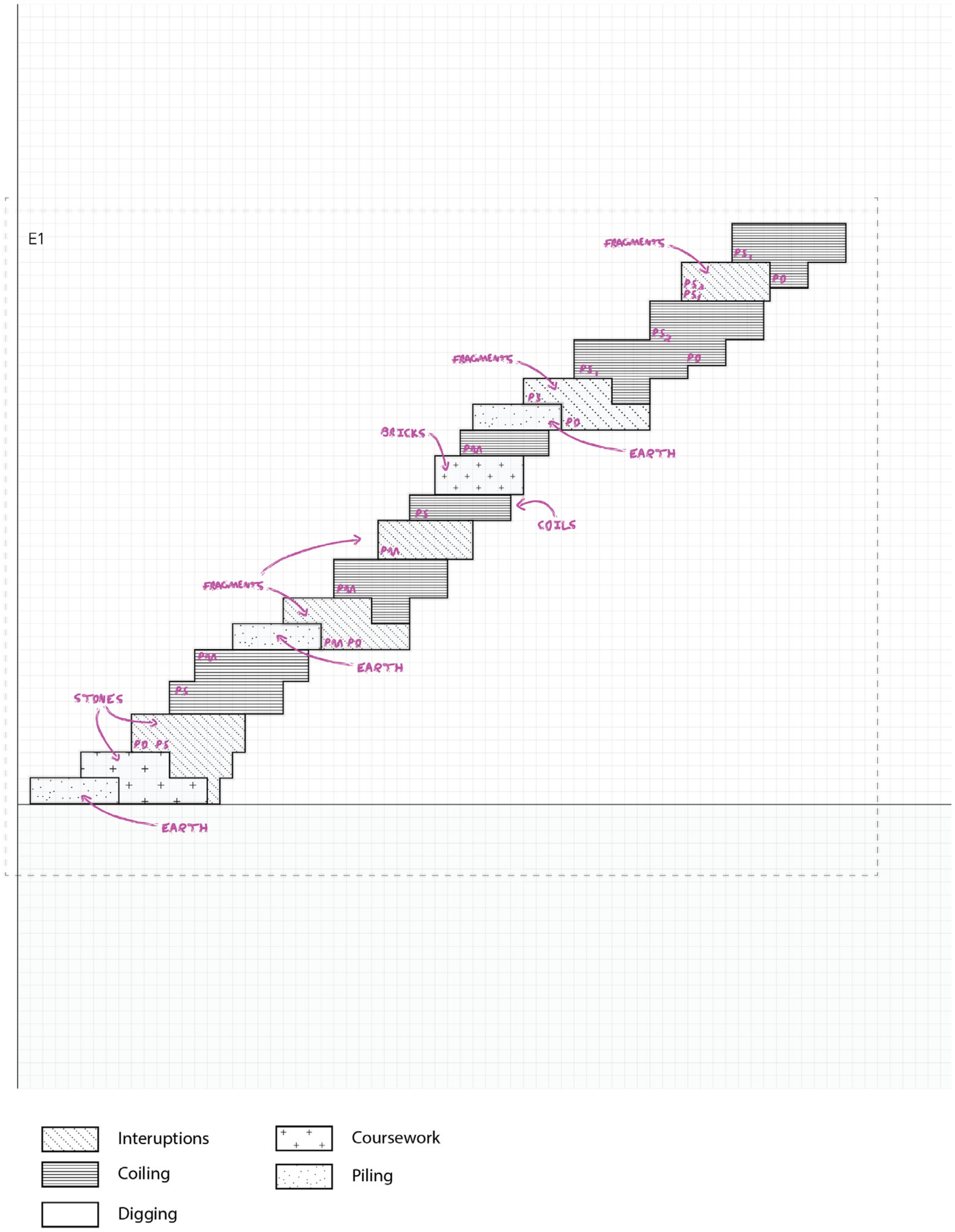


Figure 66: Close up of scoring notation.

may create new topologies, surfaces, and opportunities to build from or deal with. Regardless of what site conditions and material opportunities have to be negotiated, because of the material dialogue that occurs, what is scored, although it is a one-to-one translation between notation and performance, there is a large amount of room for improvisation - and for the most part, improvisation will be required to address emerging conditions. Things are scored, made, readjusted, continued, etc.

The artefact that was produced from the score in Figure 65, what I have been calling a cairn, is a good example of some of the dynamics mentioned above. The cairn served as a tool for developing scoring notation at scale while similarly allowing for the testing of how changes to the scores, whether through the addition or exclusion of different prompts, gestures, or modalities, would change or alter a respective stratum. Portions of the cairn were made through printing, portions through hand printing, and other forms of handcraft. Some areas involved interruptions of other materials, and some incorporated differing gestures and modalities. In its making, the cairn first involved both a scoring of differing materials, gestures, and modalities, as well as digital scripting of code that could be translated into physical objects via the printer. Coding introduced the general structure, but the interruptions and improvisations that were undertaken during the printing process flushed out and articulated specific forms and topologies. The code may determine where printed matter may be placed, but the placement of a stone, or a brick, or a fragment, determines how that material settles, and furthermore, how subsequent layers and materials settle above. Both elements were used at the outset, and because

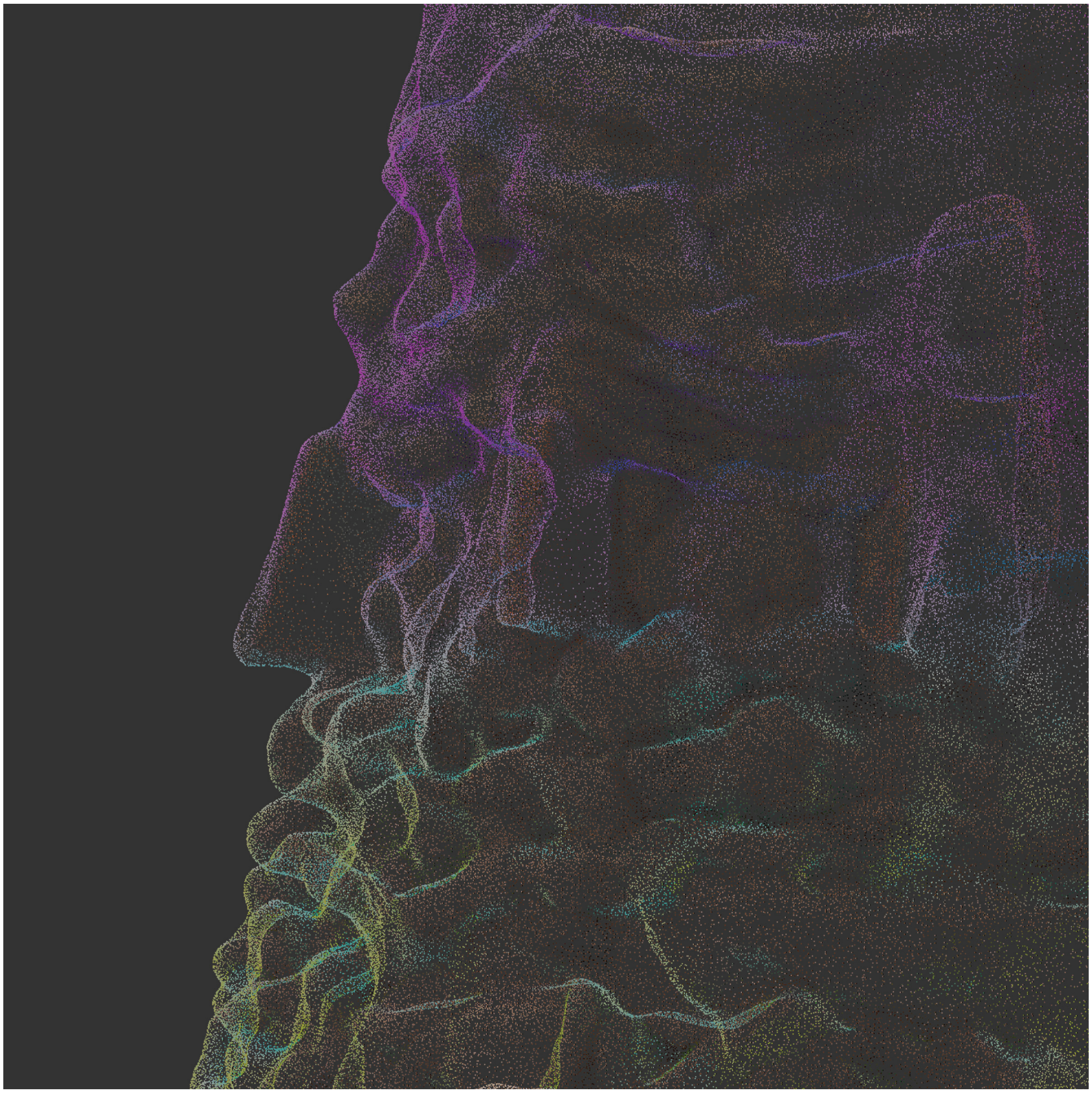

Figure 67: Hybrid view of photogrammetric scan of upper portion of Cairn. The image overlays change in elevation, U/V Texture Mapping, and Point Normals

of the nature of the material and the process, both were adjusted and re-worked continually throughout the strategy.

