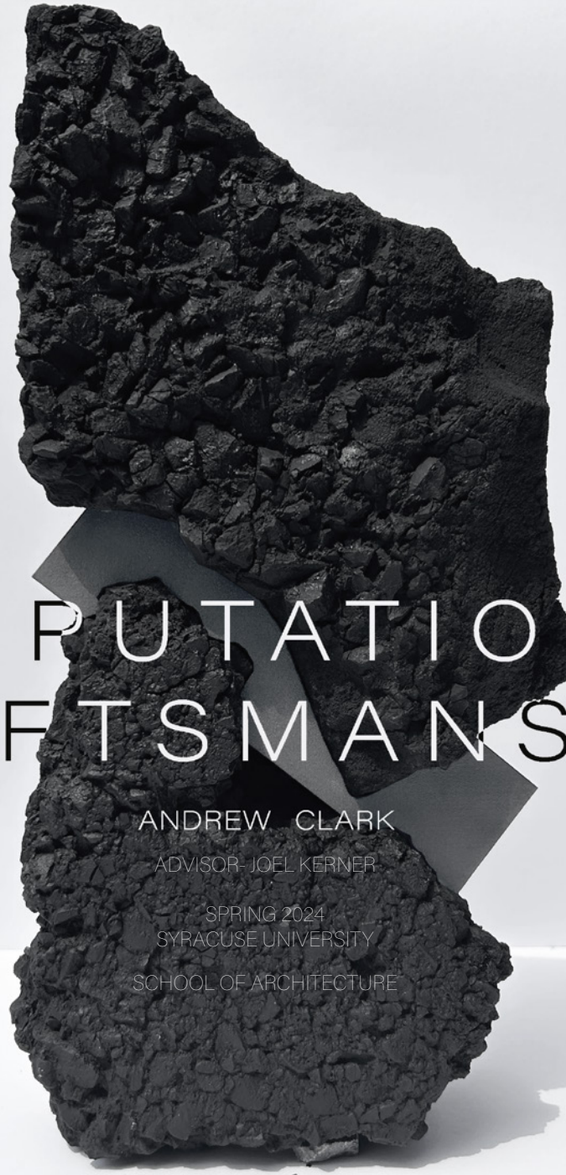

COMPUTATIONAL CRAFTSMANSHIP

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SPRING 2024
SYRACUSE UNIVERSITY

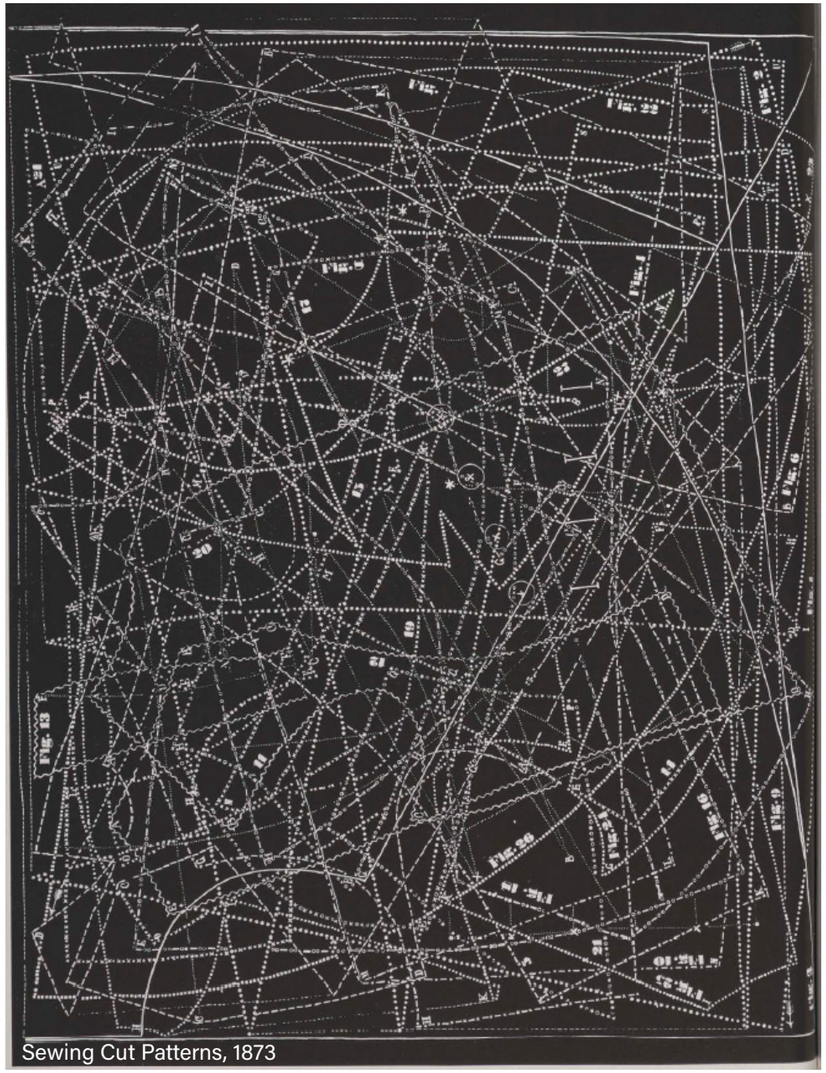
SCHOOL OF ARCHITECTURE

COMPUTATIONAL CRAFTSMANSHIP imagines a future American reality where computational designers and traditional regional craftspeople live in a symbiotic relationship, relying on each other to advance each discipline. In this future, crafts that had been thought extinct in the early 21st century are revitalized and utilized alongside digital techniques that did not exist before the 21st century. Specifically, this research focuses on one region of the United States, costal New England, utilizing local crafts embed in the culture. This project interrogates the interstitial space between local analog craft practices and global digital design and fabrication processes.

Rudofsky noted in *Architecture Without Architects* a connection between what he calls "cumbersome technology" and "vernacular architecture" and presents the idea that maybe the two aren't so dissimilar. Fifty years later, Mario Carpo resumes Rudofsky's point in Digital Darwinism, stating that "computer driven fabrication has mirrored, and at times reenacted aspects of traditional, one- to- one hand making and bespoke craftsmanship" further stating that both work utilizing "intellection". The drawing on the right appears to allude to early computational drawings, focused on optimization, form finding, and geometric packing, but is actually a hand crafted seamstress' pattern from the 1870s, published in Rudofsky's book, *Are Clothes Modern?*. While there are certainly strong connections between craft and computation, this is not to argue there are no dissimilarities.

"We learn that many audacious **"primitive" solutions anticipate our cumbersome technology;** that many a feature invented in recent years is old hat in **vernacular** architecture-prefabrication, standardization of building components, flexible and movable structures, and, more especially, floor-heating, air-conditioning, light control, even elevators."
- Bernanrd Rudofsky, from Architecture without Architects, 1964