In the lower strata of the cairn, the scoring and prompting of stones create situations where clay could settle and provide substrate for succeeding layers. Printing over the stonework resulted in an opportunity to introduce hand printing to settle out the surface before adding machine-printed elements. As the stones may cause undesired stresses to the succeeding print layers – hand printing was used to fill in voids and create sound surfaces. Additionally, prompting earth to be laid over layers created a situation where working back and forth between the print the code and the printer was necessary. In this scenario, toolpaths were repeated until either a sound surface was created for the next part of the score to be printed over or until additional clearance was required between the substrate and the tool head. Initially, this either involved letting the printer run through the code with the air compressor off until enough clearance was provided, or the G-code would have to be readjusted with an offset in the z-direction. These strategies would be repeated until a proper substrate for that given layer was provided, and the next corresponding layer could be started – either as initially intended in the score or readjusted to suit the current state of the print. These strategies similarly extend to placing interruptions or additional courses, as it allows clearance to work without having to move the printout of alignment. Lastly, prompting pottery fragments provided opportunities for creating vertical connections and support for succeeding layers to be printed over.

All of this happens amidst other corresponding and overlapping subprocesses that occur within clay and ceramic workflows - humidity, drying, firing, etc. The clay is constantly drying, and succeeding layers, depending on the modality

Figure 68: This drawing breaks down key variables that were wrestled and played with in planning out, preparing and printing work.

and the intent, need to happen within a specific window. If the substrate becomes too dry, the successive layers will not bond properly. To wet, and the weight of the layers above may start to slump or push on the layers below in undesirable ways. This adds a temporal aspect to the printing process, as time may be needed for certain operations to occur, or vice versa, where specific actions may need to occur within a certain time frame. Or certain strategies may be implemented to control, impede, or even speed up forces that act out on the material. While this work occurs at a desktop scale, away from any specific site, similar dynamics occur when taken to the site. And while these dynamics, such as wind, snow, rain, humidity, and heat fluctuations, are less predictable. They can be navigated with a lot of the same strategies that occur at the desktop scale. The same can be said for the scripting and scoring operations and strategies used in making the cairn. Piles of rock or earth can be printed over, the printer being offset upwards until solid substrates occur. Fill patterns can be controlled onsite to serve different goals, ranging from adding structure, mass, or porosity. Allowing for a substrate to take interruptions in one area and for entropy to occur in another. And where the rheology of the printing bodies afforded by the materials underfoot creates slight variances in expected flow, pliability, and performance, the code can be adjusted to suit a preferred performance and outcome, while the phasing of the printing within the score can facilitate proper accumulation, drying, and bonding.

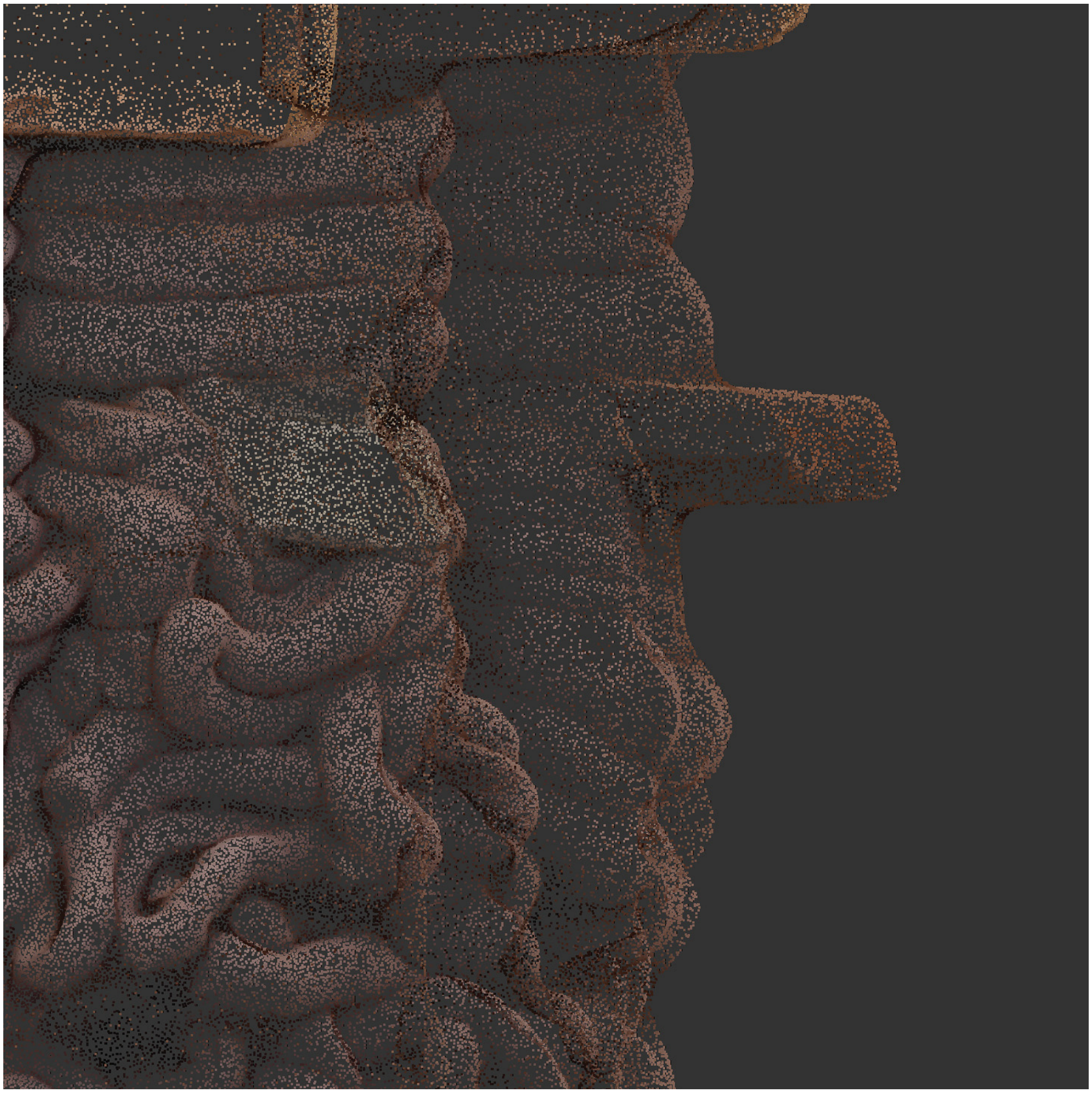

Figure 69: This drawing breaks down key variables that were wrestled and played with in planning out, preparing and printing work.

# Chapter 5: The Mounds

## Mounding in the Landscape

The formation of mounds occurs from all kinds of processes, in all sorts of contexts, and over differing periods of time. They are formed through natural processes, but they are also made through human interactions within the environment. Ingold explains that “mounds are among the commonest forms in nature,” but they often form from human interactions as well – “think of shell middens, stone cairns, sandcastles, and heaps of compost refuse and slag.” (Ingold 2013, 75). In fact, the practice of making mounds both subconsciously and consciously is certainly as old as humankind as “marking the landscape through drawings or stone piles” and the “moving of earth in baskets, to make mounds or other shapes” in the surface of the earth was first implemented and taken up by early cultures (Jarzombek 2013, 323). The Olmecs began to do so around 6000 BCE, Mesoamerican Cultures around 2500 BCE, and Eastern European Cultures around 3000 BCE. (Jarzombek 2013, 323). From burial mounds to refuse piles, the fact remains that if you travel the globe, you would be hard-pressed not to find cultural examples of mounding, both prehistoric and contemporary.

Figure 70: View of Darkhorse Medicine Wheel (Peck 2018, 116).