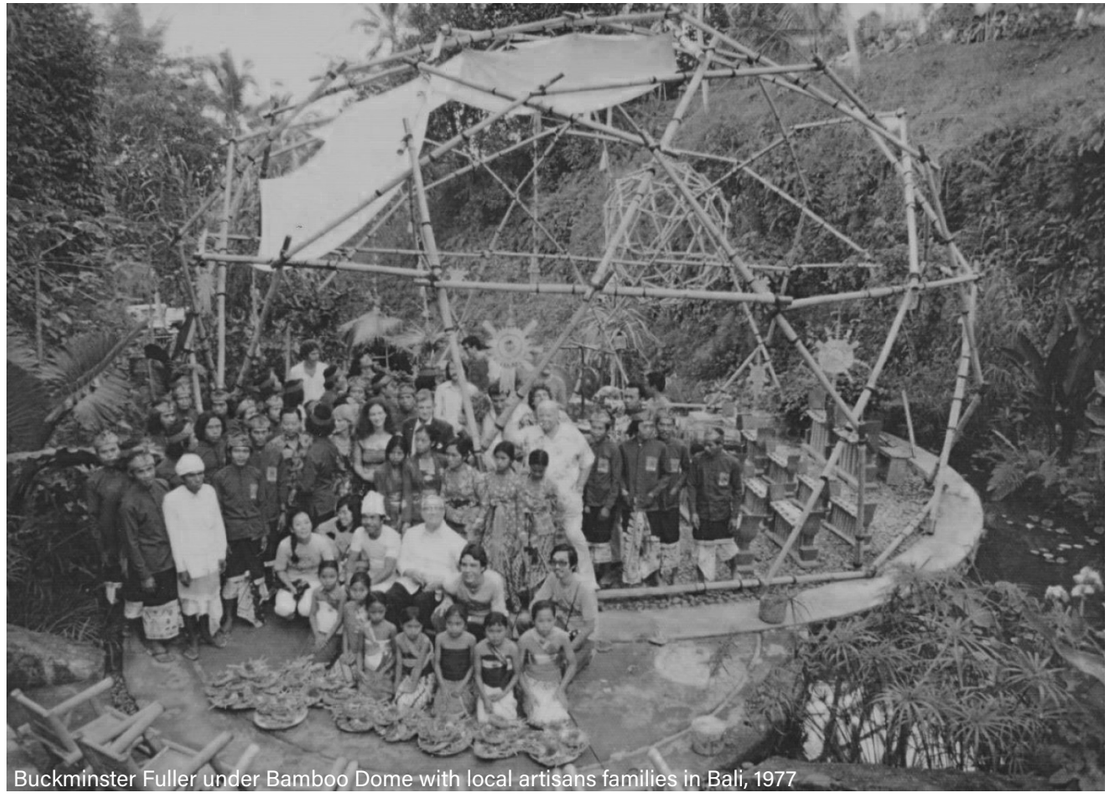
"For the last 20 years **the technical continuity between computer- based design and computer-driven fabrication has mirrored, and at times reenacted, aspects of traditional, one-to-one hand-making and bespoke craftsmanship.** Digital craftsmen increasingly perceive CAD-CAM technologies as an extension of the mind and body of the designer, and many have embraced traditional, phenomenological, and esoteric interpretations of craftsmanship, as recently epitomized, for example, in an influential work by Richard Sennerr. The "tacit knowledge" of the craftsman cannot be verbalized because it derives from a mystical union between the body of the artisan and the materials he is crafting. This union, which traditional sciences used so called **"intellection" can only happen through an Itinerarium Mentis in Deum**. Today, a new generation of digitally intelligent designers seems to sense that **computers may facilitate that itinerary- or even rake part in it.**"
Mario Carpo, from Digital Darwinism, 2012


Sewing Cut Patterns, 1873

As Picon says in *The Politics of Architecture and Subjectivity*, "things have indeed changed' but he argues that the connection of these changes to the "permanence" of historic moments "carries lessons". This past and present relationship Picon is noting, is where "architects are comfortable living" as Greg Lynn notes in Machin Language. The image to the right shows Buckminster Fuller with one of his trademark geodesic forms built with traditional bamboo construction techniques by craftspeople in Bali, "connecting new potential with... disciplinary history."

"Simultaneously, the realization that **things have indeed changed** must come with an impression of deja-vu, which suggests **underlying threads relating former historical moments to present day issues**. It is only when it explores **this mix of change and permanence** that history carries lessons."
-Antoine Picon, from Ornamnent The Politics of Architecture and Subjectivity, 2013

"**Architects are comfortable living in the future and the past**.... The big task for architecture is **connecting this new potential with our disciplinary history**, which is about **part-to-whole relationships**, that is, how elements relate to a larger grouping and a larger catalogue of components". -Greg Lynn, Machine Language, 2007



Buckminster Fuller under Bamboo Dome with local artisans families in Bali, 1977

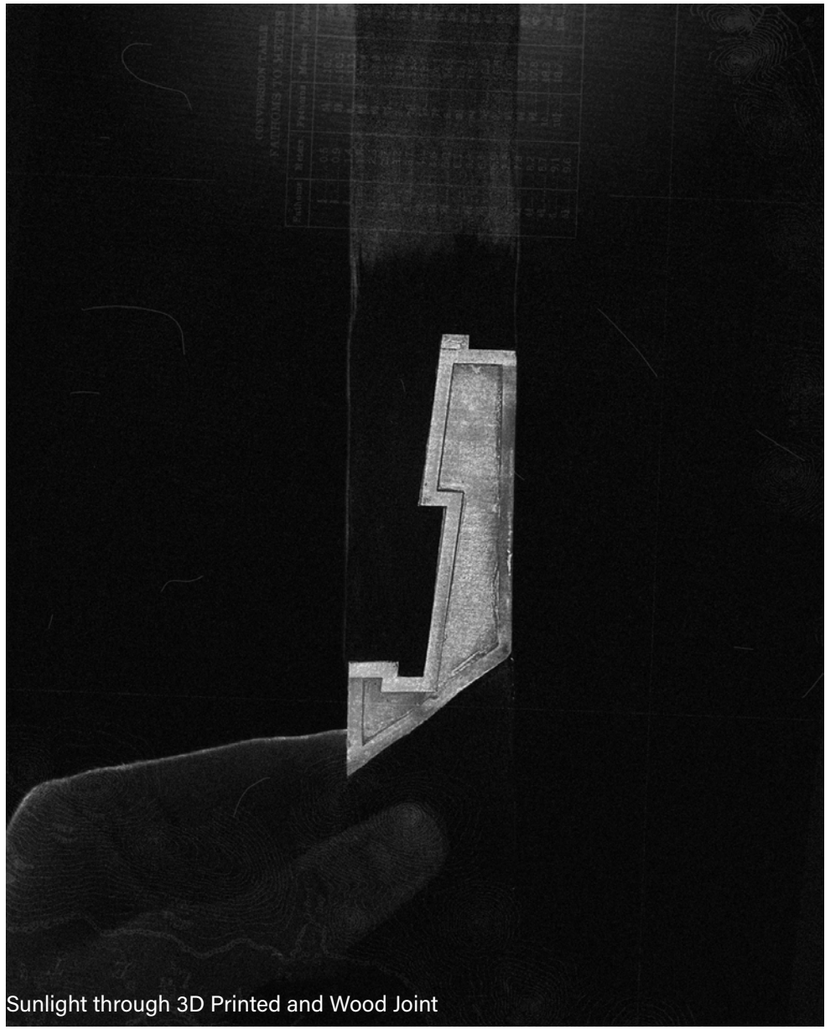
From these ideas, the question becomes, what is the goal of this connection of past and present and as Picon states in Digital Culture and Architecture, what is the "direction architecture is taking under its influence." There is certainly paradox in the connection of computation and craft but according to August Heckscher in the public happiness, "their incongruity suggesting a kind of truth."

"We are now past these initial reactions of enthusiasm or concern. The question is no longer whether digital technology is a good or bad thing for design; it is rather about the direction architecture is taking under its influence."
-Antoine Picon, from Digital Culture and Architecture, 2010

"**A feeling for paradox** allows seemingly dissimilar things to exist side by side, their very incongruity suggesting a kind of **truth**."
-August Heckscher, from The Public Happiness, 1962

Contemporary precedents who worked on similar projects were researched to understand their "truths", specifically looking into the kind of language they use to describe their projects, from T+E+A+Ms "aesthetics of reassembly" to Gil Sunshine's "interaction of parts, sites, actions and protocols". Particularly based on the language examined, the projects and practices were mapped along a blurry scale from subject (craft) to objective (computation) and vertically from aesthetic to political, and from cost efficient to optimization. Hoping to fill a void on the diagram somewhere between subjectively and culturally significant and objectively efficient, specific pairings of craft tools and computational technologies were explored.

The crafts and technologies were initially mapped independently on a political compass of attributes from local to global, strategic to tactical, and pre-consumer to post. The tools were then paired to be remapped in favor communal efforts, small catchments, and local materials. Your booklet is a cheat sheet into some of these pairings. Three of these pairings have been further detailed in drawing and model.


Sunlight through 3D Printed and Wood Joint

"Clastic Order is a series of free-standing columns made by combining reclaimed construction debris with post-industrial plastic waste, and the first full-scale demonstration of T+E+A+M's ongoing research on the strategies and **aesthetics of reassembly.**"

-T+E+A+M, Clastic Order, 2017

"**Easily deployed** and assembled, UNLOG unfolds several logs into an undulating and lightweight biomaterials A-frame structure... UNLOG utilizes robotic kerfing techniques and Mixed Reality tools to transform dying Ash trees into a **materially efficient, valuable resource.**"

-HANNAH, Log Knot, 2018

"My hope, I would figure it would be any architects hope, is that the **object always surpasses whatever you've written about it,** and to write about an object is to, at the very best, give it a glancing blow, so to speak."

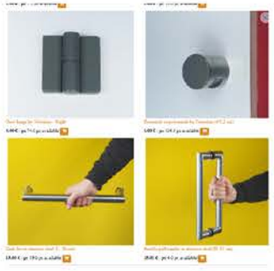
-Jason Payne, Raspberry Fields/ Rawhide, 2011

"This book contextualizes these practices, deciphers the **mysteries embedded in their cryptic geometries**, and provides a series of recipes that can be adapted, automated, and applied today."

-MATTER Design, Cyclopean Cannibalism, 2017

"Looking closely at the surface of the museum wall and its history, we looked at alternate uses and applications of drywall... Through this process, we created a new kind of **subtle relief-decoration**..."

-New Affiliates, Drywall is Forever, 2019



"We seek to collaborate with contractors, non-profits and other companies, and to become a **central part of a regional ecosystem** for large scale reuse of building materials."

-Maarten Gielen, RotorDC

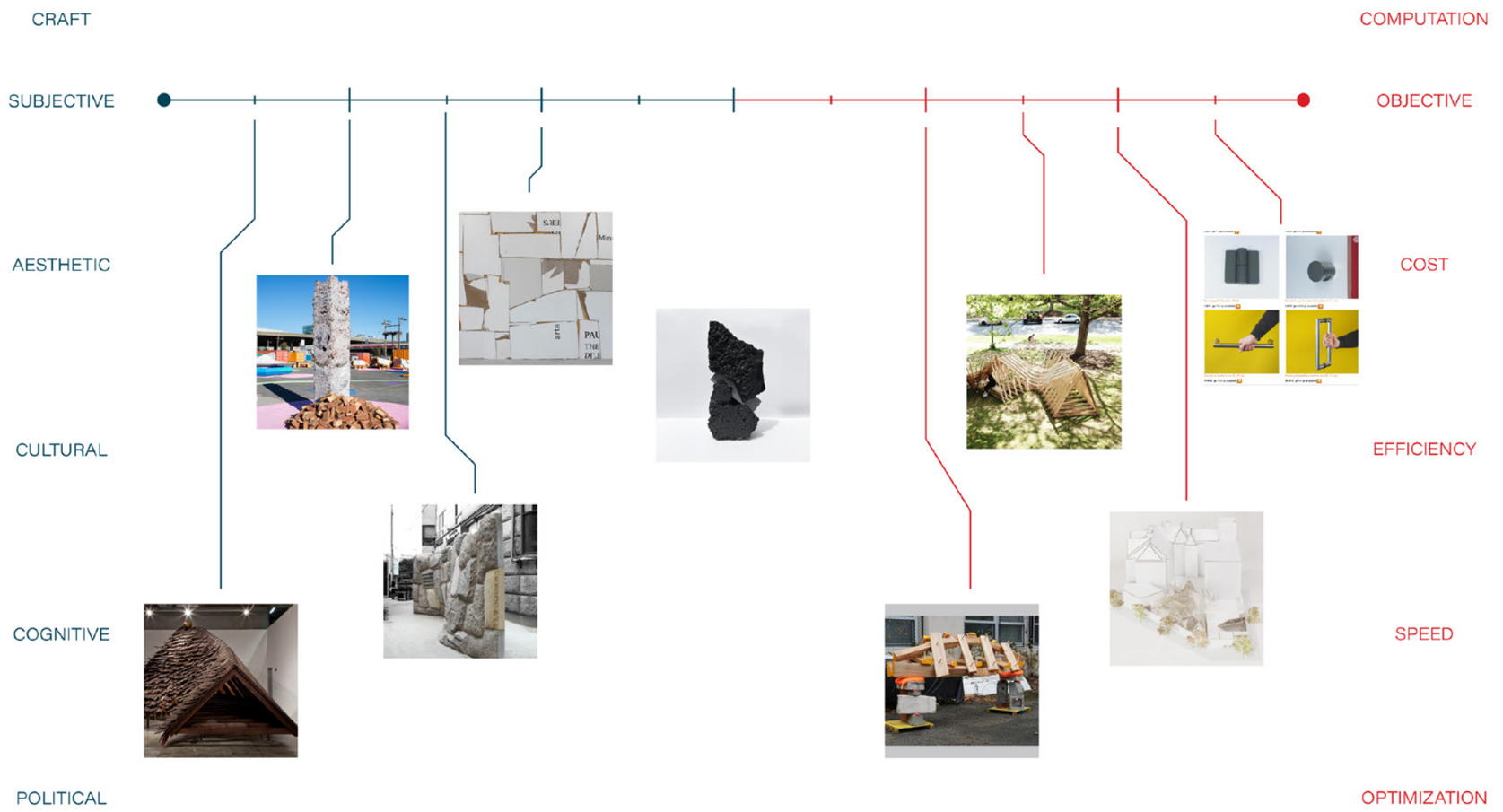
"The **construction** of the roof and deck exploit the tendency to accumulate waste that building practices typically produce. Rather than **discard material** remnants off-site, excess is cut and refit into the project for use."

-Besler and Sons, Roof Deck at MoMA PS1, 2015

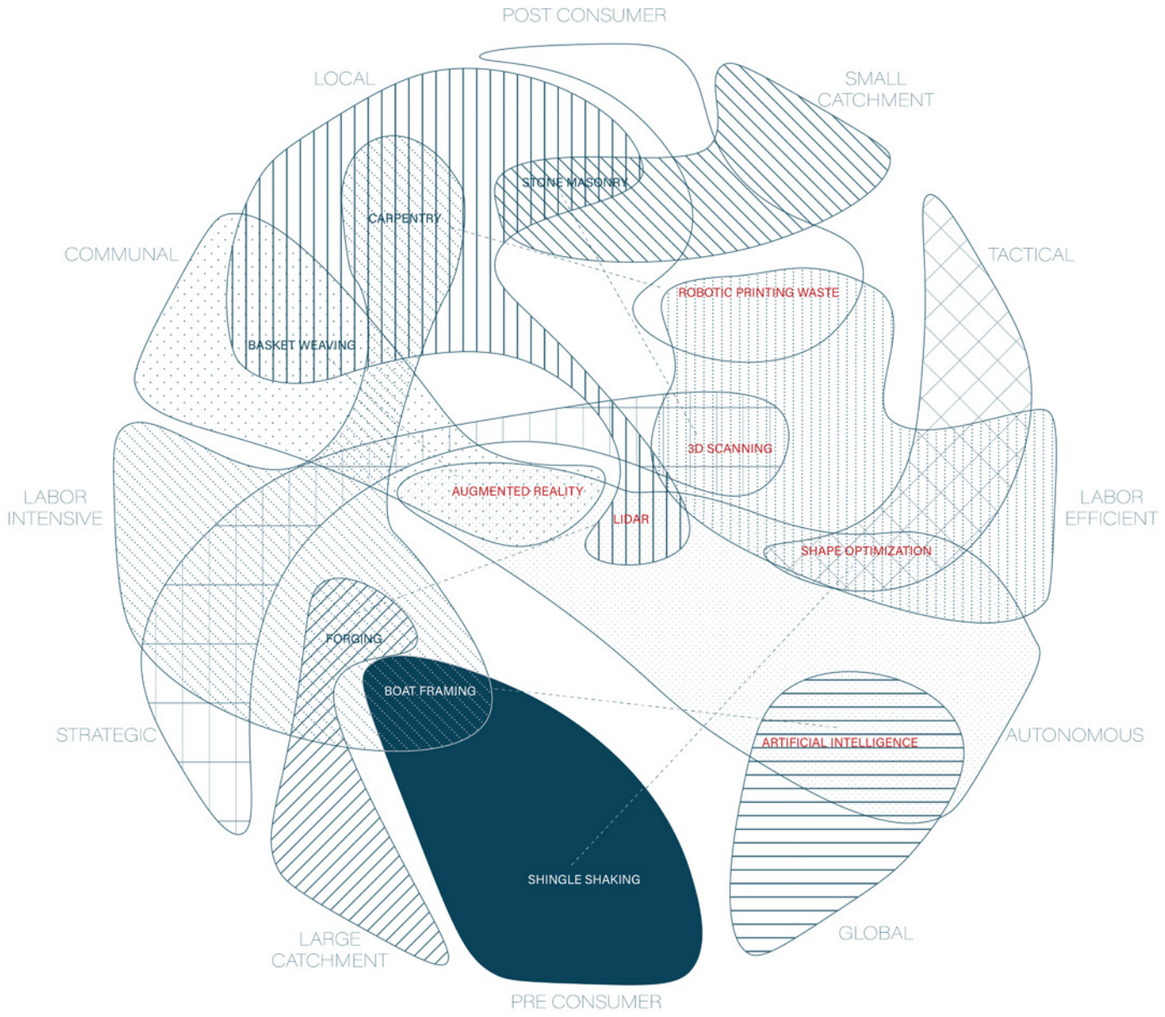
"Inventory composes architecture through the **interaction of parts, sites, actions and protocols.** Each category in its own way is an abstraction of the **physical interaction between specific materials** made possible by the medium resolution paradigm."