Within the context of Medicine Hat, there remains a broad range of human-produced mounds covering a period spanning from the early 21st century to ~3000 BCE. The latter takes the form of circular rock cairns and structures, coined as Medicine Wheels by non-indigenous people. These mounds are the remnants of rich cultural, religious, and social processes of early indigenous plains culture, potentially made over generations from 3000 BCE to 1000

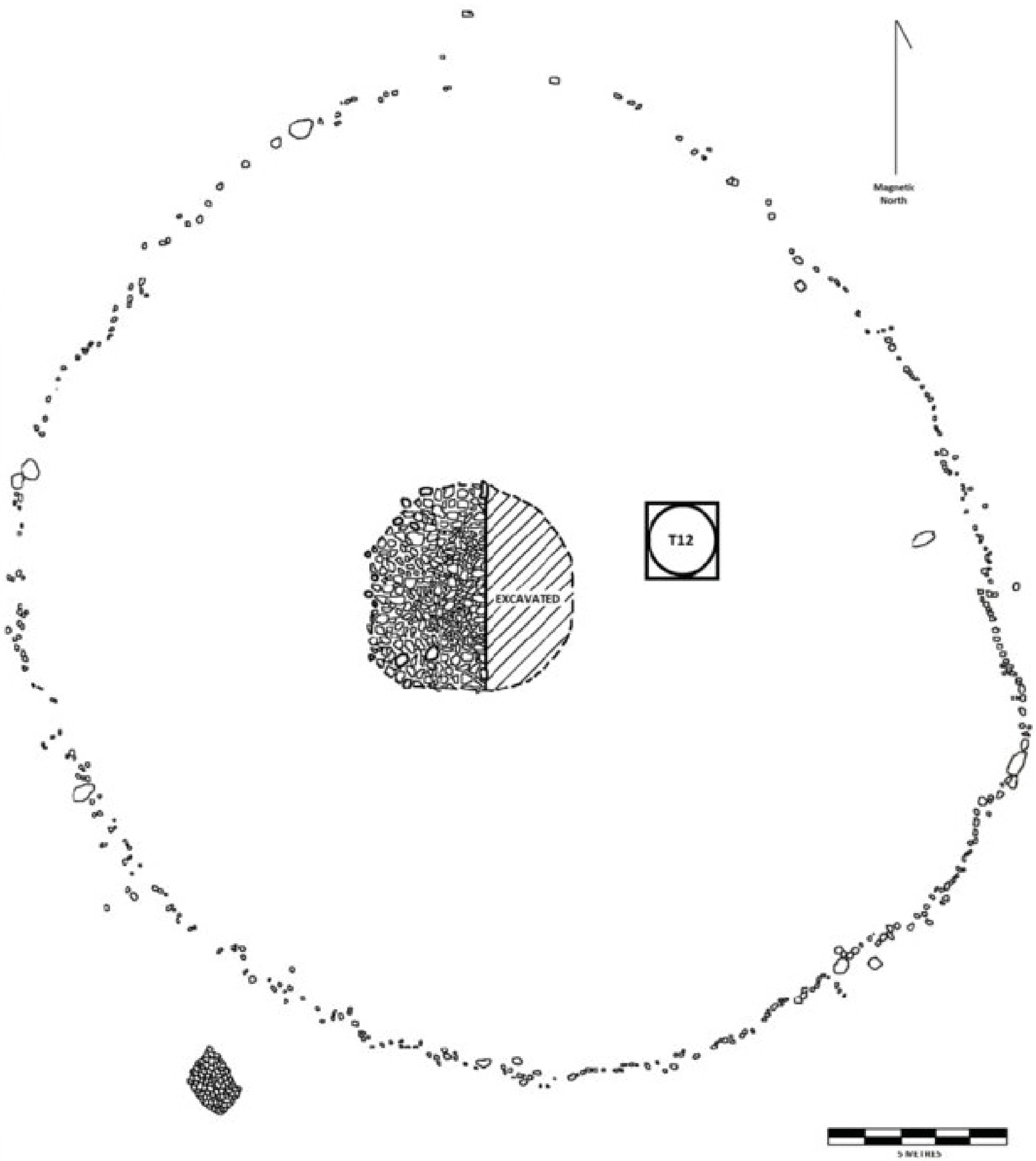


Figure 71: Plan of Twin Peaks Medicine Wheel, just north of Medicine Hat (Peck 2018, 109).

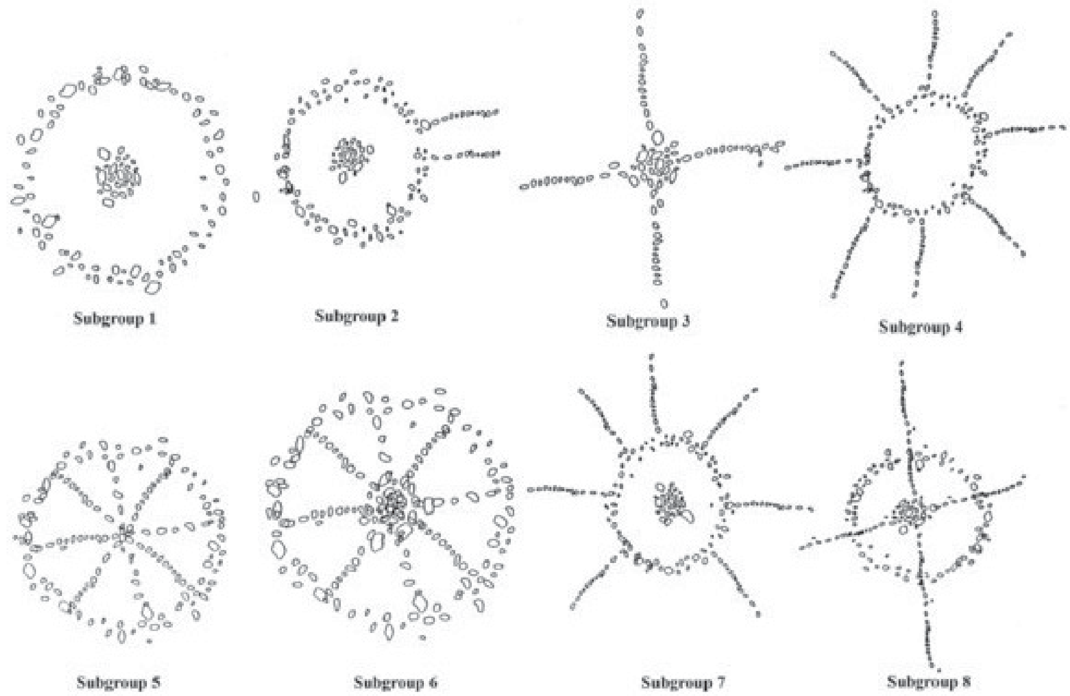


Figure 72: Medicine wheel subgroups and typologies (Peck 2018, 106).

Figure 73: Mound of bricks, north of I-XL.

Figure 74: Mound of bricks grown over, north of I-XL.

Figure 75: Mound of bricks piled along a river embankment, north of I-XL.

BCE, as well as during a small revival of the practice around 200 CE (Jarzombek 2013, 145). The cairn-like mounds were constructed by “laying stones in a particular pattern,” typically consisting of a pile of stones at the center, with various radiating lines, spokes, and outer circles, both made of stone (Jarzombek 2013, 323). While these mounds range in size and layout and their purpose is uncertain, they are currently understood as structures that potentially performed astronomical and calendric functions, acted as social, cultural, and religious forms of architecture, and potentially worked as memorial markers. These are complex, culturally significant structures, which hold unique attitudes towards materials and natural processes. The cultures that produced these mounds focused on the material underfoot and interventions that lightly altered the landscape.

A more contemporary example of human-made mounds in the Medicine Hat area would be found in the literal heaps of bricks found throughout the meadows of the flats, the accumulated piles of ceramic detritus in the creek and riverbeds, and ceramic detritus laden riverbanks and escarpments. The artifacts that now heavily populate the north flat and are the result of human processes and production. While some of the debris was transported to current coordinates by natural forces and processes, simply due to the magnitude and extensiveness of these mounds, their making can be attributed to site disposal and clearance practices. Practices where broken, leftover, and or un-distributable product was simply dumped in place. This is akin to a cairn typology, called a clearance cairn, made by the removal and disposal of stones from fields that early farmers desired to clear for cultivation (Sandals 2016). Instead of rocks and farming, ceramic products and industrial processes formed much of the mounds in the north flats. Regardless, the mounds host a variety of life and serve as a visual reminder and connector to an industry that fueled the development of Medicine Hat for over a century.

The purpose of working through the previous examples was to provide both a cultural acknowledgment to various practices and to highlight more significant trends and differences found in mounding. Both instances of mounds share similarities: they are constructed with local materials and are made through culturally important processes - whether directly or indirectly. One focused on the stacking of stones for currently unknown cultural purposes, and the other was formed through the byproduct of working with a material that is held dearly within a community. Both examples hosted various events and processes over the years – and eventually became part of the landscape, grown over and left to environmental forces and future forms of deposition and accumulation. They also have stark differences, where one mound served intentionally functional religious, spiritual, and cultural purposes, made through the stacking of stones found within the immediate area. And the other was formed as a byproduct of industry that simultaneously supported development and livelihood within a community while also heavily exploiting and extracting not only within the medicine hat landscape but in areas further afield as well. Regardless, both mounds situate people culturally within a landscape and on a continuum, they are a part of the landscape, made up of familiar cultural materials, and each has grown back into the landscape – forming new relationships and other alliances.