-Gil Sunshine, Inventory, 2022

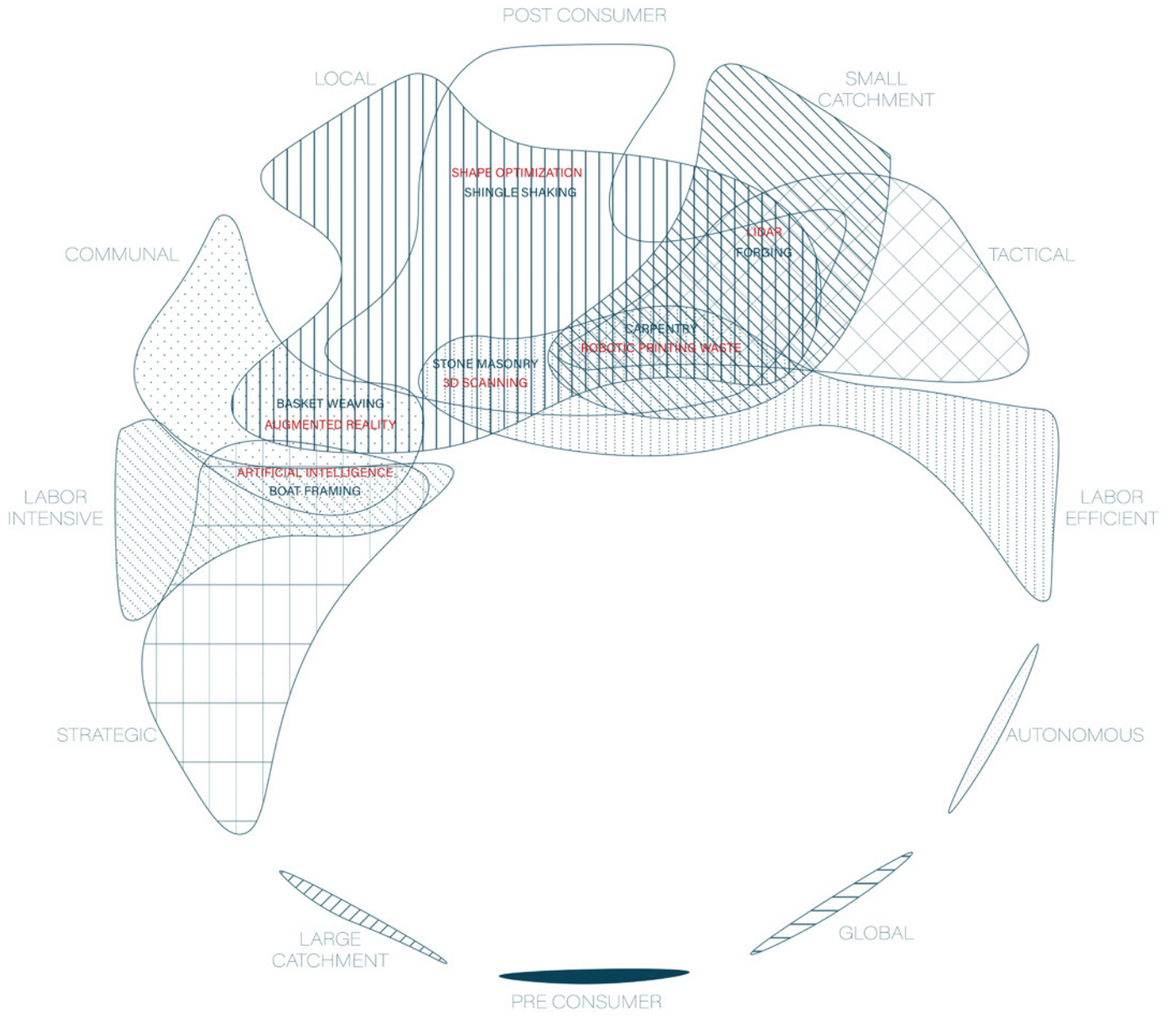
CONTEMPORARY PRACTICE REFERENCES



CONTEMPORARY PRACTICE RELATIONSHIP DIAGRAM



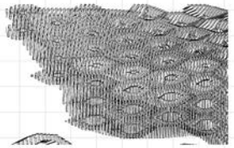
MAPPED COMPUTATIONAL AND CRAFT PRACTICES



PAIRED AND REMAPPED COMPUTATIONAL AND CRAFT PRACTICES

AUGMENTED REALITY

BASKET WEAVING



WHAT At its core lies the creation of a wooden pavilion, meticulously engineered by an architect using advanced computational tools to optimize structural integrity and material efficiency. The pavilion's facade is envisioned as a tapestry of individual basket-woven elements, seamlessly integrating architectural form with intricate artisanal detail.

WHERE This project can live within diverse spatial contexts, from urban centers to rural retreats an can be moved from place to place. This architectural intervention fosters a dialogue between contemporary design sensibilities and timeless craft traditions.

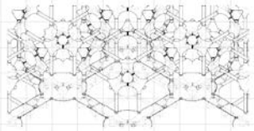
WHO The project's realization hinges upon the collaboration between an architect and a team of local basket weavers, each contributing their unique expertise to the endeavor. The architect harnesses computational design tools to conceive the pavilion's structural framework, meticulously optimizing its form and material utilization. Meanwhile, the basket weavers, equipped with augmented reality headsets, embark on a journey of creative expression, intricately weaving their craft between the structural elements with unparalleled precision and artistry.

WHEN The construction process commences with the architect's design optimization using computational tools. Once the base structure of the wooden pavilion is erected, the basket weavers, guided by augmented reality technology, immerse themselves in the weaving process, seamlessly integrating their craft with the architectural framework.

WHY By leveraging computational design tools to inform and inspire traditional craftsmanship, the project redefines the boundaries of architectural expression and cultural identity. Moreover, the integration of augmented reality technology empowers artisans to engage with architectural form in innovative ways, fostering a sense of inclusivity and accessibility within the construction process.

LIDAR

FORGING



WHAT This project focuses on the utilization of locally sourced waste metal, meticulously curated through advanced lidar technology, and repurposed into architectural elements. Through a seamless integration of digital design methodologies and artisanal forging, the project endeavors to redefine the boundaries of material reuse and structural optimization.

WHERE The project takes place nearby where waste metal can be found and sourced. The project underscores the intrinsic connection between material locality and cultural identity, fostering a symbiotic relationship between architecture and its surroundings.

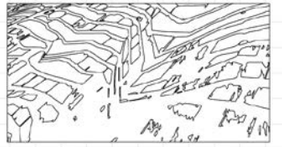
WHO At the heart of this interdisciplinary collaboration stands an architect, a resourceful distributor, and a skilled blacksmith, each contributing their unique expertise to the project's realization. The distributor harnesses lidar technology to identify and retrieve locally sourced waste metal, facilitating a supply chain for architectural fabrication. The architect, in collaboration with the blacksmith, navigates the intricate nuances of each reclaimed material piece, leveraging computational design tools to unlock its potential.

WHEN The project commences with the distributor's curation of locally sourced waste metal through lidar technology. Once selected, the architect and blacksmith embark on a collaborative journey, iteratively refining design concepts and material selections through a dialogue informed by computational analysis. Frequent updates and parametric adjustments ensure adaptability and responsiveness to unforeseen challenges, empowering the blacksmith to forge architectural elements that seamlessly integrate structural integrity with aesthetic refinement.

WHY The project's iterative design process underscores the importance of adaptability and responsiveness in navigating the complexities of material reuse and fabrication, fostering a culture of innovation and creativity within architectural discourse.

SHAPE OPTIMIZATION

SHAKE LAYING



WHAT This project repurposes second-hand wooden shingles and imperfect veneer elements sourced from nearby construction sites, reimagined through digital shape optimization tools to form a dynamic building envelope.

WHERE The project occurs on the site of a newly build or renovated façade of a building.

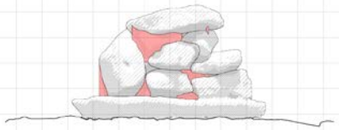
WHO At the nexus of this interdisciplinary collaboration stand a visionary designer, resourceful builders, and innovative craftsmen, each contributing their unique expertise to the project's realization. The designer harnesses digital shape optimization tools to unlock the inherent potential of reclaimed wooden shingles and veneer elements, ensuring optimal performance and respondence to the architectural composition. After which, the builders, equipped with advanced headsets, seamlessly translate the digital design into physical reality, ensuring precision and accuracy in the placement of each shingle. This collaborative exchange is facilitated by real-time communication and feedback.

WHEN The project commences with the collection and curation of reclaimed wooden elements by the designer. Through digital shape optimization tools, the designer iteratively refines the shingle shaking pattern, ensuring optimal drainage and impermeability while responding to the unique characteristics of each element. As the builders commence construction, real-time analysis and feedback through advanced headsets facilitate precision placement of the shingles, ensuring adherence to the design intent. This iterative process allows for adaptability and responsiveness to on-site modifications, fostering a dynamic exchange between digital design and physical construction.

WHY The project's seamless integration of shape optimization, AR, and shingle laying underscores the importance of adaptability and responsiveness in addressing contemporary challenges in architecture

3D SCANNING/ PRINTING

STONE MASONRY



WHAT This project explores the creation of a dry-laid stone wall, meticulously crafted from reclaimed and post-consumer materials, including repurposed construction debris, site material, and other waste. It integrates a seamless blend of ancestral craft with contemporary digital techniques to augment structural integrity and visual sophistication.

WHERE This project can take place on a site with demolition debris, local rubble, construction waste, or material runoff present, be it urban landscapes or rural settings. It can be used for creating dry laid stone walls, seawalls, fences, or other landscaping elements.

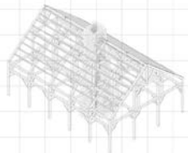
WHO At the heart of this interdisciplinary collaboration stands two protagonists: a masterful stonemason and a 3D designer. The stonemason, endowed with profound expertise in traditional masonry techniques, orchestrates the tactile manipulation of raw materials. The 3D designer, equipped with proficiency in computational algorithms and digital fabrication, orchestrates the augmentation of the stonemason's craftsmanship with precision-engineered solutions.

WHEN Initially, the stonemason commences with the foundational dry-laid stone wall construction, harnessing traditional techniques to meticulously arrange reclaimed materials. Concurrently, the 3D designer engages in a parallel endeavor, utilizing computational tools to analyze and augment the stonemason's work. As the construction progresses, collaborative dialogues ensue, with the 3D designer strategically intervening to address structural vulnerabilities and aesthetic refinements.

WHY By amalgamating the traditional craft of stone laying with computational design and digital fabrication, this project seeks to optimize material utilization, streamline a typically time-consuming construction processes, and engender structures embedded with cultural resonance a local site history.

ROBOTIC PRINTING

TIMBER FRAMING



WHAT This project revolves around the construction of a timber frame structure, where traditional builders employ time-honored techniques alongside a concurrent effort led by a computational designer utilizing a 3D printing robotic arm. The focal point of this collaboration is the creation of a hearth situated at the heart of the timber frame, embedded with a material narrative reflective of the site's history and context.

WHERE The robotic arm and designer/ operator work directly on site. The robotic arm, while printing, analyzes and responds to the workers actions and pace around it. The extruder is also able to analyze the ever-changing fed material to allow the designer to adapt the design, extrusion rate, and thickness, per the material properties.

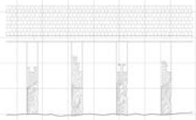
WHO At the nexus of this interdisciplinary collaboration are traditional timber builders and a computational designer and robot operator. The traditional builders orchestrate the manual assembly of the structural framework with precision and craftsmanship. Concurrently, the computational designer harnesses a choreography of the 3D printing robotic arm, infusing the hearth with a material narrative derived from local excavated earth, construction waste, and salvaged materials.

WHEN Material, from dead shrubs on site to the wood chips from hand-hewn beams, is collected throughout the construction process. As the timber frame takes shape under the traditional builders, the 3D printing robotic arm operates in tandem. The collected material is ground and blended with adhesives to be sent through the robotic arm and layered to create the hearth structure.

WHY The project seeks to push the boundaries of material exploration and spatial narrative. Moreover, the integration of local materials and site-specific histories within the hearth underscores the project's commitment to contextual sensitivity, fostering a connection between architecture, environment, and community.

CNC MILLING

STONE TO WOOD JOINERY



WHAT This project envisions the reclamation and repurposing of discarded granite curbs from a junkyard, facilitated by a sophisticated interplay of 3D scanning, CNC milling, and traditional woodworking techniques. The resulting elements serve as foundational piers for coastal sites, seamlessly integrating structural stability with material appeal.