## Site and Programmatic Approaches

Thematically, the work looks to commonalities in mounding in order to provide a programmatic route forward for the work. Like the previous two examples, the focus, programmatically, will be on situating users, inhabitants, and visitors to a landscape, a material provenance, and the respective continuums they are tied to. The final pavilions each will be designed, scored, and performed in relation to the following themes:

> Orienting / Observing. The pavilions can situate users to the continuum, the material, the landscape, and natural processes. The strategy will be to provide distinct programming that orients users to specific views and vantage points that tie to topologies, contexts, material experiences, and contexts.
>
> Traversing / Traveling. The built work will provide destination and endpoints within the landscape. Providing the potential for paths to be stitched from existing programmatic elements within the landscape and through existing yet fragmented and inaccessible portions of the landscape (i.e., the closed-off pipe plant site).
>
> Meeting / Warming. The mounds will support programming that facilitates the lingering and meeting at specific sites. Warming elements will extend the seasonality of the pavilions and potentially facilitate programming around the making, firing, and production of ceramic artefacts.

Additionally, the pavilions will be articulated through focusing on the materials, topologies, and forces at hand and underfoot. Focusing on small material diets and boundaries (~100m in diameter) will challenge the work to survey, question, and incorporate specific materials from veins that run through the surrounding sites. Where possible, the work will leverage local materials but will remain flexible and open enough to bring in other materials from slightly further afield to serve specific purposes which no locale material can feasibly fill. An example of this would be bringing in local crop residue from surrounding farmlands to facilitate burnout in clay bodies, fuel for firing, and falsework for spanning structures. Additionally, sites for mounding will be determined and selected based on the material, topological, and contextual opportunities. Sites that hold large amounts of ceramic detritus or have been dramatically altered by previous industrial and mounding processes will be given priority.

## Points of Reference

For the final architectural translation, like the cups, I pulled a series of reference points within the boundary of the 'pipe plant' site north of the Alberta Brick and Tile Factory and East of Strathcona Island Park seen in Figure 76. These locales were selected for their material, contextual and topological opportunities and were used to help score and execute a series of pavilions, each thematically working under the themes of observing, orienting, meeting, and waiting within the landscape. Each point of reference has its own material wealth, topological contexts, and sets of forces that must be contended with.

The first reference point occurs atop the cliffs, overlooking the north flats, denoted on the site map in Figure 76 as Site A.


Figure 76: Site Plan. In clockwise position, Site A, Site B, Site C. Base layers from: (GIS Medicine Hat 2010, 2012a, & 2012b).

The second point of reference occurs just below the first point on a small plateau running along a bend in the south Saskatchewan River, denoted as Site B in Figure 76.

And the final point of reference occurs just above the Alberta Brick and Tile Plant, denoted as Site C in Figure 76.

## A Place to Wait Above the Flats

The pavilion on Site A is a small outlook hidden behind the ridgeline of the cliffs. The pavilion offers up a panoramic view of the South Saskatchewan River Basin and the Medicine Hats Flats. Made of clay, stone, and surrounding prairie grasses, the small ziggurat-like pile provides a place to sit and look over the north flats at the end of a hike. The pavilion is specifically oriented to the Medalta Potteries, The Alberta Brick, and Tile Factory and to centerlines of the South Saskatchewan River – both down and upstream. The ziggurat-like pile is transected by four large ramps made of compacted earth and stone, which provided routes up to the top of the mound, seating for views out, and masses that frame the seating and views in between the ramps. The pavilion is oriented cardinally and acts as a marker within the landscape, not only orienting viewers directionally but to the surrounding landscape and environment as well. The pile hosts a plethora of simple programs centered around orienting and viewing, from offering vantage points to the surrounding flats at the end of a hike, watching sunsets along the western expanse, or star gazing throughout the year. Simple prompts provide unique material experiences throughout the pavilion. For example, the prompting of ‘stone’ creates scenarios where stones can either be used

Figure 77: View of approach of Site A, with site plan ghosted in the background. Base layers from: (GIS Medicine Hat 2010).

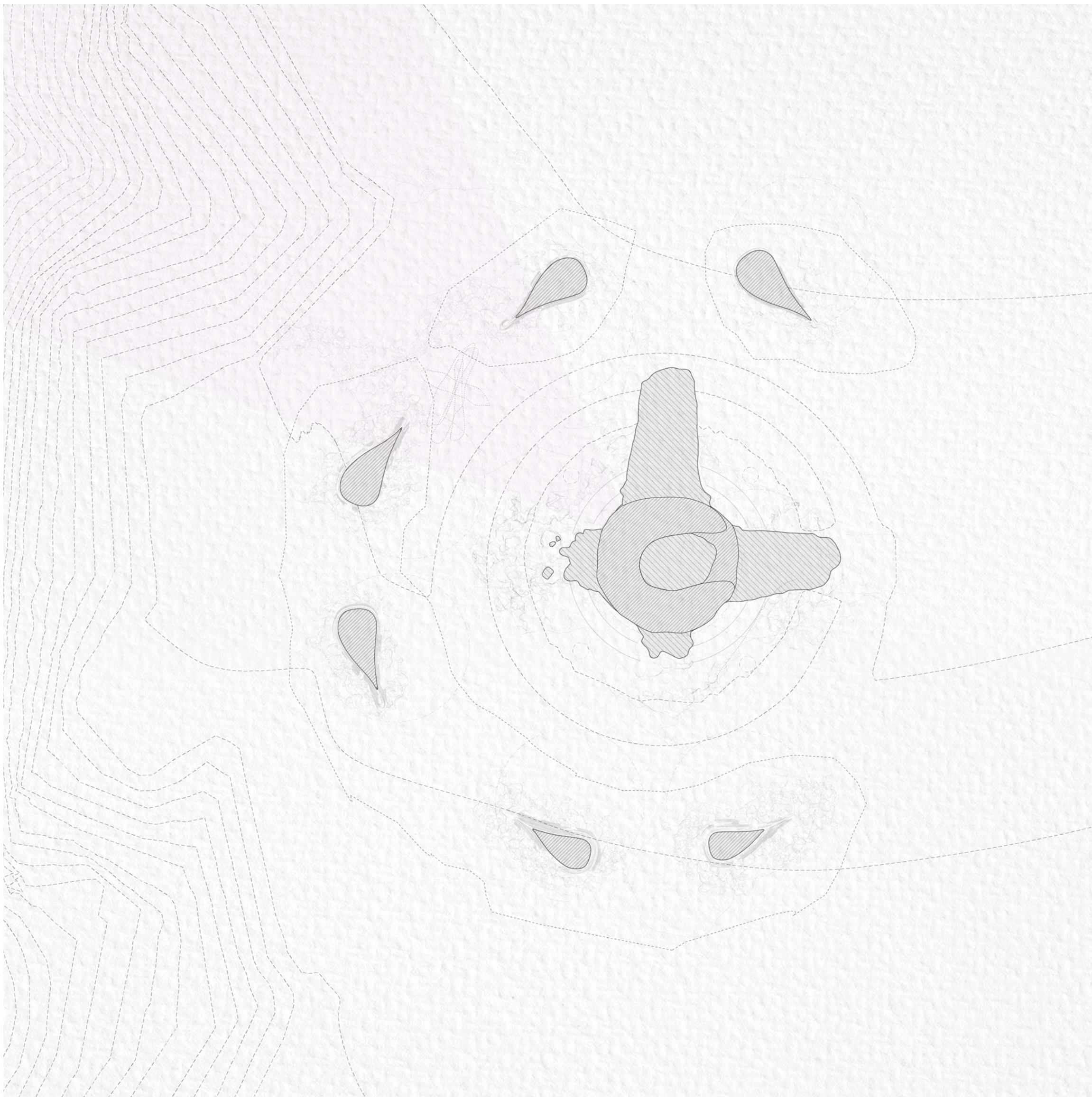

Figure 78: Floor Plan of Pavillion A. Base layers from: (GIS Medicine Hat, 2010).

Figure 79-90: Sequence of Construction for Pavilion A

as substrate to support succeeding layers or can be used as interrupting falseworks to articulate small pockets and porosity within the structure – Pockets that other non-humans can occupy.

The pavilion is made successively in relation to a specific set of prompts, gestures, and modalities – seen in Figures 79-90. Initially, the excavation, gathering, and piling of earth provides a platform that can be compacted and printed over. Printers on tracks are moved to the top of the pile, positioned, leveled, and prepped for printing. Surrounding clays, minerals, and plant matter are broken down on-site and processed into clay bodies for printing. The printer's first passes are allowed to settle against the compacted earth until a stable surface is provided. The prompting of stones and other interruptions force the printer, the operator, and the material to negotiate and settle. The piling of earth, rock, and grass provides the opportunity to engage in entropic events, allowing the material to settle within and around the print. Earth can be compacted into seating and into the ramps that frame views and bring people to the top of the Ziggurat. Over time the materials taken from the earth will return to it - as the Ziggurat slowly transitions from new build to ruderal artefact. The site offers up further opportunities for successive exploration, either through the dismantling and reconfiguration of the materials that make up the original pavilion or through subsequent additions, such as windbreaks that can be used to reduce exposure and frame views.