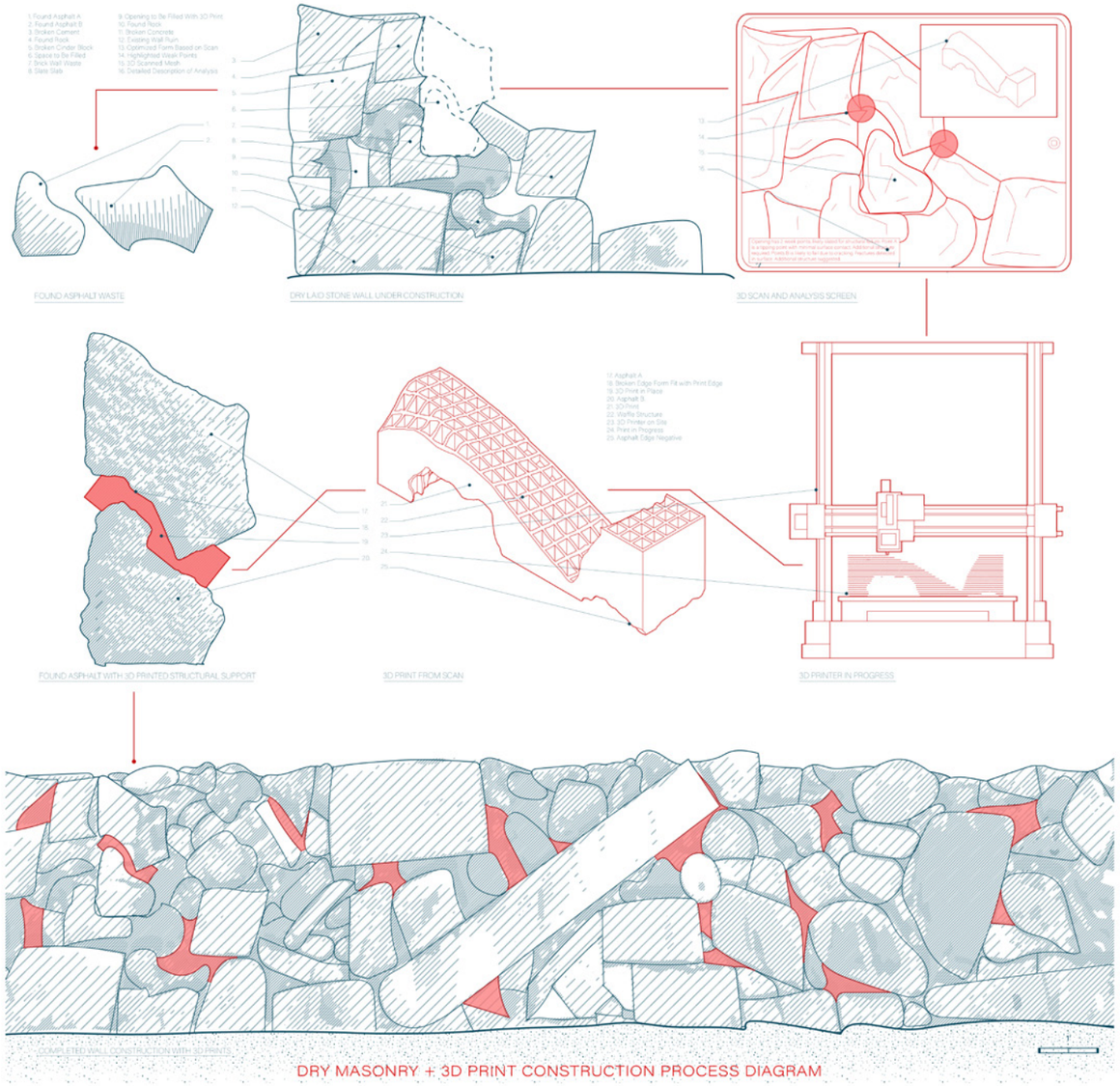
WHERE Situated within a coastal landscape, the reclamation process utilizes local infrastructural urban waste, which is still highly weather resistant and structurally valuable, fostering a dialogue between industrial detritus and natural surroundings.

WHO A team including computational designers, local manufacturers, woodworkers, and craftsmen collaborates to create this project. Through the utilization of advanced technologies such as 3D scanning and CNC milling, complemented by the skillful craftsmanship of traditional woodworkers, the project navigates the intricate interplay between digital fabrication and manual labor.

WHEN The construction process begins with the digital analysis of discarded granite curbs to identify optimal candidates for reuse. Once selected, the granite pieces are scanned, precisely mapping their geometries. A second piece of material undergoes precision CNC milling to create joinery interfaces tailored to the granite. Woodworkers can then peruse a catalog of available options, selecting components based on predefined criteria such as joint type, size, and cost. Woodworkers proceed to carve the complementary negative side of the joint, facilitating the seamless integration of wood and stone for a sturdy pier foundation.

WHY At its essence, the project not only mitigates environmental impact of newly quarried stone foundations but also embeds the built environment with a sense of narrative, authenticity, and local authorship.

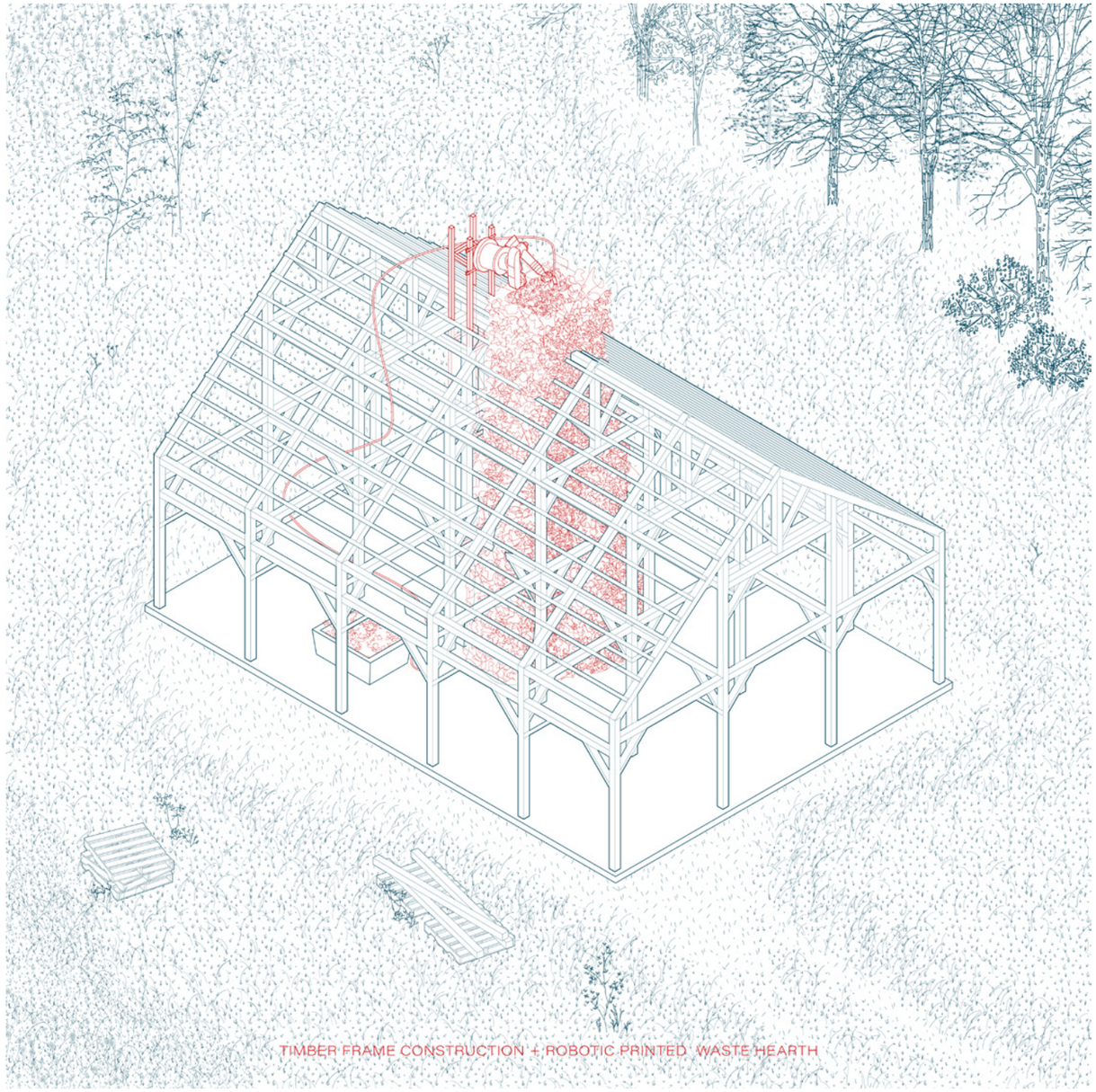
The first project pairs stone masonry with 3d printing. This project explores the creation of a dry-laid stone wall, meticulously crafted from reclaimed and post-consumer materials, including repurposed construction debris, site material, and other waste. The stonemason, orchestrates the tactile manipulation of raw materials. The 3D designer, orchestrates the augmentation of the stonemason's craftsmanship with precision-engineered solutions.



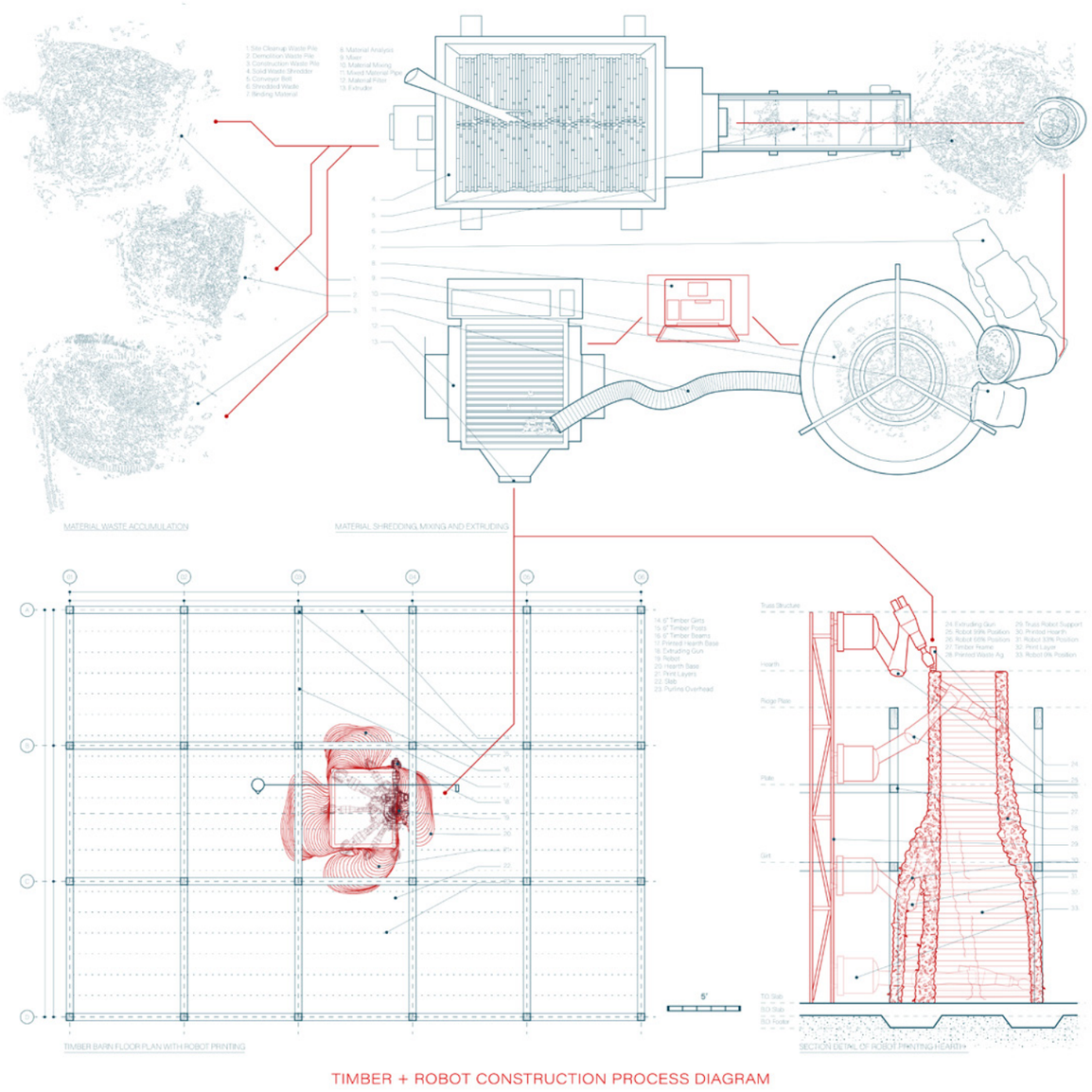
Initially, the stonemason commences with the foundational dry-laid stone wall construction. Concurrently, the 3D designer engages in a parallel endeavor, utilizing computational tools to analyze and augment the stonemason's work. As the construction progresses, collaborative dialogues ensue, with the 3D designer strategically intervening to address structural vulnerabilities and aesthetic refinements.

The model is made of two found pieces of broken asphalt which alone lack the ability to stack stably.

A precise 3D scan of the model allowed a 3D print to be made, which nests itself in the negative space between the stacked debris, adding stability.

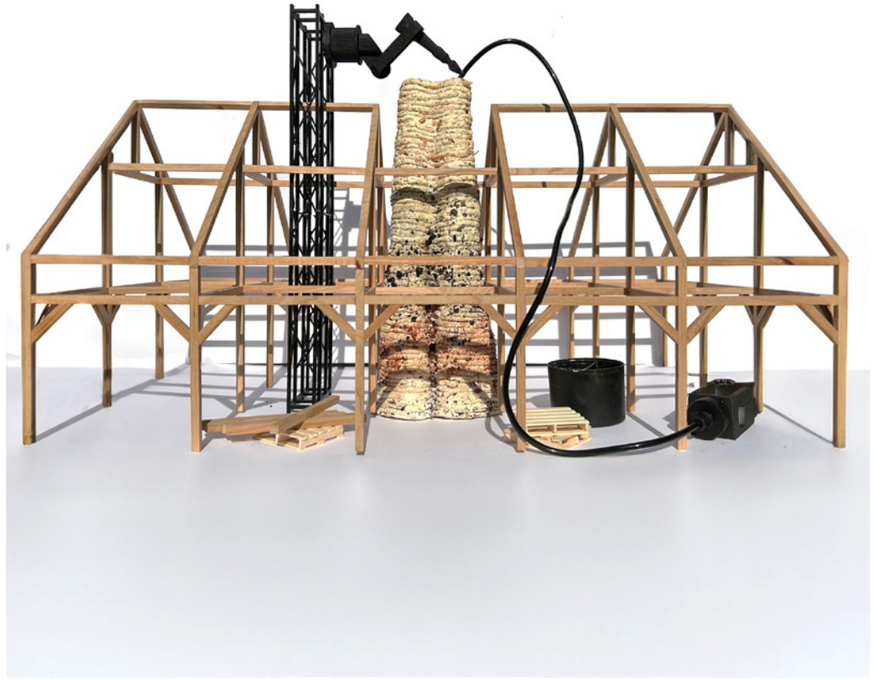


The next project is a collaboration between robotic printing and timber frame construction. At the nexus of this interdisciplinary collaboration are traditional timber builders and a computational designer and robot operator. The traditional builders orchestrate the manual assembly of the structural framework with precision and craftsmanship. Concurrently, the computational designer harnesses a choreography of the 3D printing robotic arm, infusing the hearth with a material narrative derived from local excavated earth, construction waste, and salvaged materials.