## Circles in the Scar

The second pavilion is imagined as a place for gathering, meeting, and orienting users to the clay pits that once

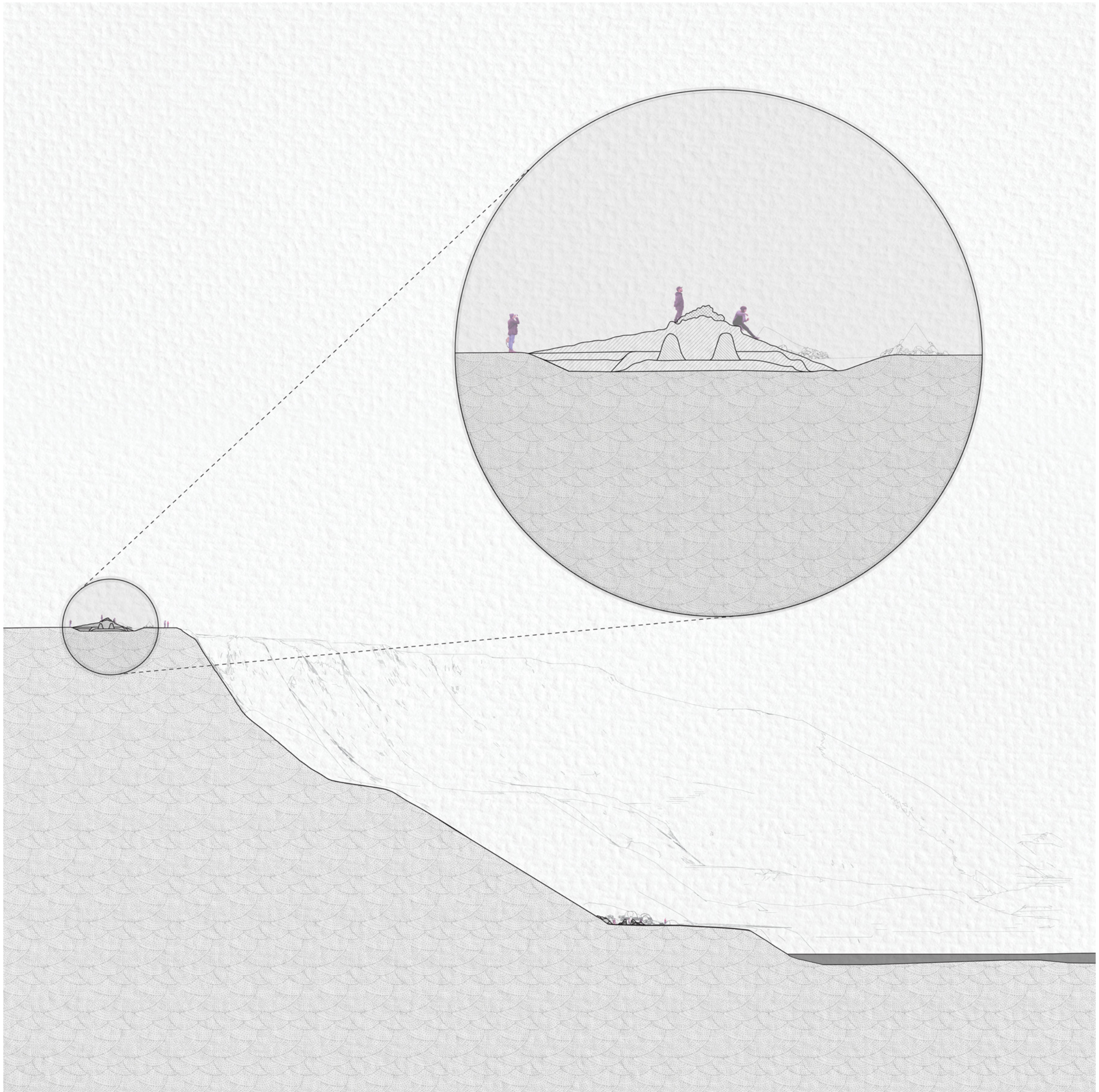

Figure 91: Site Section with blow up of Site A.

fueled ceramic production in Medicine Hat, as well as to surrounding views of the North Flats and its vibrant skies. Like the previous pavilion, the circle is made up of an accumulation of strata and mounds that correspond to specific modalities, gestures, tools, and materials—each preceding layer providing entropic opportunities or sound substrate for succeeding layers. However, rather than focusing on stone, earth, and grass, this pavilion focuses on the production and incorporation of newly made artefacts, as well as the wide range of varying clays and minerals remaining in the open scar. The pavilion is made up of an inner and outer circle. The outer circle is made up of the existing escarpment of the clay pit, which is additionally articulated by warming huts, small kilns, fuel storage, and sitting walls. The inner circle frames and articulates seating that orient users to each other, to the sky, and to fire pits. The circles also frame a transitional space in between that offers up additional seating and access to warming elements.

In the making of this mound, clay and minerals from the surrounding escarpment were processed and worked into clay bodies. Further formed into bricks, pipes, and vessels and then stacked into scove kilns and assembled into pits for firing. Distinct coloration in the varying stratum occurs from the harvesting and mixing of different clays, aggregates, and cellulose material from various locations within the area. Around the recesses in the earth created from firing, the circles emerged - made up of strata that encompass brick, fragments, stone, earth, and varying clay bodies. Each stratum printed over the previous layer pushes and pulls to provide vantage points for viewing the stars and sky, as well as enclosure for events like community pit firings or

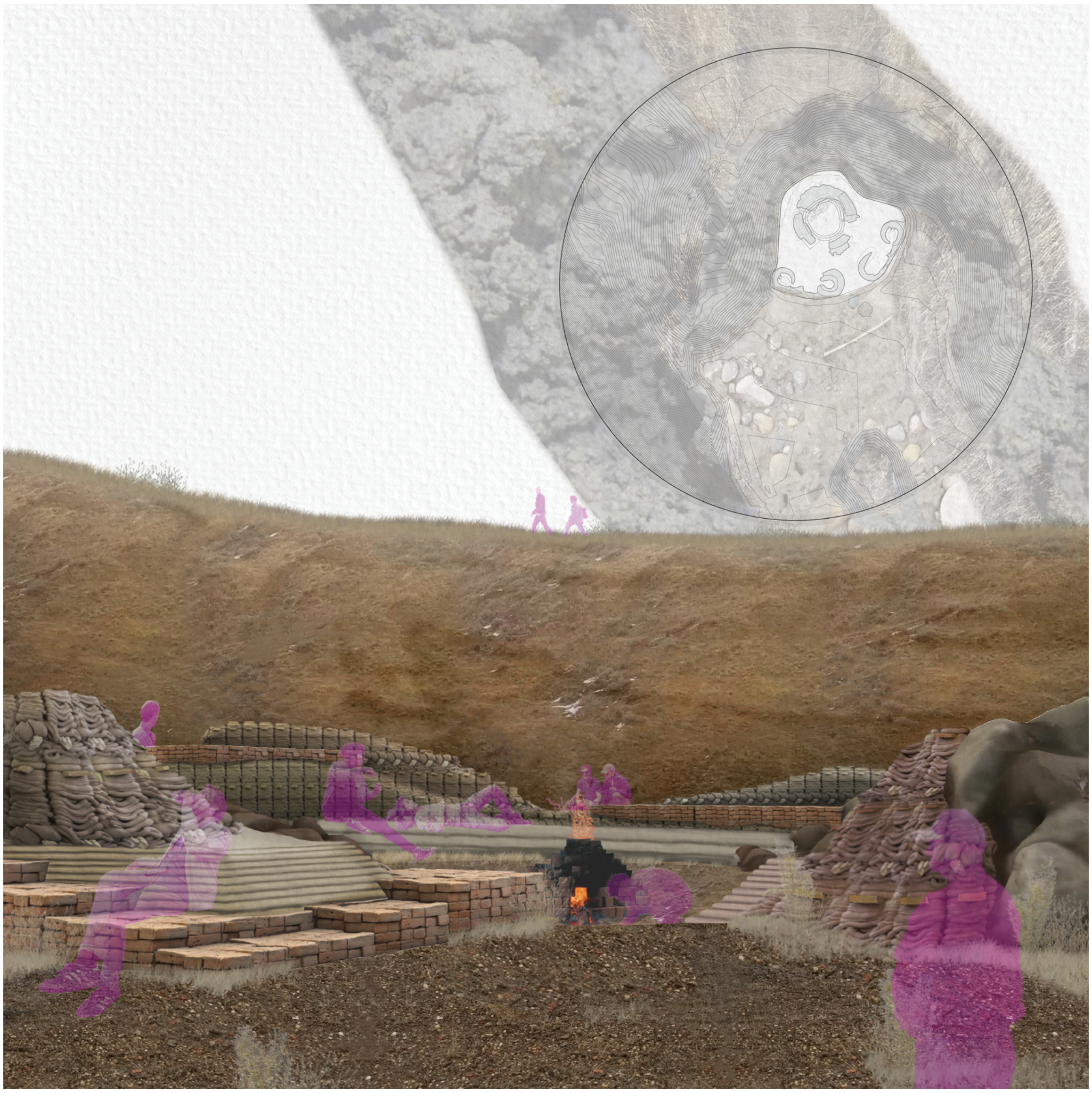

Figure 92: View looking into inner circle of Site B. Site plan ghosted in background. Base layers from: (GIS Medicine Hat, 2010).


Figure 93: Floor Plan of Pavilion B. Base layers from: (GIS Medicine Hat, 2010).

places to stop and rest before venturing onto the ziggurat that is just behind the ridgeline.

## Hearths Along the River

The last pavilion scored as a series of hearths along a sitting wall by the river is imagined as a place for gathering, views, and warmth. Situated on a small plateau just below the ziggurat sitting atop the cliffs, the hearths provide places to warm, meet and gather year-round. While the walls catch the afternoon and evening sun, provide windbreaks and seating, and offer up a place to wait and view the surrounding flats and South Saskatchewan River. This pavilion is made up of an accumulation of strata that culminate in a material library of print patterns and a wealth of interrupting materials made up of bricks, pipe, pottery fragments, and other artefacts – representative of the 100-year long reign of ceramic production in Medicine Hat.

The wall starts from a singular point and branches out, made on a base of ceramic detritus pulled from the surrounding banks of Seven Persons Creek and the South Saskatchewan River. Fragments, bricks, and pipes are collected, piled, stacked, and organized along a contour forming the base of the sitting wall. And like the previous pavilion, printers are assembled, clay bodies are gathered and mixed. The first passes are allowed to settle against the detritus, eventually providing a solid base for succeeding layers. From this substrate, a variety of stratum made up of various clay bodies, print patterns, modalities, and fragmented detritus accumulate. The work involves various areas of skill constraint, control, and certainty, where a multitude of roles from bricklayer to print operator work in sequence and in tandem. Printed mounds create opportunities for spanning with masonry through corbelling. And where spans are required but corbelling isn't as feasible, local crop residue is brought in packed, printed over, and then burned out – acting both as falsework for the spans and as fertilizer for the surrounding plateau.

This final intervention, along with the two other pavilions and the potential for a handful of other programmatic elements sprinkled throughout the pipe-plant site, could work to stitch together varying routes and experiences. Additionally, the pavilions could serve to programmatically tie the Clay District's Historical Society to working with these sites in more architectural and experiential manners.

Figure 94: Approach to pavilion C. Site plan ghosted in background. Base layers from: (GIS Medicine Hat, 2010).

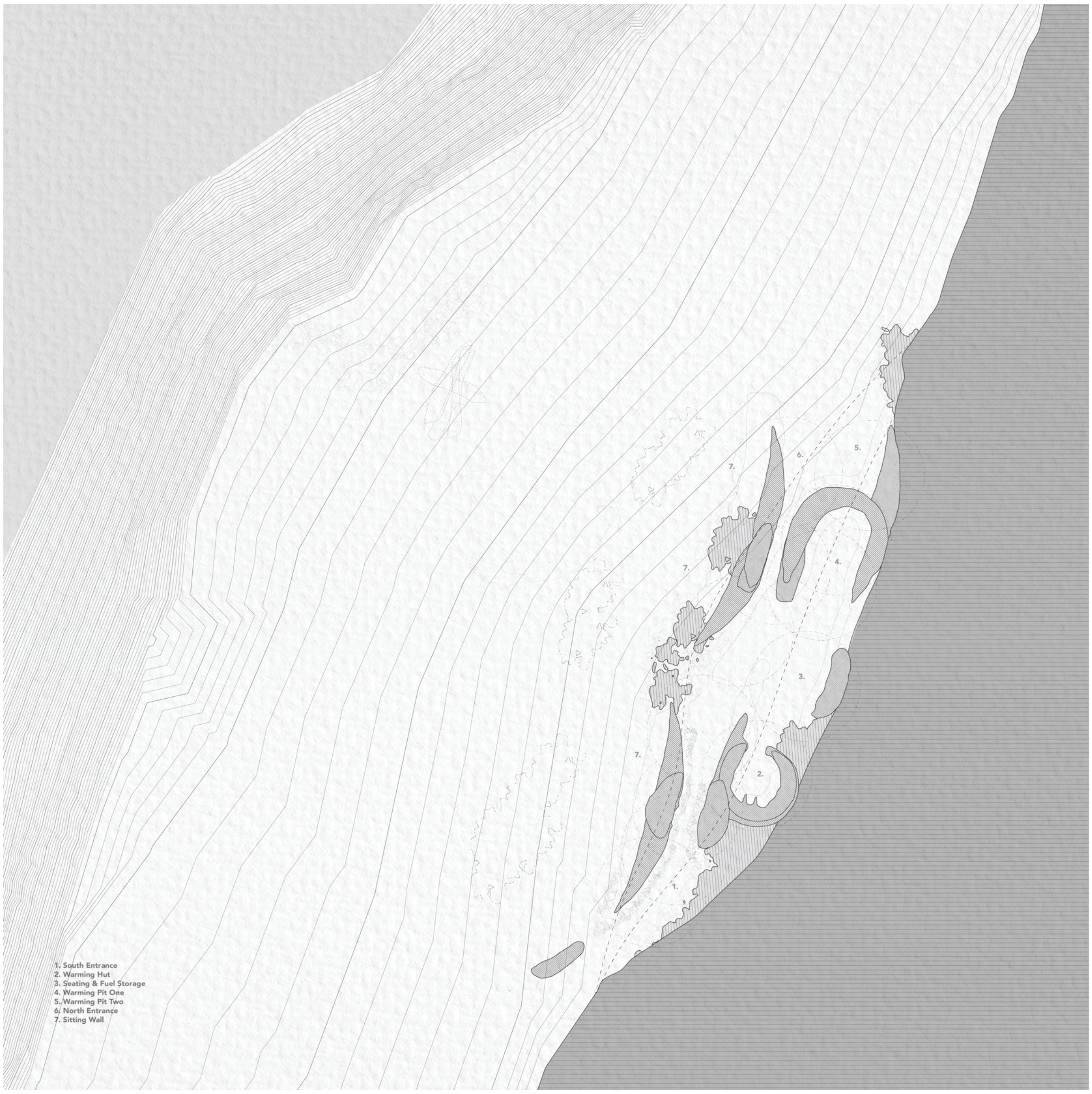


Figure 95: Floor Plan for Site C.