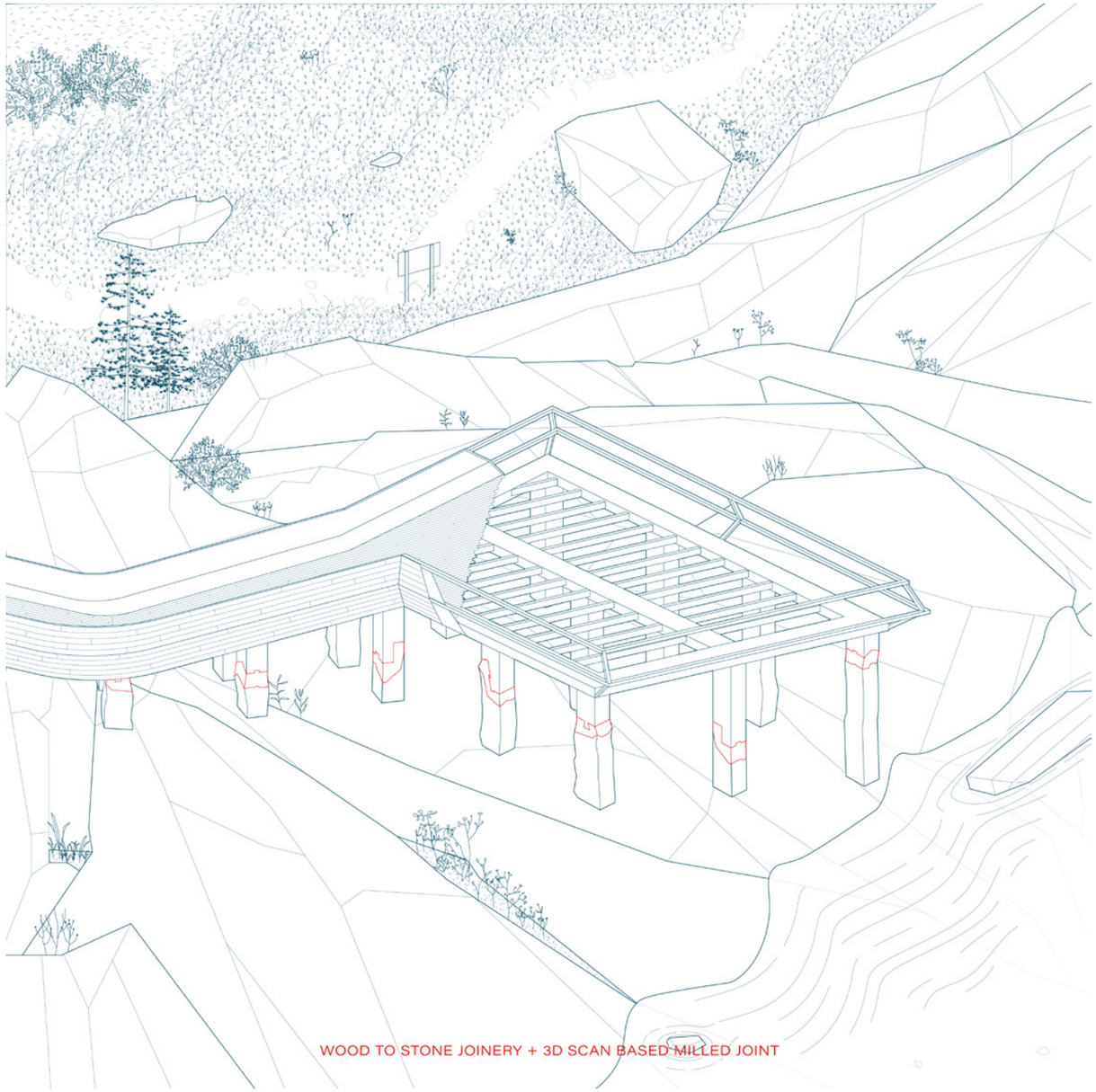
TIMBER + ROBOT CONSTRUCTION PROCESS DIAGRAM

As the timber frame takes shape under the traditional builders, the 3D printing robotic arm operates in tandem. The collected material is ground and blended with adhesives while being analyzed for material properties. The designer is able to respond to the changes in material with real time adjustments to the geometry, extrusion rate, and thickness.

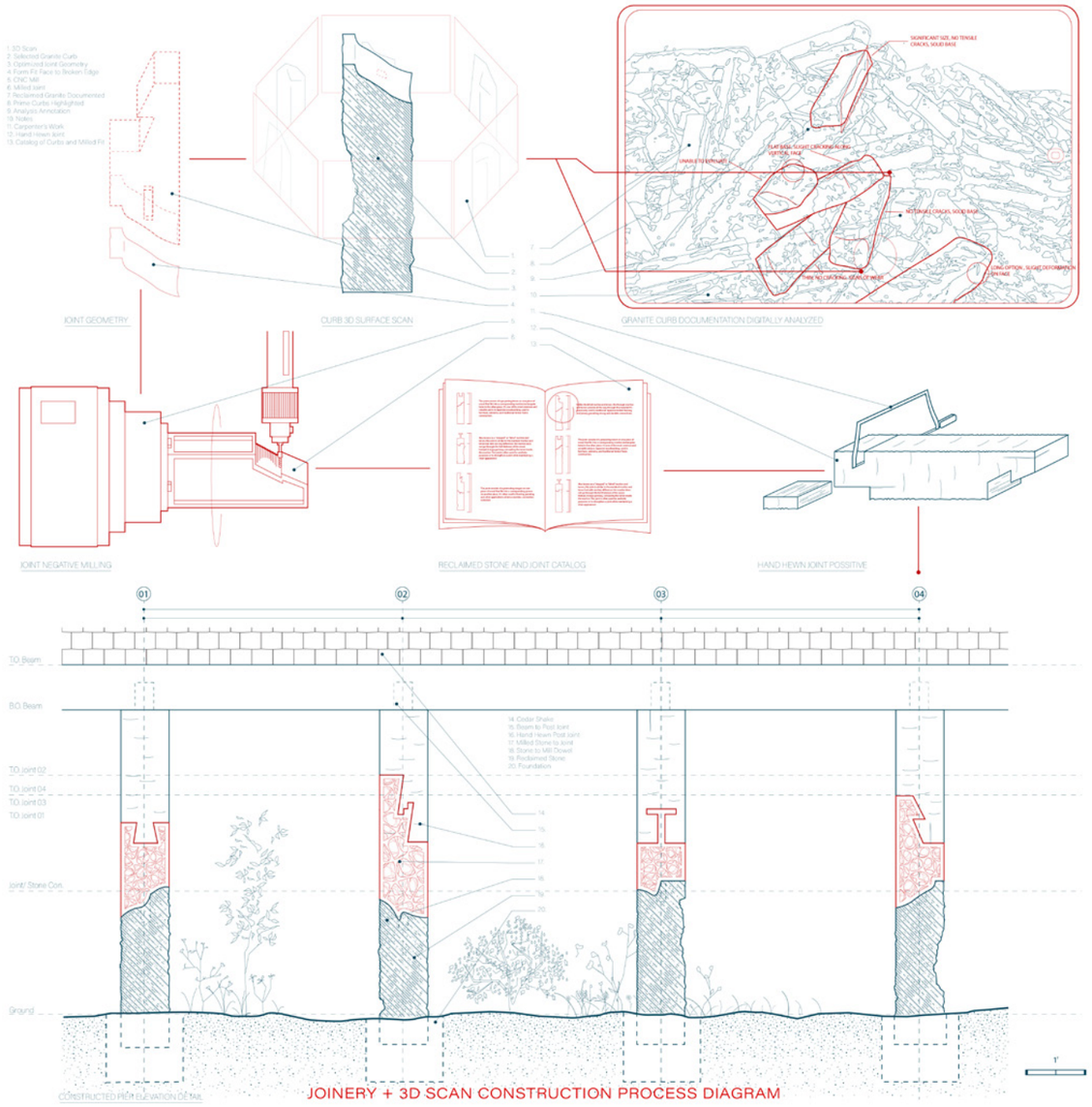


The hearth of the model was crafted utilizing an extrusion of waste from early model making experiments from all three projects, mixed with a ceramic binder. The geometry was optimized to create sufficient work area.

From the base to the opening, the hearth is made up of organic material from waste cleaning, bricks and asphalt from early masonry experiments, concrete from the joinery models, and wood blended from the offcuts of the timber frame.



The last project pairs CNC milling with traditional stone to wood joinery for pier foundations. The construction process begins with the digital analysis of discarded granite curbs to identify optimal candidates for reuse. Once selected, the granite pieces are scanned, precisely mapping their geometries. A second piece of material undergoes precision CNC milling to create joinery interfaces tailored to the granite.



JOINERY + 3D SCAN CONSTRUCTION PROCESS DIAGRAM

Woodworkers can then peruse a catalog of available options, selecting components based on predefined criteria such as joint type, size, and cost. Woodworkers proceed to carve the complementary negative side of the joint, facilitating the seamless integration of wood and stone for a sturdy pier foundation.

The model was created from broken sticks of concrete. Point-clouds of the fractures with analysed and iterated to 3D print a formfitting joint.

The precise dimensions of the printed joints were then used to hand craft the negative fitting joint from wood. The base of the wood is burnt for water protection.

Computation tends to lead to an undesirable homogeneity, and a lack of local cultural significance, where craft excels. Craft tends to lead to material and time inefficiencies, and a lack of technical significance, where computation excels. Paired together, they can better create efficient unique construction typologies. By reconceptualizing materials as active agents within the design process, architects can unlock the latent potential of site-specific resources.

This future allows once indistinguishable regions of the US to develop unique characters, based upon their people's diverse intangible cultural and ancestral heritage, while not fully relying upon the tools of the past. Individual projects are embedded with material and site histories, utilizing, and optimizing reclaimed local material in favor of "new" material. The seamless integration of computation alongside craft eases the navigation of complexities and unpredictabilities of reclaimed

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