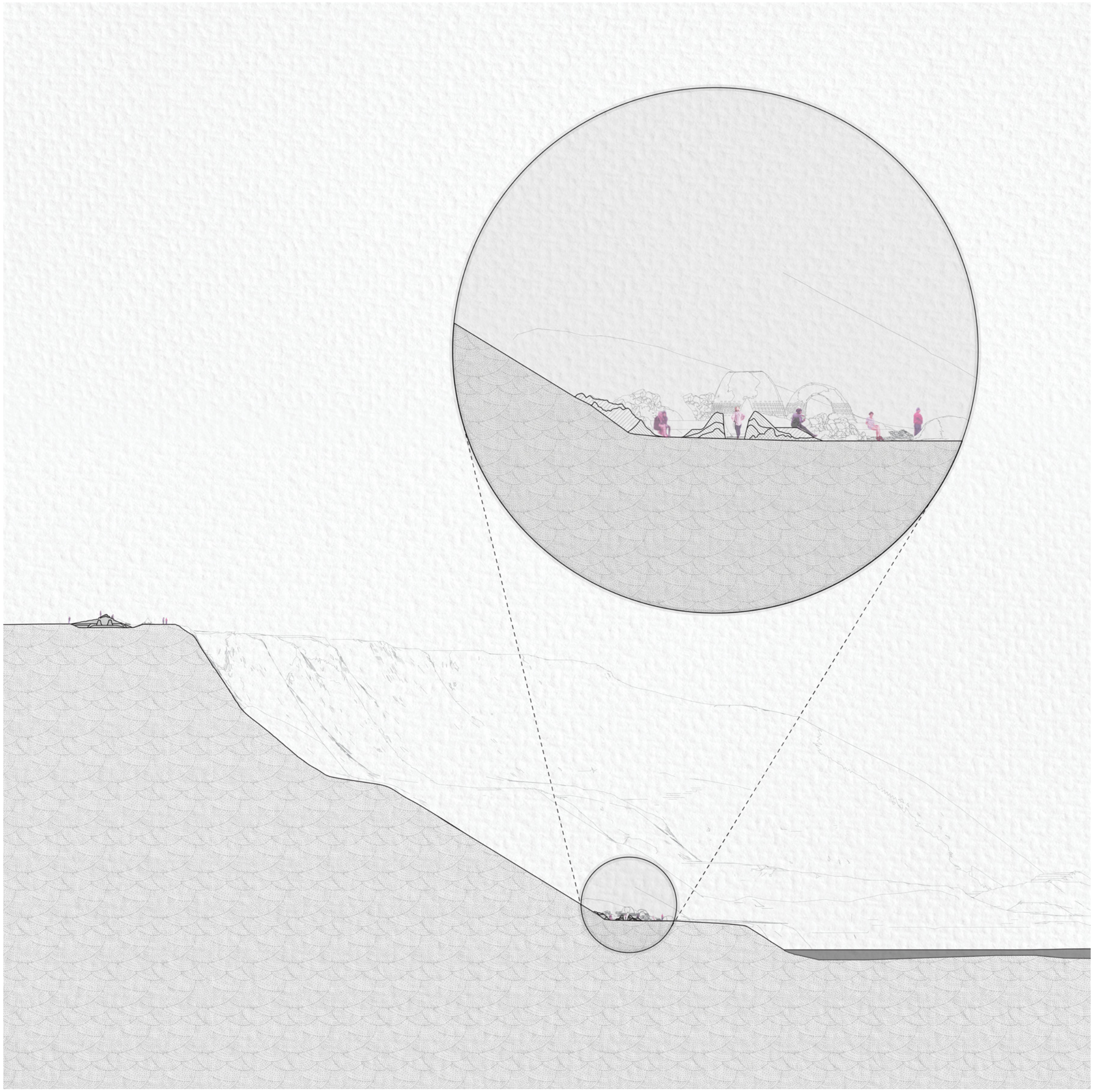

Figure 96:  Site Section with blow up of Site C.

# Chapter 6: Findings

## Summary

In thinking through mounding, the work has opened itself up to various potential participants within the fabric of Medicine Hat. Ranging anywhere from the variety of clays you would find along the banks and streams of the north flats to the variety of individuals located within the city's fabric – each bringing their own set of skills, knowledges, and willingness to participate with a material that is held so dearly within the community. While there is no certainty in an actual dissemination and uptake of the methodology, it provides the potential for the maintenance of skills, the possibilities to engage and learn new ones and provide avenues for experiencing the material landscape. Regardless, these modalities can be brought into the work at different stages and at various points to engage a wide variety of skillsets, backgrounds, and age groups, while allowing varying amounts of human and non-human agency to permeate making processes. And by engaging in a broad spectrum of printing modalities, opportunities for the restoration, remediation, and reconfiguration around craft can be broached (Sennett 2012, 213-214).

> At a restoration level, it allows for the maintenance and repair of craft already existing and embedded in the landscape. Where embodied skill surrounding brick making, pottery, and ceramic processes, built over a century of industry, and still very much present in the landscape, can take part in working with and experiencing material - continually updating, teaching, and maintaining.

At a remediation level, it allows for the update, alteration, and evolution of craft in landscape. Where novel skills, approaches, and modalities can be introduced into the cultural landscape. Specifically, this occurs where novel automated and semi-automated controlled additive processes are brought in to augment already present approaches to making. This would be present in something like machine extruding bricks or cups or printing more significant structural components.

And at a reconfiguration level, the intersection of emerging and originating modalities can be combined, paired, and reconfigured to produce emergent architecture, craft, and material gestures. This is where most of the emphasis is placed in the work and specifically looks at how artefacts, detritus, and newly produced craft products can work to interrupt both automated, semi-automated, and somatically determined operations.

## Design Agency and Community Potential

The scoring process and methodology, like mounding, opens itself up to participants and, by extension, the community. There is a wealth of knowledge and an appreciation for working with the material in the community that the process is open to. And while the scope of community participation ends at the openness of the process within this work, it still might be of some benefit to discuss how the community within Medicine Hat may be involved in this process? What may it mean to the community? And to what end should their involvement take? A larger part of the benefit of this involvement is that it provides the potential for individuals to not only participate with a material landscape that they had previously engaged with, but works to route them on the continuum that the craft and landscape sit within. The means and methods used in this work, if disseminated and implemented, provide opportunities to root oneself within a continuum, both in an archaeological manner, where past substrate tells material narratives, as wells as through an additive manner where new methods iterations and participatory interactions result in layers to existing mounds. An although the mode and approach to making are shifted in this context, it still provides meaningful avenues of experience in terms of maintenance (mentioned previously) and spatial, material, and temporal experiences.

To what end does community participation serve, is another question? On the one hand, there already exists facilitation of material engagement practices that are culturally situated by the Medalta Society through existing workshops, residencies, and classes. And the inclusion of the community in this process would seem to bolster the already existing programmatic elements of the Medalta Society through more events, workshops, and other programming that would leverage more architectural approaches to the maintenance and development of skill. On the other side, as there is a great deal of speculation, there is no guarantee that individuals will be willing to participate or donate their time, knowledge, and skill within this process – even if all the tools, methods, and framework are in place. Additionally, there is no guarantee that anything meaningful will be produced within the process, at least without proper guidance and organization. With this, differing levels of design agency that are afforded in the process come into play.

With regards to the design agency within the scoring and scripting methods utilized in the work, much like how printing can be carried out on a spectrum, so, too, can the design agency. Regardless, within the work, the speculation, the openness of the methodology, the formal organization, and structural ideas of the interventions still very much rest in the hands of the designer. The choice to place a mound along a specific topology, to frame a particular view, or to orient users within a landscape is still very much left to the designer. This rings through at both the physical level, where the designer analyzes the site and the surrounding fabric and makes design choices based on findings and the phasing and organization of work and equipment on site. Additionally, the designer's agency and choices ring through in the digital realm as well. They would be required to have a certain level of digital proficiency in order to produce the scores and translate the digital models, rules, and frameworks into code. And additionally, the designer would be required to be proficient enough to operate a printer well enough to be able to translate the code into a physical form. The designer needs to have enough digital, technical, and material proficiency in order to guide the work.

Where design agency is given over is to the small agencies that materials provide when they are utilized and forced to interact with other materials tools and participants. A material may hold a certain characteristic, and designers and participants may even be aware of this. Still, it is the plethora of complex mechanical relationships held in the material (i.e., its density, porosity, and molecular alignments) in relation to the complex series of forces at hand in the making, settling, drying/curing, and weathering processes (i.e., gravity, rain, wind, humidity, etc.) that determine how the material acts when placed. A lot of the process works to leverage the small interactions and agencies that local clay bodies, detritus, and artefacts provide, and it is the designer's understanding of this that allows the designer's utilization of specific strategies that mediate and negotiate in the making of material interventions. The designer outside of this may choose to work towards specific topologies. Still, within the methodology, the designer should be open to watching, dialoguing, and responding to what the material would like to do.

And again, because the process is open to participants, how those participants interact, work and respond within the process is part of the considerations that the designer must take into account. Agency may be given to craftsperson, bricklayer, and other participants within the process at the local level. A brickmaker may be brought in and given a score and instruction to respond and build new layers in response to what is already placed. But it is the surveying, understanding, and organization of how all these participants will be included, ordered, organized, sequence, and overlapped within the process that is up to the designer. The designer, in a sense, becomes a choreographer; they organize the score, determine what prompts, gestures, and modalities are used, and guide and direct the work. Like Anna and Lawrence Halprin's RSVP methodology, the designer is surveying not only material participants, topologies, and forces but also the skill and intelligences that are available for leveraging within the work (Hirsch 2014, 187-188). The designer orders and sequences experience, and within the process, they constantly must evaluate and revise the score as needed in response to the physical actions of craftspeople and the resultant material forms that emerge. The designer surveys, organizes and guides the execution of the performance of work within this methodology. Regardless, this is a flexible process, and there is room for collaboration and consultation.

## Material Attitudes

Similarly, what has emerged out of mounding, while not necessarily new, are attitudes towards the procurement, treatment, and use of materials. The idiom ‘one person’s trash is another’s treasure’ seems to ring true within the lens of mounding, in that, in the procurement of our materials, we do not always have to span territories and engage in massive flows of materials. Mounding to a certain degree forces those working under the lens to look and assess what opportunities are present underfoot, what in a landscape has accumulated over time, what materials are open to participate, and how they should be incorporated and used within a project. This is not to say we should not engage in larger territorial material networks, but mounding forces questions around what potential that surrounding materials carry and challenges architects, makers, builders, and craftsperson to find ways to implement and assemble these materials. Rather than transporting brick, tile, and other materials from thousands of kilometers away, a mounding lens asks how do we reconfigure and reassemble existing mounds of detritus? Or how do we form new assemblages from the mineral wealth present within the Medicine Hat landscape?

Mounding also allows the leveraging of the small agencies that materials possess. In looking at the locality of materials, trash and refuse suddenly becomes powerful narrative tools that can be used to articulate specific phenomenological experiences through providing mass, substrate, pattern, porosity, or a plethora of other strategies. Making up varying portions of differing stratums, these materials intermix to tell material narratives within the structures of the mound. Whether added to over the years or allowed to weather and return to the earth to be uncovered and rediscovered in later iterations, all materials hold portions of stories – meaningful to the surrounding community. Additionally, the process allows material to communicate with natural forces, processes, other materials, and participants that surround it in all directions. And if the operator, the brickmaker, the architect, or the maker watches closes enough, they are presented with an opportunity to engage in a material dialogue. The material might settle in a way that provides an interesting topology to print over, or the settling of clay bodies could lead to level surfaces, spans, different types of enclosures, porosity, and a variety of other material outcomes and experiences. Nevertheless, mounding gives life to these materials; it allows them to present their narratives, act in relation to each other, and to speak and offer up experiential opportunities. Mounding offers up phenomenological and material experiences that would be missed out on, if in the procurement of materials, we looked to larger territories, as is often done in architectural work, rather than looking at what is local or 'underfoot.'

## A Mounding Taxonomy

The lens provided a route towards dense and varying material experiences. Culminating in a suite of phenomenological strategies, where certain moves, gestures, and materials could be mobilized for creating mass or creating porosity. The addition of a brick during printing and its removal after drying provides a situation where light, wind, and water

Figure 97: Composite image of studies.

can move through enclosure. The settling of extra material near a hearth may provide additional mass to hold heat and warmth. While the articulation of code can create porosity, allowing wind, water, and light through the material at varying densities – seen in Figure 97. The introduction of various gestures, prompts, and modalities, along with their potential to mutate and evolve, create an infinite toolbox of strategies that can be handed off, learned from, utilized, and potentially passed down. Each study produced in this body of work successively contributes to the development of a large variety of strategies. And within the final pavilions produced in this work, the strategies embedded within this toolkit started to populate architecturally. Some strategies were specific to a pavilion, emerging out of the architecture, such as the woven-like patterning found in the warming huts seen in Figure 94 - letting light and smoke pass through the enclosure. While some strategies are shared between but produce different results and effects based on the context, such as the use of other materials as an interrupting force – offsetting, pushing, and pulling the toolpath. In Figure 94, the structures are used as an archeological narrative device. In contrast, in Figure 77, the addition and removal of interrupting material creates porosity and recesses in the structure that are potentially compatible with other non-humans.

Additionally, the nature of mounding allows the deposition of material experiences to occur, exhibiting them for future inhabitants to enjoy and for future makers to assess, utilize, develop and build upon through their work and potential additions. Overall, the mounding lens facilitated the development of the methodology as a sort of toolkit, where different strategies, modalities, gestures, and materials can coalesce to create context-specific architecture and material experiences. There is a formal language within this toolkit, with digital and physical components that can be handed off, passed down, and built upon. And more importantly, the toolkit or toolbox or taxonomy of materials frames printing as something that occurs over a spectrum and that has the potential to be open to a variety of participants, all with differing backgrounds, intelligences, and skillsets. Architecture can be printed with machines and operators, but it can also be printed by hand, made with a wide range of modalities, or any range and mix of differing modalities, along with material strategies can be utilized to articulate a broad and almost infinite range of phenomenological and material experiences.

## Towards Printing Within the Environment

Lastly, what is important about mounding is that it holds a density of indiscriminate reciprocal relationships between participants, which can morph and change over time as needed. In looking back at the work, I do not think the architecture needs to share the tectonics of the mound, nor should it share a homogeneity between elements. But in thinking through mounding, the lens certainly seems to provide a benefit to the approach. The lens provided a route towards dense and varying material experiences, and through speculation, provides potential routes towards printing processes that can be context-aware. Aware of the cultural fabric and its associated material provenance and plethora of participants, each bringing a unique set of skills, knowledge, and intelligence. Aware of the material opportunities and the strategies, experiences, and meanings that come along with them. Aware of a landscape that brings forward its own set of ever-changing forces and processes. And the potential to be mindful of the needs and experiences of non-human participants, whether flora and fauna, that populate the north flats of the Historic Clay District in Medicine Hat. Thus, while speculative, the work arranges and pulls together various threads and avenues – each providing trajectories forward.

# Chapter 7: Conclusion

## Limitations

The scope of the work in this thesis is that it focuses on practices that are open to varying participants. But there is no guarantee that if the methodology is disseminated, there will be an uptake and implementation. The methodology, in a sense, relies on surveying and organizing what prompts, gestures, materials, and modalities will be a part of the toolset being used. This requires a level of guidance, requires some designing, and will, of course, often come with some level of agenda. You can provide tools and frameworks, but that does not necessarily mean people will take to the process. It does not mean anything good will be made either. Additionally, while the desktop and lab type speculations have the potential to scale to site, as they deal with similar underlying dynamics. There is a world of unforeseen complexities and challenges that are not and cannot be characterized in these studies.

## Future Directions for the Work

While the study encompasses a broad range of speculation, and the technical investigations of printing are well characterized within the current discourse, the lens of mounding gives a new way to enter those investigations. As such, the work has left me questioning how mounding could be investigated in relation to existing technical methodologies, other materials feedstocks, and traditional space planning scenarios. Moving from a mode of speculation to another that involves fieldwork and context-aware printing is a logical next step for the work. Being on-site, walking the landscape, taking in the sounds, its forces, and its fluxes provides a better backdrop for carrying out field tests and investigations with materials found on site. In addition, each material may physically bring forward different performances and properties that could be leveraged in-situ or semi-in-situ workflows. And working on-site would additionally force the printer, the operator, materials, and other participants to deal with a specific context, its related forces, and fluxes (whether those be gravity, wind, rain, snow, etc.), and the passage of time and its associated issues (phasing, drying, humidity, etc.). Striving towards this would provide a scenario to further test, adjust, and expand on the scoring technologies while providing an opportunity to tie the process to a specific site deeply. This would also involve introducing existing procedures and methods already existing in the printing discourse and would further serve as an avenue for testing the process against existing methods and practices.

Additional future public workshops, outside of a Covid-19 environment, could potentially push the methodologies and processes in different ways and start to resolve questions around the involvement of public participation that emerged throughout the thesis. Questions around how public participation might fit into this process and to what end and manner. Workshops, whether directly associated with architectural interventions within the landscape, or indirectly related through exercises, involving other participants in this manner provides an opportunity to help test, refine, and further develop the work and its methodologies, as well as create meaningful and compelling forms, experiences, artefacts, and architecture. This would involve organizing specific frameworks in which to test the scoring processes in relation to workshops.

Lastly, there now exists a curiosity around introducing the methodology to other feedstocks and modalities. Printing Provenance and its methodologies do not necessarily have to strictly exist within Medicine Hat’s Historic Clay District boundary but could be carried out in other contexts. New contexts, new feedstocks, and new material landscapes could potentially push and pull the methodology in different ways and different directions and with new focuses emerging out of new contexts. New contexts could shift the focus of the work as well, from work that is primarily cultural to work centering on more ecological lenses, participants, and clients. What might these mounds look like if they centered specific natural processes within a context? And what might they look like if they specifically focused on the intersections between human beings and their non-human neighbors? How would those mounds be scored? How might this context affect how they are scored? And how might this shift the work and the methodology in new directions.

## Concluding Remarks

Overall, the work sets out to address how specific forms of printing could coalesce and create reparative material experiences. And in many ways, the work starts to achieve this. The mounding lens provided an excellent avenue for opening a process that is typically seen as inaccessible by most people while centering culturally important narratives, materials, and processes. At a base level, the work provides some benefit in showcasing applications of technologies in relation to materials. That technology does not necessarily have to be siloed into rigid purposes but can be flexible, reconfigured, and misused in certain ways. And that there is room for embodied knowledge and tacit action within a process where various somatic operations can work in tandem with highly technical and mechanical operations. The work additionally brings forward the material as a design driver, where the ‘small’ agencies offered up by various materials really start to inform the output and the direction of the work. The locality of materials within the landscape focuses the work, and the intrinsic and extrinsic qualities of those materials impact the artefacts, interventions, and architecture that can be made. Through this, specific relationships between material, environment, tools, and maker are brought forward. Overall, the method treats building and making as a process of growth, centering the operations and processes involved in the continual making and remaking of mounds rather than the consumption of materials. And while the work is speculative and possesses its own limitations, it pulls together a variety of threads and avenues that can be further pursued.

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